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Poster abstracts

Cumulus PhD network

Acknowledgements

Nature Positive/Design for Transformation

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Introduction

The Track Nature Positive/Design for Transformation started off with a few big questions: Even if we are technologically able to do so, are we still allowed to create our designed environment as we see fit? How can we navigate through sustainable transitions and within planetary boundaries? Can a systemic lens help us creating an overview to better overcome the present and imminent future conflicts? And can we regenerate ecological and social damage done? Indeed, the futures we want tomorrow are enabled by the actions we take today. Shaping societies, industries, buildings, products, and behaviours is a task to tackle by those able to cut across different disciplines and become agents for change. A call out to designers around the globe to put nature positive transformation at the heart of their actions. Many of them have responded within the framework of this Cumulus Conference.

We received 150 abstracts that, after a double-blind review process, resulted in 37 high-quality academic papers. Furthermore, out of 17 workshop proposals, 5 were selected for the conference. In addition, the program for our track includes several visual papers and posters. 8 themes were identified that determined the final division in paper sessions.

The attention for ***Design Methodology***, a theme to which 2 sessions were allocated, is not surprising, since existing methods and tools are to be critically assessed with respect to the challenges we face. The envisioned transformation concerns a large-scale systems integration of deep ecology strategies, which is a complex endeavor. Departing from the notion that current design approaches are incapable of dealing with *uncertain* conditions of critical complexity, as argued by an increasing number of scholars, we need to break away from attraction to *existing* systems and values. At the same time, high levels of complexity pose new questions concerning ***Design Education***, which comprises another theme within our program. Philosophical and pedagogical concepts concerning design education are discussed, as well as the role of the physical learning space. Trans-disciplinarity is put forward as a mode of collaboration that looks beyond bridging divides in academia, engaging directly with external sources of knowledge. Internalizing environmental and social awareness has inherent material implications. A third theme has thus been dedicated to ***Design Materialization***. Within this theme, the future of material selection for products and interior design is discussed, amongst other topics. Enhanced guidelines for Life Cycle thinking are addressed in one of the papers, making the connection with circular material use: a hot topic in practices and policies alike. The act of repairing and caring for living systems in truly *restorationist ways* is closely connected to this, but often neglected in simplified circular concepts towards material use. The theme of ***Biophilic Approaches in Design*** elaborates further on such notions of restoration. Bio-receptive Design, as an example, embeds living organisms in design processes through the creation of materials and artefacts, whilst connecting design and biology. In another article, boundaries between living and non-living are pushed through the parametrical control of plants in the creation of furniture. As such, the biophilic approach centers on both local and global human/nature relationships. Other perspectives on those human/nature relationships are brought to the fore in the theme ***Eco-Social Transitions***. Here, the concepts of systems thinking, and co-creation have been connected to leadership and business, for example. One paper takes the role of Design as central to sustainable change processes, underscoring the transformative power of the designer to unlock solutions by sequencing seemingly distant dots and generating new meanings. One theme has been allocated completely to ***Fashion Innovations***. The diversity of angles varies from negotiations with fabrics, form, and future for re-balancing design thinking, to issues of greenwashing and brand communication, and from the importance of indigenous textiles and know-how to difficulties in changing unsustainable lifestyles. Although we have grouped these articles into one topical session, it can be observed that challenges and opportunities are in many ways overlapping with those in other fields of design. From that perspective, also the urban scale shows parallels, based on the rationale that human-centric approaches transcend scales through conscientious contextualization, as can be found in the session on ***Urban Design and Citizen Inclusion***. Time-limited planning of urban living circles, for instance, reconnects the physical proximity of urban residents with basic daily needs, such as food, health, and education. This gives way to slower means of traffic, such as walking and cycling, whilst reducing negative effects to human well-being, climate, and the environment. A similar scope can be found in yet another research, in which an innovative form of development is proposed to radically change the urban landscape in favor of a human-centric approach, by means of a quantitative measuring method. End-user inclusion is also central to a paper on Do-It-Yourself studies to establish new

'partnerships' between products and users. This can be filed under the act or process of *democratizing design*. And that aspect seems to join the various tracks within this Cumulus '23 Conference: no matter from which way one approaches it – nature positive, inclusion and care, hybrid realities, or otherwise – the *human scale* is paramount for understanding contemporary challenges and finding solutions. Talking of new methods to facilitate this, the digital world is never far away. The theme ***Design & Digitization*** showcases assets of computation regarding the shift from a degenerative societal paradigm, to a regenerative one. For example, through serious gaming to create awareness, understanding, and – ultimately – behavioral change. To increase imaginative capabilities, less conventional methods have been proposed for approaching unsustainable behavior. One study does not shy away from using dystopian futures, fantasy-scape, and even zombies, exploring new ways of inquiry and how (sub)conscious perceptions of time and space affect people's beliefs and the choices they make.

Choices made through design should always be 'nature-positive'. The opposite is no longer viable. If there is anything this selection of papers shares, it is that: in the transition we are all agents of change.

Scenario building through a systemic lens: a new perspective on tools and methods to design for sustainability transitions

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Abstract

The connection between sustainability and the future has its roots in the early days of environmental movements. The report 'The Limits to Growth' (Meadows et al., 1974) highlights how sustainable action implies wide-ranging, systemic considerations and forward-looking thinking. This is also reflected in the definition of Sustainable Development provided in the Report 'Our Common Future' (WCED, 1987). Working for sustainability, in fact, usually means taking a long-term approach, which also ties in with radical and socio-technical innovations. In recent times, however, the world has faced complex systemic social, technical, and environmental challenges, which will be increasingly interconnected and interdependent. Systems theory allows us to rethink such phenomena as isolated elements and complex systems made up of many interacting parts (Vargo et al., 2017). Placed in a timeline, it is possible to highlight how changing events are getting closer and vertical, showing us a new vision of time and the future. Scenario Building is a widely used method in design to generate future visions. By applying a systemic lens to this methodology, this paper aims to provide a new awareness through which it can emphasise the relationships that a new future implies and underlies. The analysis has made it possible to define new characteristics of Scenario Building that emphasise its relationships and spatio-temporal connections. These new considerations converge in the Design for Sustainability Transitions perspective, showing how the designer, thanks to the connections capacity and envisioning, plays a crucial role in transforming a socio-technical system (Ceschin & Gaziulusoy, 2019).

Author keywords

Systemic Design; Scenario Building; Design for Sustainability Transitions; Sustainability.

Introduction

In recent years the world has been facing significant systematic complex challenges such as climate change, inequities, and lack of natural resources heightened especially because of the Covid-19 pandemic, the conflict in Ukraine, and the climate crisis. The nature of these problems is multidimensional, and because of this, they will become increasingly intertwined and interdependent in the next years. Moreover, when placed on a timeline, these events show a shattering peculiarity that lies on a new vision of time and future that is not spread out linearly but is increasingly rhythmic and vertical, showing shorter and closer time gaps. As a result, many academics and industry professionals are looking at novel models that employ design skills, techniques, and expertise to inspire futuristic ideas and creative solutions. Consequently, in a world where the future is constantly crumbling and getting closer and closer, what are the new parameters to be considered? And yet, what contribution can Systemic Design make in this challenging task to be able to act concretely in the short-term with a long-term impact?

Using a systemic lens, this paper seeks to offer an overview of the tools and processes related to Scenario Building techniques. The paper initially analyse a theoretical background that explores the conceptual pillars of the three topics addressed: Scenario Building, Systemic Design and Design for Sustainability Transitions. Subsequently, the methodology implemented to analyse Scenario Building techniques through a systemic lens is shown. Insights from the analysis are reported in the last part of the paper highlighting a new perspective of Scenario Building, which is more relational, contextual and ecosystemic. Finally, limitations and opportunities are reported to foster further and subsequent research questions.

Theoretical background

Scenario building

Scenario Building is one of the most popular methods for defining possible futures. It is based on the fundamental scenario concept, often considered a synonym for vision (Carella & Marengoni, 2022). Historically, the first text on this methodology dates back to the 19th century, however, they spread from the Second World War onwards, moving from the military to the public and finally into the private sphere (Bradfield et al., 2005; von Reibnitz, 1988). Since they deal with the future, scenarios fall within the discipline of Future Studies (also known as futures field or foresight), i.e. the systematic study of possible, probable and preferable futures (Carella & Marengoni, 2022). Scenarios are considered the archetypal products of the discipline and are condensed representa-

tions of possible futures with different plausible paths and endings, told in coherent and engaging forms (Bishop et al., 2007; Buehring & Bishop, 2020). These contain a vast amount of information on a single topic that is useful in defining a historical, social, cultural, manufacturing, technological and environmental context, thus composing the points of view, relationships and flows between the elements (Bistagnino, 2009). Thus, scenarios require a comprehensive look, where the present is a fundamental part, to provide a holistic schematic view of futures that are not only possible but also desirable (Sardesai et al., 2021). The capability of the designer is to use the vast amount of information to create narratives that are open, interpretable, and exciting, yet concrete and palpable. A correct balance of technical feasibility, economic viability, and desirability (Zurlo et al., 2020). This is also thanks to the designer's freedom and ability to observe multiple levels, understood as different dimensional scales (from product to systems) and different times and insights. Design is, therefore, a carrier of values and beliefs, but also tools and methods capable of helping those who make strategic decisions in uncertain times. In particular, Strategic Design can confront this uncertainty, defining strategic directions through scenarios and glimpsing opportunities in the external environment (Zurlo et al., 2020). Here is possible to find a common goal between design disciplines and foresight; both seek to make sense of uncertain futures through scenarios, inspiring and communicating possible (better) futures (Buehring & Bishop, 2020). The role of the designer in scenario building is also to act both as a facilitator in the realisation of scenarios and as a mediator in defining the steps to reach these futures (Gaziulusoy & Ryan, 2017). Scenario development for designers can be a means for both stakeholder engagement, realisation of strategic pathways and alternative systems for sustainable transition (Gaziulusoy & Oztekin, 2019).

Systemic design

In the previous paragraph a strong need emerged for interconnections and relationships between events, people, and phenomena, all essential elements of systems thinking and Systemic Design. The latter stems from the opportunity to integrate systems thinking theory into design through the three levels of sustainability: environmental, social, and economic (Barbero & Pereno, 2020; van der Bijl-Brouwer & Malcolm, 2020). Systems thinking emerged about 100 years ago and is based on the axiom that the *"whole is much more than the sum of its parts"* (van der Bijl-Brouwer & Malcolm, 2020). Systemic Design (or System-Oriented Design) has been formalised by Luigi Bistagnino in 2009 as a local economic model based on networks of relationships capable of exploiting the waste of one production system into resources for another. It is a design approach inspired by natural models, where resources are never wasted, but with a relational and territorial focus typical of industrial ecology (Ceschin & Gaziulusoy, 2019). Because of this, the goal of Systemic Design is not only to design products, but rather complex industrial systems where flows of energy and matter never become waste and damage the environment but are metabolised, reducing environmental impact and creating new economic opportunities (Barbero & Toso, 2010; Bistagnino & Campagnaro, 2014). Although similarities can be made with other design approaches, such as System Design, Service Design or Life-Cycle Design, Systemic Design differs in terms of scale, complex social systems, and integration (Jones, 2020). The Systemic Design approach, however, calls for capabilities from the designer that are also recurrent in other approaches, such as his strong relational and mediation skills, or his ability to grasp causal relationships between different elements (Barbero & Cozzo, 2009; Bistagnino & Campagnaro, 2014). Visualisation skills are also recurrent, necessary to trace and communicate the flows and relationships between actors and the system context (Mosca et al., 2015). The designer is assisted by methods and tools that have emerged in the last decade to support the practical application of Systemic Design. Namahn, in collaboration with shiftN, SDA, MaRS have developed the Systemic Design toolkit to guide the designer (van Ael et al., 2019). The toolkit consists of several frameworks and templates, which guide the designer step by step, from analysing the system to fostering the transition.

Design for Sustainability Transitions

It is important to emphasise the topic of transition since this represents the meeting point of both Scenario Building and Systemic Design. The former, as previously mentioned, aims to imagine the future to define new products, services, and strategies; the latter triggers a change, a transition from one state to another, of a territory or a community. Design for Sustainability Transitions (DfST) or Transition Design focuses on the transformation of socio-technical systems by promoting technological, social, organisational and institutional innovation (Ceschin & Gaziulusoy, 2019). The transformations that DfST aims to promote are *de facto* systemic changes affecting both production and consumption systems, as well as social systems, through a change in institutions, organisations, socio-cultural constructs and technology (Geels, 2005; Loorbach, 2010). However, technology is not seen as a unique and pre-determined means through which these changes can be achieved, but rather as a system element supporting the transition. Such complexity is often associated with wicked problems, i.e. ill-defined, political and systemic problems (Rittel & Webber, 1973). Designers, and strategic design are used to tackle such problems by analysing them, re-framing, looking ahead and proposing innovative solutions (Zurlo, 2022). Transitions are achieved by promoting long-term visions and transition pathways with step-forwards and step-backs made of materials, products, services, new behaviours and new policies necessary to achieve the imagined futures (Ceschin & Gaziulusoy, 2019). Indeed, transitions need to imagine new futures. Still, they also need new configurations of actors, new systems, but also facilitators of participatory processes and strategic decision-making (Gaziulusoy & Ryan, 2017). We can conclude that DfST frames Scenario Building and Systemic Design in a transformational perspective, giving them a clear direction and not just absorbing their methods and tools. Since DfST is a young approach, it is necessary to consolidate and clarify its theoretical foundations, initiating a dialogue with real experiences in which methods and tools are applied and possibly adapted to different contexts and situations.

Methodology

The aim of this paper is to identify the contribution of Systemic Design in introducing new parameters to lead the Scenario Building methodology toward a sustainable transition perspective. Therefore, an exploratory case study methodol-

ogy was planned, in order to obtain insights from real experiences and best practices.

Empirical setting

Six cases that apply the Scenario Building methodology has been identified to be analysed trough a systemic lens. We selected and identified the cases according to the following parameters:

- Cases with different time horizons (short, mid and long term);
- Cases in which the application of Scenario Building has different objectives (reading a phenomenon, identifying strategic directions, defining project briefs ...)
- Cases that have had a real potential fallout/impact.

The case studies differ in the trigger of the process, but all address concrete problems faced mainly by organization of the secondary and third sector from different industries.

Data collection

We conducted semi-structured interviews to get first-hand data with senior design researchers, responsible and actively involved in the design research and Scenario Building activities of the analysed case studies. Each interview lasted on an average of 1 hour. We applied a research protocol structured in four main sections:

- **General information:** aims at collecting information on the project typology, content, aim, time horizon, people involved (quantity and professional background);
- **Scenario Building process:** aim at understanding activity conducted in the research phase (typologies and relevance in the process), and in the scenario generation phase (format, people involved, output);
- **Results and Impact:** aim at understanding the Scenario results, their usage and impact (realization, adoption and feasibility), if measurable;
- **Self-assessment:** aim at understanding pro and cons of the process adopted and what could be changed.

Data analysis

Based on the interviews, factual elements were examined with the aim of identifying commonalities and differences in the use of Scenario Building. More specifically, data were clustered according to the following variables:

- **Client typology**, to highlight the different sectors and company typologies commissioning the project, if any;
- **Content**, to analyse the territorial, socio-economic and sectoral variables that define the context in which the scenario is to be set;
- **Time**, to identify the time horizon of each case study;
- **Format**, to highlight the different ways in which the process is conducted;
- **Participant typology**, to identify the variety of people involved in the process;
- **Journey**, to analyse the sequence of the different actions performed during the process;
- **Research activities**, to highlight the different research activities conducted and understand their role in the process;
- **Involvement of experts**, if any, to identify when they were involved and in what role;
- **Output**, to examine the variety of formats in which a scenario is delivered;
- **Outcome**, to investigate how the scenario's results are used;
- **Impact**, to verify the impact of the scenarios in terms of fulfilment and feasibility.

Then we searched for regularities and patterns, trying to understand which of the above variables had a greater role and weight in the Scenario Building process and its realisation. Finally, we looked at the variables used to analyse the Scenario Building process through a systemic lens, to understand whether Systemic Design can help turn Scenario Building into a tool for the sustainable transition. To do this, we studied a number of Systemic Design toolkits, in particular the Social Ecosystem Map developed by Namahn and shiftN in 2016, to understand the different levels of an ecosystem and its importance in the systemic approach as opposed to that in the Scenario Building process, where context is usually considered one of the elements to be observed in the definition of a user-centred vision. With the toolkit, we began analysing the Scenario Building process of the selected cases by observing whether the different levels of the ecosystem had been considered within the research phase and whether the impact of the scenarios on the different levels of the ecosystem had been reached.

Results & discussion

Thanks to the literature review and the analysis, it was possible to recognise and highlight patterns and reflections with Scenario Building and Systemic Design as their common point (Fig.1). Before exploring the outcomes of this research, it is necessary to cluster the results that emerged into two macro groups, those relating to the process of Scenario Building and those relating to its context. Regarding the former, it was interesting to note how the various research phases are fundamental to creating a solid base of work and envisioning capabilities. It is a common and consolidated practice to perform at the beginning of the Scenario Building methodology an initial research that allows the researchers or designers to grasp the conditions of the context of the users that characterise the background in which the project will be placed. This is done mainly through PEST analysis (political, economic, social, and technological) and user research. The former is that desk research activity that allows the participants to gather data regarding the context by extrapolating socio-cultural and technological trends, giving a snapshot as both a starting and ending point of the market, society, and context. Within this research category, it is possible to find blue sky research, trend, and mega trend research. The exploratory case study analysis showed how those trends, whether inspirational or innovative, strongly linked to the imposed time frame allow the designers or researchers to make the subsequent envisioning work truly feasible. On the other hand, the user research makes it possible to collect qualitative and quantitative data on the user under consideration. In the case studies with the most significant impact, it is possible to see how user research offers a more excellent systemic vision of the context where the analysis focuses not only on the user, but on the entire ecosystem of actors surrounding him. This means identifying, investigating, synthesising, and visualising not only the latent or non-latent needs of the user but the re-

lationships that exist in the context as an ecosystem of actors, actions, and touchpoints.

Figure 1. Pathway of research and analysis of Scenario Building towards sustainable transition through the systemic lens. The contribution of this work of revision, analysis and updating of the Scenario Building methodology, therefore, sees the importance of the research phase not as a critical and superfluous step offering volatile hints without a possibility of concreteness; indeed, it is a fundamental phase, especially if spread throughout the process and not just its initial steps, because it empowers the scenario researcher or designer, creating awareness and helpful knowledge to make the scenario real, be it in the short, medium or long term. Just as the system is increasingly recognised as a living ecology that grows, declines, changes, and evolves (Sevaldson, 2022; Walker et al., 2004) the scenario has indeed similar intrinsic peculiarities. Even more revealing is the fact that a new awareness of Scenario Building towards sustainable transition has emerged from this analysis, namely the realisation that the scenario is not a static snapshot of something to be achieved, but is a dynamic ecosystem of actors, relationships, and actions in constant evolution. In recent years, scholars and practitioners have been able to verify and agree on how reality is increasingly showing its complexity and how systemic and strategic skills are increasingly valuable for visualising, anticipating, and dealing with these complex realities or systems. The complexity lies in the network of relationships between different actors, actions, and touchpoints, which inevitably imply new research and design methods. And it is here that Systemic Design comes into play, the encounter between systems thinking and design thinking, skills that are useful for grasping the nodes and edges of every system, be it micro, meso or macro, ranging from the individual to society to the environment and so on. It is no coincidence that new design trends incite us to think and consider non-humans as well, both for the benefit of humanity and the entire planet. Therefore, it has become necessary to try to grasp those patterns useful for building dynamic ecosystem scenarios, capable of affecting and intervening both the small to the large and vice versa. In order to aspire to a sustainable transition, it is necessary to research, ideate and implement this new awareness that the scenario is a dynamic ecosystem based on two fundamental characteristics and dimensions:

1. **Scenario as a set of contextual relationships:** that considers the entire network of actors and relationships that exist in its given context.
2. **Scenario as a spatio-temporal ecosystem:** that considers its positioning and evolution in a spatio-temporal dimension.

An example that can be briefly reported is one carried out in collaboration with a prefab house manufacturer in southern Italy, performed in 2018, with a two-year time horizon. The process saw an initial research phase followed by the brief reframing and then the development of scenarios, presented through cards with visual stimuli, and possible design directions. The scenarios stimulated the company's designers in the realisation of a modular and reusable product, later launched on the market. The analysis phase focused on the ecosystem of actors and stakeholders, looking at their needs, socio-cultural and value context, as well as the market, the brand partner and blue-sky stimuli. As previously mentioned, this information highlighted the network of actors and their relationships, not only understood as exchanges of money, information or goods, bringing out critical points and possibilities (scenario as a set of contextual relationship). It also highlighted possible changes in time and space of the actors, context and relationship giving the possibility to imagine their evolution in an organic sense (scenario a spatio-temporal ecosystem).

The new characteristics presented must be considered throughout the entire scenario process, especially in its implementation. This awareness should therefore contribute to a strategic plan of sense and purpose to make the scenario viable, feasible and sustainable aware.

Conclusion

Through the systemic lens, it was possible to highlight how the scenario is inherently relation-based and a spatio-temporal ecosystem. In this new interpretation, scenarios are seen as dynamic systems, changing in time and space. Scenario analysis and development with this in mind should allow companies, organisations, institutions, and communities to be guided through a sustainable transition, connecting the needs of today with those of tomorrow, avoiding blind spots. Such awareness opens further research opportunities. First of all, it is important to ask whether the skills and capabilities of today's designers are adequate to deal with the complexity that a systemic scenario requires, and if so, which of these

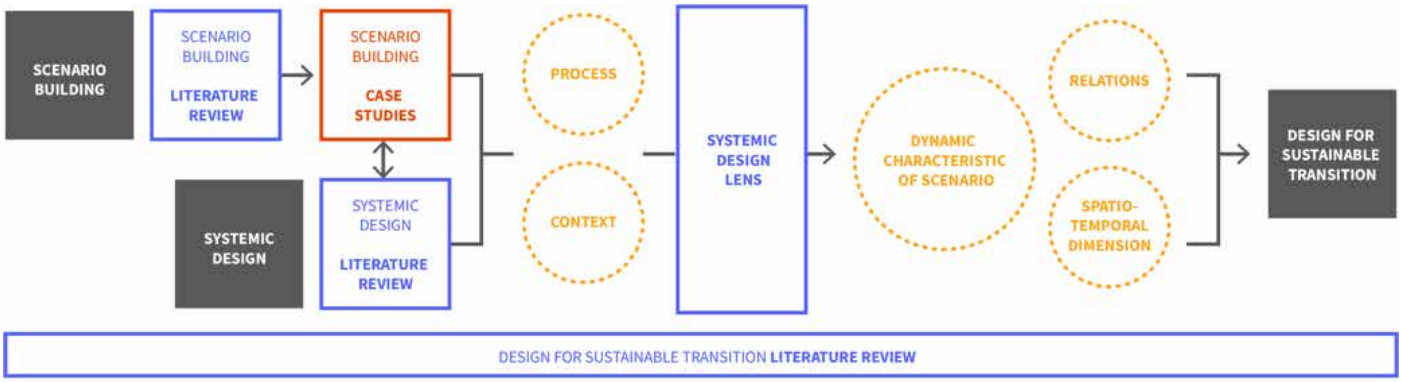

Figure 1. Pathway of research and analysis of Scenario Building towards sustainable transition through the systemic lens.

should be implemented. Furthermore, it would be interesting to understand whether the tools used for Scenario Building support or limit such systemic vision, both in research, scenario development and narration. If necessary, it might be interesting to develop new ones. This aspect can also be interpreted as a limitation of this research, since a systematic analysis of the tools might bring out new considerations. The tools connect us to a more participative and actionable dimension, so a further opportunity could be to test scenario development from a systemic perspective with organisations and company figures. This allows to understand how these concepts fit into organisational strategic and operational terms and how non-academic figures react to such complexity. To conclude, from a field-testing perspective, it would be interesting to understand if and how this perspective allows for the strengthening or creation of new relationships between different stakeholders to foster collaboration and implementation towards increasingly complex objectives and the sustainable transition of socio-technical systems.

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Intimacy/Integrity: a framework for thinking about epistemological styles in design activity

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Abstract

Design research has established several dichotomies around styles of knowing and thinking, such as 'thinking vs. doing' (e.g., Bagchi, 2020), 'intuitive vs. deliberate" (e.g., Schaathun, 2022; Jones, 1992), or 'rational problem solving vs. reflective practice' (e.g., Dorst, 1997). In this paper, the authors explore and integrate these dichotomies using the 'intimacy/integrity' framework proposed by Kasulis (2002). The 'intimacy' and 'integrity' pair is presented as a heuristic device that can help us characterize two broad ways people develop and present arguments, generate knowledge, establish values, and even develop a metaphysics. An integrity orientation separates object and subject, and knowledge is objective and verifiable. In contrast, an intimacy orientation blurs the line between object and subject, and the self is relational. In an integrity framework, the knower and the known (whether a thing or another being) have each an individual, well-delineated identity, while in the intimacy orientation knower and known (the self and the other) are interdependent and intertwined with one another, and can't be seen as separated units. The paper centrally argues that his framework serves to examine alternative individual styles of thinking in design practice. Furthermore, the authors posit that Kasulis' framework is a useful lens to examine design theory and methodology and can enrich ongoing debates. In particular, the paper explores the aforementioned dichotomies to show they can be advantageously subsumed into Kasulis' conceptual apparatus, which is more overarching and has greater explanatory power.

Author keywords

Epistemological difference, ethics, intuition, rationality, problem-solving.

Introduction

Several interrelated dichotomies around styles of knowing and thinking in design activity have been established in the field of scholarly design research over the years, such as 'rational problem solving vs. reflective practice' (e.g., Dorst, 1997). In this paper, we engage with these dichotomies through the lens of a framework for conceptualising different styles of knowing and thinking proposed by philosopher Thomas Kasulis (2002). This framework, itself a heuristic device, gravitates around two central notions: those of 'intimacy' and 'integrity', which characterise two broad cultural orientations in the way people develop and present arguments, generate knowledge, establish values, and even develop a metaphysics.

Building on an analysis of well-known dichotomies, we posit that Kasulis's heuristic framework is a useful lens to examine design reasoning. We are of the view that the 'intimacy-integrity' perspective can extend and enrich ongoing professional and academic debates and perspectives on epistemological diversity in design activity. What's more, we argue that Kasulis' conceptual apparatus serves to subsume frequent terminology ('intuition', 'rationality', 'doing', etc.) into a richer and more overarching heuristic that has greater explanatory power than the traditional opposites we are familiar with in design research and practice. It is, however, not our intention to argue that either of these terms and taxonomies is wrong or false. All of them have explanatory power and have proven to be useful to advance design theory and methodology. Our claim is simply that the integrity/intimacy framework encapsulates and links many of these.

The content of the paper proceeds as follows. In the next section, we introduce and briefly discuss three conflicting perspectives—i.e., dichotomies—for conceptualising design activity. This section is followed by an overview of Kasulis' framework. Together, the dichotomies and Kasulis' framework serve as a springboard for the constructive argument we'll develop in the Discussion section. We close with a general conclusion.

Dichotomies in design

We will concentrate on three well-discussed dichotomies: 'thinking vs. doing' (e.g., Bagchi, 2020), 'intuitive vs. deliberate" (e.g., Schaathun, 2022; Jones, 1992), and 'rational problem solving vs. reflective practice' (e.g., Dorst, 1997). These are particular lenses through which different styles of knowing and thinking are often approached and studied. They are the result of different normative and descriptive perspectives on the design process and design activity.

Furthermore, because they are directly linked to deep-seated ways of understanding what design *is*, they are still enormously popular and part of the professional and scholarly design vocabulary. Nonetheless, their putative conflicting nature has also been challenged in recent years (see e.g., Schaathun, 2022; Guersenzvaig, 2015). Before we attempt to present Kasulis' framework as a suitable alternative; i.e., a richer way of conceptualising different styles of knowing and thinking in design, we will briefly introduce these perspectives.

Thinking vs doing

One dichotomy we frequently encounter is an elementary one: the distinction between thinking and doing, in which these activities are conceptualised as distinct modes of knowing and acting.

'Thinking', in the context of this dichotomy, has a meaning akin to 'reasoning', involving the contemplating, examining and evaluating that are classically involved in analytical problem-solving:

> You're a [design] thinker if you like understanding every aspect of the problem statement, solving it in the abstract confines of your mind before you even put pen to paper. People know you for being thoughtful, precise and consistent (Bagchi, 2020).

On the other hand, 'doing' is a portmanteau term for imagining and shaping activities *as a way* to solve and explore problems without the need for a preceding full-blown problem definition. Thus, as a design doer:

> You love solving problems and believe in rapid iterations. People know you for making decisions and moving quickly. You're known for being adaptable and tactical. [...] You're not afraid to be scrappy and find quick ways to test your ideas (Bagchi, 2020).

The distinction between thinking and doing, however, is as helpful as problematic. Bryan Lawson (2006, p. 137), although using a somewhat different vocabulary, questions it here:

> If reasoning and imagining were truly independent categories of thought, one should not be able to speak sensibly of 'creative problem-solving' or a 'logical artistic development', which are both quite meaningful concepts.

We follow Lawson in that 'thinking' and 'doing' are just different epistemological styles employed by designers, not monolithic and exclusionary descriptions of personality types. Rather, these modes are alternative—though interrelated, as we shall see—styles of knowing, reasoning, and acting. Claiming that no designer exclusively employs one single epistemological style is an uncontroversial statement, as modal shifts between, for instance, drawing and evaluating have been consistently shown in design research since the mid-nineties (see e.g. Cross, Christiaans and Dorst, 1994; Akin and Lin, 1996). What's more, one of the most crucial findings in design research is that given the nature of design problems, the designer is in most cases unable to move linearly from problem to solution precisely because these entities co-evolve. These modal shifts obey the logic of the constructivist task of co-defining problem and solution (see e.g., Dorst, 2017, pp. 21, 24, 25, 28, 71).

Despite all this, the dichotomy between thinking and doing is persistent and ubiquitous in design activity. Plausibly, it might be even constitutive of the Western way of understanding knowledge itself, as it was no one less than Aristotle, who famously divided knowledge into *theoria* (Greek for theoretical knowledge), *praxis* (practical knowledge), and *poiēsis* (productive knowledge) (*Meta* 1025b 25). Hence its inclusion in this list.

Intuitive vs. deliberate processes

Another frequent dichotomy is the distinction between 'intuitive' and 'deliberate processes'. We find a canonical instantiation of the dichotomy in the classification of designers as 'black boxes' and 'glass boxes' made by John Chris Jones (1992).

On the black box extreme, Jones describes the designer as a kind of magician whose mind performs mysterious creative leaps that produce a result through an unknowable process. According to Jones (1992, p. 46), for the defenders of this view: '[the designer] is capable of producing outputs in which he has confidence, and which often succeed, without his being able to say how these outputs were obtained.'

The black box view of designing is anchored on common definitional features of intuition. Herbert Simon (1992, p.13) highlights the (at least partial) lack of awareness that, in line with black box design, is characteristic of intuition: 'a performance that is speedy and for which the expert is unable to describe in detail the reasoning or other process that produced the answer.' Intuition is more a category than a homogeneous cognitive process and there is both agreement and controversy about what intuition is. Glöckner & Witteman (2010, pp. 5-6) find common ground between alternative views:

> Intuition is based on automatic processes that rely on knowledge structures that are acquired by (different kinds of) learning. They operate at least partially without people's awareness and result in feelings, signals, or interpretations.

The intuitive 'black box' perspective can be contrasted to the deliberate, conscious processes that are characteristic of 'glass box' designing. The designer as a Glass Box operates computationally to produce an optimal result. In this view, designers carry out a perfectly discernible design process which is transparent, hence the glass, and it can be rationally explained. A canonical sequential process (see e.g., Cross, 2008) is structured around at least three clear stages: (1) a stage of analysis consisting of a list of requirements and a performance specification, (2) a stage of synthesis consisting in finding solutions for every performance specification, and (3) evaluating these solutions according to various criteria (e.g. cost-effectiveness, ease of use, commercial impact, etc.). The characteristics of these models are: (1) objectives and criteria are fixed in advance, (2) analysis is completed before solutions are sought, (3) evaluation is logical (not empirical), and (4) strategies are fixed in advance (Jones, 1992). An early example of a deliberate process is the systematic model of design proposed by Archer in 1965 and a more recent example is the one proposed by Pahl & Beitz in 1999 (see Jones 2008, pp. 34-41).

Granted, these are just two models of design activity and many other models do not proceed linearly from problem to solution but highlight the co-evolution of the problem-solution pair (Dorst, 2017, p. 21). However, the logical linearity embedded in the 'glass box' methods has been for decades hailed as a standard even in process models that are purportedly iterative and less rationalistic than the classic ones—think of the all ubiquitous 'Double Diamond' model of design (Ball, 2019).

Paradigms of rational problem-solving vs. reflective practice

We based this dichotomy on a distinction made by Dorst (1997), in which design methods can be seen to belong to either one of two paradigmatic perspectives on design:

1. The paradigm of design as rational problem solving
2. The paradigm of design as reflective practice

Let's consider the first paradigm. In line with 'The Sciences of the Artificial' (Simon, 1996 [1969]), the most influential work within this paradigm, design can be understood as a rational search process: the designer defines the problem space that has to be examined in search of a satisfactory solution. This paradigm is registered within a positivist outlook on science with a strong emphasis on rigour: objective observation and logical analysis must lead to general formal models of the design process. The *rationalistic*, deliberate models and methods discussed above can be assigned to this paradigm. While more could be said about it, due to space reasons we switch to the other part of the dichotomy.[1]

The publication of 'The Reflective Practitioner' (Schön, 1983) marks a point of inflexion in design methodology whereby early rationalistic methods are superseded by the paradigm of the designer as a *reflective practitioner*, in which the design process can be seen as a reflective conversation with the situation. This paradigm views design as inherently argumentative and constructivist, in the words of Schön (1983, p.79):

> Because of [...] complexity, the designer's moves tend, happily or unhappily, to produce consequences other than those intended. When this happens, the designer may take account of the unintended changes he has made in the situation by forming new appreciations and understanding and by making new moves. He shapes the situation in accordance with his initial appreciation of it, the situation 'talks back', and he responds to the situation's back-talk.
>
> In a good process of design, this conversation with the situation is reflective. In answer to the situation's back-talk, the designer reflects-in-action on the construction of the problem, the strategies of action, or the model of the phenomena, which have been implicit in his moves.

The reflective turn moves the designer away from technical rationality and thus from the separation of knowing from doing. It fully positions the designer in a situated rationality of reflection *in practice*. Schön highlights alternative epistemic styles other than applying general principles and standard scientific knowledge to dealing with ill-defined problems. This new stage in methodology and epistemology 'tried to embrace a wide range of issues (poetical, rhetorical, phenomenological, hermeneutical, and ethical) in order to obtain greater insights and an improved understanding of the design phenomenon' (Bousbaci, p. 39).[2]

The paradigm of design as a reflective practice is a constructionist epistemology, where means and ends are inevitably intertwined. Knowledge is often tacit and situated in a practice. It is thus a radically different paradigm that arises in reaction to the rationalist paradigm. For Dorst (1997, p.70), in 'reflective practice design tasks may be analysed and subdivided in a number of different ways, and there is no a priori way to determine which approach will be the more fruitful. Therefore, design task and solution are always and inherently developed together.'

As Dorst argues, both paradigms are useful in approaching different design problems and each of them can be applied to one of the two fundamental classes of design activities:

1. *Objective interpretation* activities in which the interpretations of design or solution are based on an impression caused by something beyond the designer, which prints meaning on the subject. In this case, the designer behaves according to the rational problem-solving paradigm.
2. Activities that suggest *subjective interpretation* or the modification of the design tasks print meaning or value on it—Schön (1984) calls it framing; i.e., a particular way to perceive a design situation. In this case, it is the subject that prints meaning on something. These kinds of activities can be better addressed from the paradigm of reflective practice.

To Schaathun (2022), Simon and Schön have more in common than suggested. Namely, they share the view that practical reason is indispensable to deal with real-world problems. However, one important difference remains. Unlike Simon, Schön invokes a distinctly human power to *see-as* for goal setting; i.e., for figuring out what to do in terms of being a human individual, in a way that is different from the prevailing scientific paradigm.

Mapping dichotomies: the 'generation game' in design methodology

Design's methodological and epistemological developments since the 1960s are discussed in a historical timeline called the 'generation game' (Cross, 1981; Bousbaci, 2008). The 'generation game' illustrates the profound changes that occurred in design methodology from the first generation of rationalistic design methods, at one extreme of the timeline, to the reflective turn at the other extreme.

We believe the dichotomies we explored above come back as conceptual building blocks in this well-known historical timeline. The dichotomous terminology can be mapped onto this timeline rather neatly. Consider, for instance, Bousbaci's (2008, p. 38) description of the origin of the first-generation design methods in terms of 'a strong reaction against the intuitive, artistic, and 'beaux-arts'' vision of the design process [in favour of a] very logical, systematic, and rationalist view of design activities'.

Along these lines and using the terminology from the dichotomies, first-generation methods could be characterised as thinking-centred, deliberate, rational problem-solving, with the glass-box as a model for the designer. There's a caveat, we can see that to obtain a rich description we need to interlace terminology from several dichotomies. More needs to be said about this but we will expand on these themes later through the integrity-intimacy lens. First, we need to introduce Kasulis' framework in the next section.

The integrity/intimacy framework

Originally, Kasulis's intimacy versus integrity framework is presented as a way of understanding and analysing cultural differences in styles of generating, validating and transmitting knowledge. According to this framework, cultures, relationships and thinking models can be characterised as either emphasising

1 Simon made profound changes to his own theory in the third edition of his influential book in 1996, conceding that due to their limited cognitive capabilities, humans cannot oversee all aspects of a problem, which invalidates the early methods to a certain extent due to their psychological implausibility.

2 Due to space reasons, we take no issue with establishing whether more recent streams in design research and practice such as 'Speculative design' (e.g., Dunne & Raby, 2013) or 'Design for the pluriverse' (e.g., Escobar, 2018) are part of the reflective turn, an evolution thereof, or something new altogether. We believe that for the purposes of this paper, answering this question isn't necessary.

intimacy or integrity.[3] Even though Kasulis is more interested in comparative philosophy (i.e., comparing cultures and geographies), we believe his framework serves also to examine alternative individual styles of thinking, which also manifest within a given subculture or practice, such as design practice.

Intimacy

Kasulis characterises 'intimacy' as making known to a close friend what is innermost (Kasulis 2002, p. 42). Intimacy-oriented cultures place a high value on emotional connections and personal relationships, to create a feeling of belonging-with. According to Kasulis (2002, p 46), the main characteristics of an intimacy mindset are:

1. Intimacy is objective but it is personal, not public.
2. Within an intimate relationship, self and other are connected in a way that it is not easy to distinguish them.
3. Intimate knowledge has an emotional, affective dimension.
4. Because of such an emotional dimension, besides being a psychological state, intimacy is also somatic.
5. In general, the ground of intimacy is not self-conscious, reflective or self-illuminating.

When these five characteristics are present, the subject will build a feeling of belonging with the situation they are in. Intimate knowledge is therefore extensive as well as intensive: someone knows something intimately if that knowledge is key for them; i.e., if it is part of their definition as a person.

A relevant process of learning within an intimacy framework is empathic imagination. According to Kasulis, this is a learning-by-imitation process, in a non-discursive way. This imitation process does not relate only to a mechanical level of know-how, but it implies putting on the teacher's shoes, imagining how the teacher thinks, feels and acts, and then putting all this into practice, learning by doing, without following a specific model. (Kasulis 2002, pp. 54, 58)

This implies that knowledge is transmitted in an esoteric manner. That is, key aspects of knowledge are only accessible to insiders, who have practised for several years, and that knowledge cannot be transmitted in a public manner, even if one states all the steps logically (Kasulis 2002, p. 62).

Integrity

Integrity is understood as the ability to remain whole, in one piece. It is the ability to have an autonomous identity that is not influenced or corrupted by whatever is outside (Kasulis, 2002, p. 67). The main characteristics that define integrity are the following (Kasulis, 2002, pp. 70-79):

1. Integrity is impersonal. Knowledge should be established objectively, independently of the individuals that generate or test it. Evidence should speak for itself, and subjectivities are irrelevant.
2. Integrity establishes a 'belonging to' type of relationship. That is, if A and B establish a relationship between them, they both belong to such a relationship, but they remain the same in essence. The fact of belonging to such a relationship doesn't change them.
3. Integrity is purely intellectual. Emotions are irrelevant, or even worse, counterproductive. One should mistrust emotions and be guided just by reason if one wants to find out the truth
4. Integrity leads to pure conceptual knowledge. That means that any somatic component is suspicious and should be eliminated. That implies that knowledge is exoteric, public and accessible to everyone, without the need for years of practice to reach the expert state.
5. Integrity is bright and clear. Knowledge is accessible to everybody if they apply their intellect and reason to find the truth, so it is self-illuminating.

Discussion: Integrity and intimacy in design research

In this section, we will present two examples of how the integrity/intimacy pair could be used to discuss and analyse design methodology and epistemology. In the first example, we will try to show that the framework could be used *instead* of the dichotomous vocabulary that is already used in discussions of design methodology. In the second example, we will attempt to use intimacy and integrity in an altogether *different* and quite *unrelated* discussion (design negotiations). If our descriptions are cogent, then we will have succeeded in showing the strong descriptive and explanatory capacities of the intimacy/integrity framework.

The generation game: from integrity to intimacy

As we mentioned earlier, the dichotomies are insufficient when used individually—in the sense that they need to be interlaced with one another to produce rich descriptions of design broad phenomena. The integrity/intimacy framework solves this by offering an overarching terminological approach. To illustrate the potential of Kasulis' framework, we will augment the 'generation game' conceptual apparatus by using the intimacy/integrity pair as an overarching and integrative approach *instead* of using more fragmentary dichotomous terminology.

We find Integrity at the foundation of the first generation of design methods, which were a reaction against the artistic and *ad hoc* design methods that were in use before 1960. The new methods proposed variations of scientific, logical models of the design process, anchored in a view of unlimited rationality. These models would release the designer from their bonds with the traditions from the past and idiosyncratic, arbitrary decision-making. This is directly related to an integrity-centred conception of what can count as a legitimate basis for knowledge. The dominant orientation in Western thinking has to do with the expectation of supporting assertions with evidence so that everyone can investigate for themself. Truth is thus underwood as something others can verify. Unbeknownst to the early methodologists, everything in their methods was guided by integrity reasoning.

The second and third-generation design methods moved away from this ambition of modelling an omniscient designer with unlimited rationality and a transparent and complete process of design activity that characterised the first-generation methods. During these years (the 1970s and early 1980s), we see moves towards intimacy and a growing rejection of integ-

3 The locus of Kasulis' framework is cultural differences across the world. Yet, while it highlights cultural differences (especially detectable when comparing Asian and Western thought), it does not in the least suggest that different cultures are monolithic and unchangeable nor perfectly demarcated. Rather, Kasulis shows how particular facets of human experience are emphasised in some settings, while others are placed in a secondary role. So, in every culture, we can find instances of both intimacy and integrity.

rity. For instance, consider Alexander's famous rejection of the Design Methods Movement ('I would say forget it, forget the whole thing') (cited in Cross, 1981, p. 3) and Rittel's proposal for participatory and argumentative methods (Cross, 1981; Bousbaci, 2008, p. 38).

Another important move towards intimacy is the 'primary-generator model' proposed by Jane Darke (1979), which draws not on the integrity of rational analysis as a starting point of the design process but on a profoundly personal conjecture that blurs the separation between analysis and synthesis. This model famously describes how empirical, situated, and expert knowledge are intertwined to yield that type of knowledge Kasulis has characterised as *intimate*. Because of design's intractability, an initial, subjective narrowing down and framing occurs when early ideas or organising principles define the boundaries of the problem space and suggest the nature of its possible solution.

Yet, integrity was far from gone. Despite a manifest recognition of the complexity and intractability of design problems, second and third-generation methodologists still maintained the view of design as an essentially problem-solving activity, all of which entails 'some shared beliefs in a certain degree of rationality, logics, and objectivity which fundamentally characterise the design process' (Bousbaci, 2008, p. 41).

Because of their complexity, design problems or briefs can seldom be solved simply by examining requirements and processing information mechanically in a detached manner. Integrity is insufficient. Arguably, the very failure of the early design methods was due to erroneous premises centred on integrity. Design problems are not to be taken as a given but actually start with a particular action of framing (Kolko, 2010), in which subjective interpretation is a fundamental aspect of sensemaking and synthesis; that is, intimacy.

Does this mean we go back to viewing the designer's mind as a black box? To the 'beaux-arts' vision of the design process? Not at all.

Intimacy doesn't reject or exclude the possibility of 'objective' knowledge, it just accepts that a legitimate basis for making claims about certain aspects of reality needn't be necessarily publicly verifiable (Kasulis 2002, p. 33). Objectivity is preserved by reconsidering it; while an Integrity mindset understands objectivity as publicly verifiable knowledge that is based on hard facts that can be computed (i.e., the glass box model), an intimate form of knowing, even without publicly verifiable knowledge, retains objectivity in a substantive sense (the designer as a reflective practicer). Kasulis (2002, pp. 35-36) writes that intimate knowledge's objectivity:

> is accessible only to those within the appropriate intimate locus, those who have achieved their expert knowledge through years of practical experience. Trust in intimate knowledge's objectivity, like that in positivistic knowledge's objectivity, relies on an assumption of universality, but this universality has a somewhat different formulation.

The key aspect here is that knowledge that is acquired 'through years of practical experience' becomes a legitimate source, regardless of its verifiability. This, of course, aligns with the Schönian perspective of reflective practice and other scholarly work on design expertise (Lawson & Dorst, 2009).

A short detour before proceeding to the next subsection. The orientations of intimacy and integrity can also be applied to analyse the creation of the very models of design we formulate as design methodologists, which are the main characters in the 'generation game'. But what are models? A model is a representation of a phenomenon; i.e., a fact or situation that is observed, inferred or assumed to exist or happen. For Frigg and Hartmann (2020):

> Models can perform two fundamentally different representational functions. On the one hand, a model can be a representation of a selected part of the world (the 'target system'). [...] On the other hand, a model can represent a theory in the sense that it interprets the laws and axioms of that theory.

Any model necessarily embodies a particular way of understanding and framing phenomena. In other words, they are grounded on particular styles of knowing and thinking. From an intimacy mindset we get different models than when approaching an issue from an integrity perspective. Both the black box and the glass box models we referred to above are Aristotelian idealisations; i.e., simplifications aiming at making reality more tractable. The model maker only models those and only those properties that they have reason to believe are relevant to the problem at hand. We believe that Kasulis's apparatus serves well to explain how the decision occurs concerning what to include or exclude in a model. What counts as relevant and how relevance is judged is dependent on the employed epistemological style.

Kasulis (2002, p. 80) uses the metaphor of a computer operating system to understand the frameworks of intimacy and integrity. Choosing between them implies that certain procedures will work differently, that some ways of reasoning will be available while others won't, just as the way we sort documents and folders or the software we have access to varies depending on the OS in our computers.

To round up this part of the discussion, Bousbaci (2008, p. 40) convincingly argues that 'each shift in the evolution of design thinking in fact corresponds to a major shift in the implicit models of the designer included within the analogous theoretical discourses.' We add that any shift in design thinking, such as the fluctuation from first-generation methods to the reflective practitioner, is also a shift in the implicit epistemic models. Intimacy and integrity seem to be well-fitted to illustrate and explain what these implicit models of styles of knowing and thinking in design activity consist of.

Design negotiations as 'belonging-with'

Our second exploration is about negotiations in design. Let's start with a quote in which Paula Scher (cited in Millman, 2007, pp. 50-51) talks about this issue:

> There are all kinds of problems and compromises that [one] must negotiate. Things that have to be held on to, things that have to be protected to make something move forward. And it's very, very, very hard work.

What's important to note is that Scher is not merely *wishing* to hold on to the elusive things she alludes to. She makes these things especially her own; they truly matter to her because she intimately *identifies* with them and it would be a personal loss if what she cares about was diminished. For Kasulis (2002, 37), 'my intimate relations are more than connections I have made; they are actually part of what I am or have become.'

Scher's intimate relation with her work highlights how design work and the designer as a whole person are irremediably intertwined: there is no external work that is fully separated from the person who creates it. In an intimate relation, the work overlaps the person and is thus *internalised*. In this sense, the work belongs *with* the designer; it is not merely a separate object. One of us has explored this in more detail elsewhere (Guersenzvaig, 2021; Guersenzvaig & Ventura, 2022).

As per Kasulis, this phenomenon of being intimate with the work is known to be 'known only to those within the locus of intimacy' (p. 38). In this sense, a work—a design—overlaps in an intimate relation first with the design team and the project commissioner, but when the design is instantiated in a real-world artefact, it can also be part of an intimate relation with others. So, in principle, every stakeholder, design participant, or user could have this intimate relation.

Indeed, we are intimately connected to a myriad of objects and things, and some of them end up mattering very much to us. We all have a special chair or T-shirt with which we are intimately related. These relationships have an anthropological dimension. Not only do designers and project commissioners engage in meaning-making, but also people carve meaning into their own possessions. A friend of one of us had one wheel of his favourite bicycle compacted into a metal cube. He *belonged with* the bike—just like Paula Scher was intimately connected to her own work. Naturally, a classical Western rationalist—integrity—mindset would suggest that this is utter nonsense as the bicycle and the cyclist can't possibly be anything but separated entities. A view from intimacy suggests otherwise.

Conclusion

Throughout this article, we have presented how supposedly unrelated dichotomies used to describe design activity can be subsumed into Kasulis' more overarching distinction between integrity and intimacy. A simpler, yet richer, heuristic facilitates a more comprehensive approach to describing design thinking styles, without the need to rely *ad hoc* on ambiguous opposites such as thinking versus doing or intuitive versus deliberate.

As we saw in the previous section, thinking about design in terms of intimacy and integrity helps us to better understand the development and evolution of design methods and epistemology as a transition from an assumed but inarticulate integrity approach to a more nuanced understanding of design processes based on an intimacy lens. In other words, it can be argued that design methods and epistemology have moved from integrity towards intimacy.

Here, we want to insist on the somatic, embodied, and situated nature of intimacy and its relation to praxis. Intimacy needs to be enacted. Surely, one can learn a lot about, say, spacing type from books and lectures, but it is only by *actually* spacing type and reflecting upon it that one can develop expertise and become an expert. The more we engage in this 'reflective conversation with the situation'—to express it in Schönian terminology—the more intimate the knowledge about spacing type becomes and the more this expertise becomes our second nature. In short, 'Intimacy deepens as the praxis is repeated or habitualized' (Kasulis 2002, p. 43).

In other words, having an intimate knowledge of type (whether about its history or about designing or spacing type) means that the designer, in this case, is not fully separated from the known object. There is an overlap between the known (type) and the knower (designer, typographer, or historian).

However, using the intimacy/integrity heuristic does not invalidate the knowledge gained through other approaches like the ones discussed above. Instead, the heuristic presented here is a powerful way of thinking about design that can help us become aware of relevant aspects that may remain unobserved when using other terminology.

To end, due to space reasons we have chosen to only explore epistemological examples, we believe, however, that the framework can be aptly employed for ethical discussions; for instance, on the issue of contrasting an individual understanding of responsibility based on autonomy and duty with a relational one, based on care and belonging-with.

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Democratizing design: the development of a 'Design for Do-It-Yourself' framework

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Introduction: an unsustainable human-product relationship

Traditionally, design merely focuses on satisfying the increasing 'need' of consumption. However, (1) a higher level of consumption does not elevate the perceived happiness of people (Lipovetsky, 2006; Porritt, 2003). (2) Maintaining the economic principles of growth and profit, in a mass production context, promotes and accelerates the exhaustion of nature; it impedes a healthy human-product relationship and a proper relation with nature (Hirsch & Pauw, 2022). In this context, designers have been 'active agents of an un-sustainable idea of well-being', says Manzini (2006). An alternative "...Interpretation of well-being is (...) required, disconnected from a perceived need to increase consumption" (Thorpe, 2010). A reconnection would help counter so-called 'alienation' and it would align to the views of various scholars (Ehn, 2008; Pacey, 1992; Papanek, 1985) who advocate for a 'new partnership' between people and the products they use and own.

Design for DIY

Anticipating (a) today's distant human-product relationship in a mass-production context (Cerny, 1999; D. Ehrenfeld, 2003), (b) people's desire to create (Csikszentmihalyi, 1998; J. R. Ehrenfeld, 2008; Maslow, 1943; Press, 2007; Sanders, 2006; Sennett, 2008), and (c) anticipating the great potential of novel making tools and the availability of online information (Anderson, 2010, 2012; Bonvoisin, Galla, & Prendeville, 2017; Salvia, Bruno, & Canina, 2016), this paper introduces a 'Design for DIY' scenario and a novel 'Design for DIY' framework. A variety of scholars suggest that the practice of DIY promises to support a sustainable relationship between things and people, respectively between people and nature (Bianchini & Maffei, 2013; Bonvoisin et al., 2017; Hoftijzer, 2012; Salvia, 2013; Van Abel, Klaassen, Evers, & Troxler, 2011). More specifically, this paper addresses the facilitation of DIY activity, the role and responsibility of design therein, and the grounding and design of a 'Design-for-DIY' framework to help designers facilitate DIY activity.

Do-It-Yourself (DIY)

As the opposite of 'passive consumption', designing and making things for oneself aligns better with people's natural motivations (Franke, Schreier, & Kaiser, 2010). DIY enables people to express their intentions, capabilities and identity (Atkinson, 2006; Shove, Watson, & Ingram, 2005; Wolf & McQuitty, 2011). According to Schreier (2006), as a result people benefit from functional advantages, from the uniqueness of the outcome, from enjoyment of the process and from the 'pride of authorship', even in case of limited input. DIY activity enhances awareness and product attachment; it imbues a product with meaning (Csikszentmihalyi & Halton, 1981; Maldini, 2016; Mugge, Schoormans, & Schifferstein, 2009; Seldis, 2017). In short, DIY brings people closer to 'Being' (Helne & Hirvilammi, 2016; Maslow, 1998), and aligns well with Ehrenfeld's definition of sustainability (J. R. Ehrenfeld, 2008) which involves ethics, human and nature. Despite these advantages in the long run, it would be fair and valid to state that DIY activity has the potential of asking a lot time from people, and of producing waste and of littering the environment with DIY experimental results, in the short term (Hulbert, 2015).

The role of the designer, the Design for DIY scenario

According to various authors, the designer has a moral responsibility to try solving the imperfect human-product relationship (Kries et al., 2018; Myerson, 2016; Papanek, 1985; Schumacher, 2010; Sparke, 1987). Schumacher and Myerson suggest that designers need to reverse their thinking and concentrate on 'scaling down': adopting a mind-set of participation, designing for people and aiming for engagement (Myerson, 2016; Schumacher, 2010). In line with Manzini's view (2012), who suggests that designers can no longer maintain their 'monopoly on design, this paper proposes a Design-for-DIY scenario in which the designer takes responsibility and facilitates the layperson's DIY activity. The designer's role thus changes from being a directive, decisive authority to that of a facilitator.

'Design-for-DIY' studies: exploration of the 'Design-for-DIY' process

In order to gain knowledge of the process of designing for DIY, this study considers a series of four 'Design-for-DIY' studies (Table 1). The study presented here focuses on the design steps a designer can perform to facilitate a layperson's DIY

name	method	data	facilitators	participants laypersons	partiparts design students
1. 'DfDIY' of a coffee maker	research through design	observation of process and results, and interviews	1 to 3	17	
2. 'DfDIY' of a desk lamp	idem	observation of process and results, and interviews	1	7	
3. 'DfDIY' of headphones	idem	observation of process and results	1	8	4
4. 'DfDIY' re-using plastics	idem	observation of process and results	1	2	

Table 1. Design-for-DIY studies

activity. The studies were exploratory in nature and designed to help bring to the surface issues to take into account in developing a Design-for-DIY framework. They also helped to discern whether the notion of a generic framework capturing all the various approaches taken and design challenges addressed would be feasible. The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Design-for-DIY studies conclusions

The insights and models from the studies serve as valuable and relevant information in search of a suitable, preferably generic, Design-for-DIY framework. They helped to map the development steps taken by the facilitator, which supported the identification of numerous common aspects of the Design-for-DIY process. All four projects included instructional media and a concrete kit that distinguished fixed elements from the free design space available to the layperson concerned. To reach their intended audiences, all the cases included a DIY platform environment to enable laypersons to enrol in the DIY project and obtain the necessary support materials. All four studies had to consider the varying layperson's skills and level of experience, which was done by distinguishing means of facilitation, accommodation and support. In line with conclusions drawn from DIY practices in history (Atkinson, 2006; Bonvoisin et al., 2017; Goldstein, 1998; Hollinetz, 2015), the studies highlighted the importance of collaboration, templates and tools for manipulation, adjusted to the layperson's level. As a general conclusion following the studies, the DIY projects appeared to be possible, feasible and doable, and the Design-for-DIY processes were reasonably similar. A generic step-by-step scenario of a Design-for-DIY process was derived from the studies.

Taxonomies of design models and frameworks

To learn and to serve as a reference for the development of a generic Design-for-DIY framework, this paper explores a relevant selection of existing frameworks and design models.

Schön's reflective practitioner model though approaches designing as a process of solving a unique problem, not as a generic step-by-step process (Schön, 1984). Roozenburg & Eekels' (1998) basic design cycle, similar to Schön's model, emphasizes its circular, thus reflective, intention. Similarly, Evans has long ago proposed a spiral-shape process model to 'highlight the iterative nature of the design process' (Evans, 1959; Vossen, Kleppe, & Randi, 2013; Wynn & Clarkson, 2018). He argues that a design project cannot be run through following a sequential process alone. He suggests a procedure of iteration, reflection, and refining; a spiral shape.

Since 'Design for DIY' specifically and clearly comprises the elements of reflecting and experimenting, as the 'endless' learning cycles of Kolb (Kolb & Kolb, 2008) and Gibbs (Gibbs, 1988) do, a cyclic and 'prescriptive' character would suit best for the Design for DIY framework.

DIY process models

When regarding specific design models or frameworks for DIY or Design for DIY, Fablab (Bo-Kristensen, 2018; Gershenfeld, 2012) has depicted its 'designing the design process' model in their Fablab manual, approaching it from an educational perspective: the model clearly distinguishes the concentric shells of (1) setting learning goals, (2) arranging design materials, and (3) design activities. Although this model does not operationally guide the designer in facilitating DIY, the model is relevant for this study, as it distinguishes the different cycles of preparation, and the design stages inside the most centric design activities shell.

Set up of a Design-for-DIY framework

The knowledge gained in this research serves as input for the construction of the Design-for-DIY framework, a means to help the designer set up DIY projects. Additional to the aforementioned challenges, the Design-for-DIY framework should address both the designer tasks and the steps to be taken by the layperson, each of which forms a design process by itself. The framework, consequently, needs to describe a process model inside a process model. All has led to the insight that 'Design-for-DIY' requires a novel Design-for-DIY process model.

Key elements from that gained knowledge have served as requirements for the shape and structure or the framework (see Table 2). We highlight two of them.

Table 2. Knowledge and requirements for the setup of the Design for DIY framework

(1) The Design-for-DIY scenario and the Design-for-DIY studies have taught us that the entire process is represented by a 'sequential' range of distinctive design cycles, to be executed one cycle after the other, and that each of those tasks can be seen as a process by itself. Additional to the consideration of example frameworks from literature (Bo-Kristensen, 2018; Vossen et al., 2013) and from the Design-for-DIY studies, this pleads for a multi-level approach. (2) Both literature (Peppler & Bender, 2013) and the Design-for-DIY studies indicate the pedagogic character of 'Design-for-DIY' and the importance to support creativity, elements associated with circular and even with spiral shapes and structures that represent designers' cognitive processes.

All the findings together in this study have contributed to the development of the multi-cyclic Design-for-DIY framework depicted in Figure 2, comprising two dimensions: (1) the dimension of concentric design cycles (tasks, functions) to perform, and (2) the analytical and iterative design stages that are part of each cycle.

Design levels represented in the cycles of a Design-for-DIY framework

The proposed Design-for-DIY framework represents the major design tasks to be done, at different decision levels. The

model aims to facilitate a dialogue between the designer and the layperson. The concentric shape also reflects the iterative cyclical character of models for teaching and learning documented by various scholars (Gibbs, 1988). The option of re-running a cycle resonates with the 'learning-by-doing' approach.

Figure 1 shows the proposed spiral shaped Design-for-DIY framework. Each cycle prepares for the next, in centripetal direction. The order in which successive cycles are positioned in the framework is considered fixed, however the designer is free to improvise, and choose his or her preferred path.

Figure 1. The proposed Design-for-DIY Framework and its elements, visualizing its dimensions: the cycles and the stages.

Referring to Figure 1, cycles 1 to 4 represent preparatory and facilitating tasks by the owner/designer, while the fifth (the DIY cycle) is where the layperson actually undertakes the DIY project, guided by the designer.

Cycle 1: The Project cycle helps to define the goals and contents. The layperson's interests, the product's suitability and accessibility, all need to be considered, as was e.g. the case in study #1. *Cycle 2:* The pre-design serves as a preliminary product design and as a reference for the project, as well as an example for the layperson. Activities in the Pre-design cycle are geared towards anticipating DIY options. The need for such a cycle was observed in all four case studies. *Cycle 3:* The design of the toolkit, a fundamental element of all Design-for-DIY cases run, should include clear task allocation (to what extent is the layperson involved, and for which aspects), specific tools and instructions, and e.g. a specific design-space medium that supports relevant techniques. *Cycle 4:* The Platform cycle considers designer support, tangible and digital materials for inspiration, examples, and e.g. community and network. Related to this, this cycle should cater for a 'post-design' re-interpretation step, in respect of manufacturing, safety, aesthetics and so on. The Design-for-DIY studies #2 and #3 indicated the value of such a 'Post-design' step. The Platform should be inviting, attractive and accessible, and potentially offer multiple projects. *Cycle 5:* The DIY Design cycle is when the layperson is invited to perform their DIY task, guided to a greater or lesser extent by the facilitating designer.

Design process stages represented in each of the framework's cycles

Explained, each of these cycles comprises a full and iterative design process. Either a model as e.g. the Double Diamond model (Design-Council, 2019) or Roozenburg and Eekels' Basic Design cycle could represent the stages within each of the cycles. The latter has served as a reference here.

Validation

An experiment was conducted to evaluate the Design-for-DIY framework as a method, in which twelve designers were asked to develop a DIY project for laypersons to facilitate them in designing and making their own radio receiver. The experiment's research questions, the procedure, the results and conclusions are described below.

Goals and experiment research questions

The goal of the experiments was to evaluate the quality of the Design-for-DIY framework using questionnaires for numerical assessment. The research questions addressed in undertaking the Design-for-DIY experiments centred on the quality and usability of the Design-for-DIY framework as a method and tool to support the designer in establishing a DIY project for the layperson. The specific Experiment Research Questions (ERQ's) were as follows:

ERQ (1). Do designers judge the Design-for-DIY framework as complete?

ERQ (2). Is the Design-for-DIY framework clear?

ERQ (3). Is the Design-for-DIY instructional video clear?

ERQ (4). Do designers perceive the framework as providing sufficient freedom to design?

ERQ (5). Is the Design-for-DIY framework sufficiently accessible?

ERQ (6). Does the Design-for-DIY framework provide new knowledge for building DIY projects?

ERQ (7). Do designers understand the reasoning behind the Design-for-DIY framework?

ERQ (8). How can the Design-for-DIY concept (the vision of Design-for-DIY) and the Design-for-DIY framework be implemented?

Experiment set up and method

The experiments concerned six runs (Table 3), I to VI, each conducted by a different pair of collaborating designers. In doing the experiments, each pair of designers were assigned to the task of running a 'Design-for-DIY' project' by using a set of tools for support: The Design-for-DIY framework (presented as a board game), sketching tools, paper, glue, tape, radio electronics (for indicating the size of the components).

name	method	data	facilitators
experiment I	research through design	observation of process and results, and interviews (Lickert scale)	2
experiment II	idem	idem	2
experiment III	idem	idem	2
experiment IV	idem	idem	2
experiment V	idem	idem	2
experiment VI	idem	idem	2

Table 3. Design-for-DIY experiments: Design-for-DIY of a radio

Detailed spreadsheets and footage showing all the experiment results are available from the corresponding author, upon reasonable request. The experiments concentrated on cycles 2 to 4 of the framework, respectively on the stages from 'problem' to 'concept' within each cycle.

Results and findings

The questionnaires subsequently completed by the twelve participants have generated numerical data on a Lickert scale (graded responses to closed questions). These are presented below, in turn. The data that support the findings of this study are available from the corresponding author, upon reasonable request. Table 4 shows the results from the questionnaire completed by participants following the experiments. It shows only significant results. The maximum number of responses to each question was 12, since there were 12 participants. As we were interested only in retrieving the positive and negative opinions, since the random results would have been either positive or negative, all neutral scores were omitted from the X^2 analysis.

Research Question (ERQ)	Questionnaire question		N	Positive answers	χ^2
ERQ (1)	Q5	To what extent was the process you ran complete?	10	9	6,40
ERQ (1)	Q20	How would you rate the completeness of the framework?	12	10	9,33
ERQ (1)	Q1	How confident are you that the layman is capable to create his own radio with the kit you designed?	12	12	12,00
ERQ (2)	Q4	To what extent did you specifically address the division between the fixed part by the designer and the design space for the layman?	12	12	12,00
ERQ (2)	Q26	How would you rate the cycle arrangement? (order of cycles)	9	8	5,44
ERQ (2)	Q28	Please rate the clarity of the position of the predesign cycle in relation to the entire DfDIY framework.	11	11	11,00
ERQ (2)	Q29	Please rate the clarity of the position of the toolkit cycle in relation to the entire DfDIY framework.	11	10	7,36
ERQ (2)	Q31	How would you rate the suitability of the followed process steps for other DfDIY cases?	11	9	4,45
ERQ (3)	Q36	How would you rate the clarity of the movie used in this experiment?	11	10	7,36
ERQ (4)	Q9	How would you rate the amount of design freedom you had when creating the kit?	12	11	8,33
ERQ (5)	Q10	To what extent did you feel comfortable to start designing	9	8	5,44
ERQ (6)	Q32	To what degree did the use of the framework increase your knowledge, considering 'Design for DIY'?	8	7	4,50
ERQ (7)	Q33	How do you rate the clarity of the reasoning behind the framework (why the framework is developed)?	10	10	10,00
Q = questionnaire question					
X2 = Chi square					
ERQ = experiment research question					
N = answers except neutral answers					

Table 4. Numerical results from experiments I - VI: Only significant results are shown (df=1, p<0.05). Results are significant if $X^2 > 3,84$ (a result from df=1, p<0.05, according to standard X^2 table).

Discussion and conclusions

Reflecting on the quality of the Framework

The framework does address the different design tasks and design abstraction levels, it offers freedom to design your own path as a designer, and it addresses the iterative and pedagogic character that was required. It seems plausible to conclude that the participating designers judged the quality of the proposed framework as positive. The framework provided guidance, appeared to be fairly clear, suitable and complete. The outcomes of the experiment allow us to conclude that the goal of 'creating a Design-for-DIY framework that sufficiently helps the designer to develop and establish a DIY project' has been achieved, which contributes to a sustainable approach to product design and making, through the small-scale and democratised approach of design for DIY. Hence, the outcomes align to the ambition of the paper.

Limitations

Albeit the results of the questionnaire answers in Table 4 are significant, according to the X^2 analysis methodology, which means that the answers are definitely not random, it would be valuable to conduct further experiments in search for potential areas for improvement, and in search for the character of these improvements. Further, the authors advice to carry out studies that include an active role of the layperson to whom the Design-for-DIY framework is addressed, and so learn from the implementation of the Design-for-DIY framework.

Implications and future research

To sketch an optional scenario for what Design-for-DIY could entail, the designer's capacity could be envisioned as serving the supplier of either DIY materials, DIY tools, or the platform (compare Maker Nexus). The designer could also be subsidized by the (local) government to propel people to engage in DIY and making activity. As attitudes and contexts change, the Design-for-DIY approach has the potential to gain ground. Our framework and the accompanying vision could help to increase awareness and so inspire the democratization of design, e.g. through teaching the concept of Design-for-DIY as part of design curricula. In manifesting the Design-for-DIY vision, the framework stresses the importance of the responsibility designers should take.

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The power of imagination: Immersive and experiential counterfactuals to engage with sustainability

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Abstract

Imagination is a faculty that can underlie the transformations towards alternative futures, which are central in the discourses developed in Futures Studies and Design Futures, composed of different approaches and methodologies, such as Speculative Design (Dunne & Raby, 2013), Design Fiction (Bleecker, 2009) and Experiential Futures (Kelliher & Byrne, 2015). All these share a common goal: the crafting of questions related to futures to foster dialogues about present wicked issues rather than problem-solving (Angheloiu et al., 2020).

Focusing on the topics of interest, imagination has demonstrated to be able to influence transformations towards sustainable and just futures (Moore & Milkoreit, 2020) and, if fostered and enhanced, it can be become a powerful medium to engage with more-than-human actors (Romani et al. 2022); however, as R. Bendor (2018) argues there is still a lack of collective ability to imagine rich possibilities for building alternative futures. Wapner and Elver (2016) note the same lack of options and pathways to achieve them. Imagination turns out to be necessary to draw experience and knowledge from the present and the past and to reconstruct this knowledge with a new meaning, thus acquiring a new (Abrahams, 2020; Salis & Frigg, 2020). This characteristic of imagination, also referred to as counterfactual thinking, and strongly linked to what-if questions, introduces an initial gap found both in the discipline of Futures Studies and Design Futures: it is clear the connection between counterfactual thinking and future thinking, and, consequently, the link that exists between pasts, alternative pasts and possible futures, which is a still poorly researched subject by future scholars and practitioners (Bendor et al., 2021). Like the future, also the past may be seen as a plurality and a sort of repository for opportunities and possibilities (Bendor et al., 2021) that can deepen and strengthen the engagement with alternative futures and their potentiality in shaping, in return, new worldviews and mindsets in the present. Within the field of Design Futures, several researchers highlight a second gap that can be defined as an experiential gap: the difficulty in making futures livable and tangible.

To overcome this gap, immersive technologies can represent an important design opportunity, capable of implementing the frameworks, methods and tools related to Design Futures. In this direction, the research introduces the concept of Immersive and Experiential Counterfactuals, as an approach to be integrated to Experiential Futures.

Author keywords

Imagination; Counterfactual thinking; Immersive experience; Nature-human interaction; Alternative pasts.

Introduction

Imagination can underlie the transformations towards alternative futures, which are central in the discourses developed in Future Studies and Design Futures, a Design field that tries to nurture questions, reflections, and dialogues about current and potential trends, issues and opportunities, by projecting possible scenarios in the future and backcasting them in the present to define and design the paths to achieve what is considered to be desirable.

The research introduced in this contribution focuses on the interaction between human beings and nature and the relationship with more-than-human actors, by identifying imagination and immersive experiences as potential media to raise people's awareness and involvement on the topics of interest.

It is interesting to note that imagination, in its complex functioning, contributes both to our ability to think about future and to our capacity to remember past situations: it can be seen as a medium that let us to travel backward and forward in time, of which the latter, as stated above, constitutes one of the fundamental pieces for the Design Futures field. These aspects allow to introduce a first disciplinary gap, which is a key focus of the research being presented: the link that exists between pasts, present and futures is still a poorly researched subject by future and design scholars and practitioners (Bendor et al., 2021). By traveling backwards in time, it is possible to pluralize the past, and then, moving forward to present, the result is a set of alternative and desirable presents that can be projected forward in time, exponentially multiplying the pathways to achieve future goals.

Both futures and (distant) pasts are inherently nearly impossible to actually experience, precisely because of their temporal placement: this aspect represents a second gap, which can be defined experiential, and which led to the definition of the framework of Experiential Futures (Candy & Dunagan, 2017), that, exploiting Design tools, tries to bridge this gap, making futures liveable and tangible. To utterly overcome this issue, immersive technologies can play an important role and opportunity: in this direction, the research introduces the concept of Immersive and Experiential Counterfactuals, as an approach to be integrated by Experiential Futures.

The first part of the paper presents a discussion on imagination; the second deals with the theme of immersive experience and immersive technologies, while the third briefly presents the field of Design Futures, with particular attention to speculative approach, Design Fiction and Experiential Futures. The fourth part is dedicated to the introduction of Immersive and Experiential Counterfactuals. The contribution ends with the conclusions that summarize what was previously stated.

Imagination

From a general perspective, imagination is a speculative state of mind that allows us to consider situations outside of the here and now (Kind, 2017); it is also capable of producing ideas and images without direct sensory stimulus, often by combining fragments of previous sensory experiences into new syntheses (Van Den Bos, 2007). It presents perceptual, recollective, generative, phenomenological, and altered-state-of-mind (Abraham, 2020) facets.

Focusing on the topics of interest, imagination has demonstrated to be able to influence transformations towards sustainable and just futures (Moore & Milkoreit, 2020), but as R. Bendor (2018) argues there is still a lack of collective ability to imagine rich possibilities for building alternative futures. Wapner and Elver (2016) note the same lack of options and pathways to achieve them. Imagination turns out to be necessary to draw experience and knowledge from the present and the past and to reconstruct this knowledge with a new meaning, thus acquiring a new (Abrahams, 2020; Salis & Frigg, 2020). However, it also represents a form of liberation from reality (Kind & Kung, 2016), becoming a resource for the creation of ideas that does not suffer from the constraints given by rationality (Hairston, 2016), and, so, a source for novelty and change (Hawlina et al., 2020).

Interestingly, imagination is strongly situated and influenced by different factors, such as physical, social and ecological realities that shape our memory and experiences (Whyte, 2018).

It can enable transformation-focused agency (Moore, 2017), helping in identifying goals and actions to support the realization of the hypothesized situations (Galafassi et al., 2018). Finally, it needs time and spaces for interaction and collaboration, to let people share ideas and thoughts (Yussof & Gabrys, 2011) about alternative worldviews. There are other agents capable of

influencing individual and collective imagination which clearly contribute to transformations and transitions towards alternative futures: nature (Milkoreit, 2017) and technology (Balsamo, 2011).

The technological imagination can be defined as the mindset which enhances people to think and perform with technology, and to transform the unknown into possibilities (Balsamo, 2011).

Other authors define the concept of imagination in relation with technology: for example, G. Wellner (2018) defines the posthuman imagination, from an examination of the concept of imagination in modern and postmodern philosophy: a faculty that works by layer and it is co-formed by the relationships between human beings and technologies, which empower, mediated and shift; it is distributed and incorporated by humans and technologies.

Through this process of analysis, it has been possible to define imagination as "the recollective (related to experience and memory), generative (related to hypothetical reasoning and counterfactual thinking), immersive (related to action and interaction), and phenomenological process (related to emotions, engagement, and sensemaking), that enables to experience past, present and future situations and generates peculiar conditions to embrace alternative possibilities" (Fig. 1).

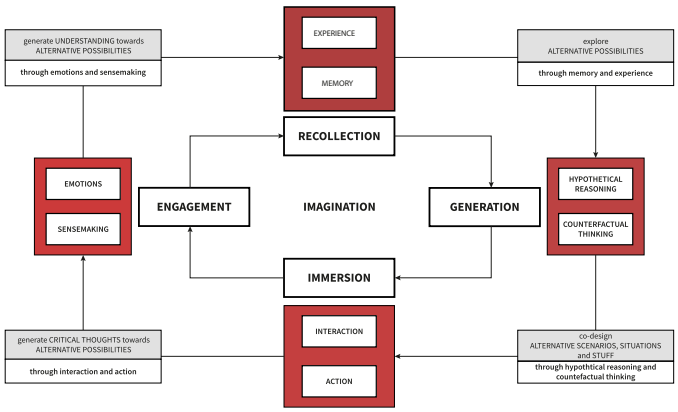

Figure 1. The imaginative framework

Immersive experience

Imagination is strongly connected to and influenced by experience, which represents, in its immersive aspect, the second subject of the research, with particular attention for immersive technologies. Regarding this topic, it has been decided to provide a single taxonomy (Milgram & Kishino, 1994; Skarbez et al., 2021), to define the reality-virtuality continuum: starting from reality, and moving to the right, the degree of virtuality of possible environments and interactions increases, finding Augmented Reality (AR), Augmented Virtuality (AV), Virtual Reality (VR), and what has been defined as Matrix-like Virtual Environment).

To make clear the connections between this topic and the subject of imagination, it is interesting to cite the research by Stapleton and Davies (2013) which is focused on extended and mixed reality technologies and the role that imagination can play in relation to these: it becomes a third reality in the reality-virtuality continuum that benefits from mixed reality as a new medium to be exercised in different fields. The combination of immersive technologies with the activities among different fields creates what is known as immersive experiences (Lucho Lingan et al., 2021). In order to define and achieve an immersive experience, various aspects must be evaluated and taken into consideration: sensorial fidelity (Bowman & MacMahan, 2007), sensorial immersion (Dangxiao et al., 2019), sensorial stimuli (Bowman & MacMahan, 2007; O'Brein & Toms, 2008), "being there" (Bowman & MacMahan, 2007; Shin, 2017), challenges (Ermi & Mäyrä, 2005; O'Brein & Toms, 2008), connection participation (Pine & Gillmour, 1999), involvement (Pine & Gillmour, 1999; Slater & Wilbur, 1997), imagination (Ermi & Mäyrä, 2005; Pine & Gillmour, 1999), presence (Shin, 2017), interaction (Dangxiao et al., 2019), and, finally, engagement (O'Brein & Toms, 2008; Shin, 2017). Starting from this analysis, Lucho Lingan et al. (2021) proposed a framework to map, ideate, design, and produce immersive experience, namely Immersive Cycle, divided into different steps, for which they also developed guidelines (Fig. 2).

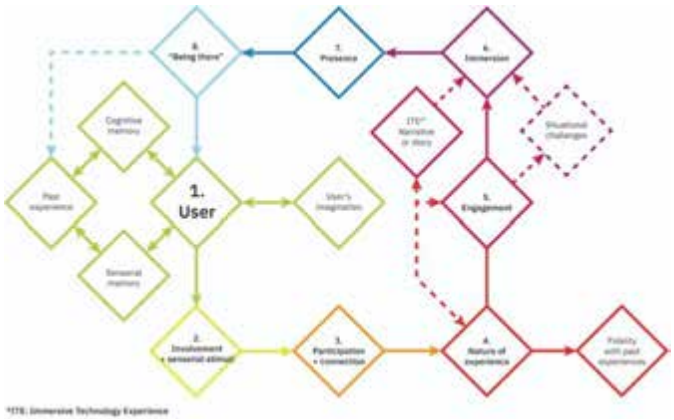

Figure 2. The immersive cycle.
(Credit: Lucho Lingan et al, 2021. Graphic revision by the author)

It is interesting to note the different overlaps between the Immersive Cycle and the framework developed to define Immersive Imagination, especially noticeable in the IC areas of the user (step 1) and in the ones dedicated to engagement (step 5) and immersion (step 6).

Merging the two frameworks may result in an effective starting point for developing a set of guidelines to facilitate the design of alternative situations (Candy, 2010), and, therefore, to let people be able to experience these, utterly facilitating the identification and the immediacy of the user's experience itself, and, thus, the bridging of what Candy (2010) indicated as the experiential gap.

The research recognizes Augmented Reality as the most suitable and promising technology to be applied in the field of interest, for several reasons: its accessibility and ease of use and less complex design compared to other immersive technologies, due to the numerous tools and platforms available. Finally, by working through layers, it allows us to experience multiple alternatives and realities simultaneously, thus enabling the collapse of different timelines onto each other. In ontological terms, this characteristic brings it closer to the field of design futures and to certain intrinsic traits of imagination.

Design Futures

Throughout the last two decades, the intersection between the field of Design and the field of Future Studies has generated various approaches such as Speculative Design (Dunne & Raby, 2013), Design Fiction (Bleecker, 2009) and Experiential Futures (Kelliher & Byrne, 2015). Although they are not structured methodologies, it is possible to identify common strategies in these approaches, taking into consideration what reaction is intended to be triggered in the people who benefit from the designed outputs in some way: at a first level, there is an exploratory strategy, whose aim is to make people aware about the topics of interest and alternatives and possibilities; the second strategy deals with reflection and it aims to provoke or stimulate the creation of critical thinking regarding the topics and the explored alternatives and possibilities; finally, there is a strategy that aims at a real understanding of the topics and alternatives and, therefore, at embracing the possibility for a change. These highlighted strategies informed the design of the framework that will be described in the next section. Speculative Design is an approach that deals with long-term futures, focusing on technologies, social and environmental trends, weak signals and wild cards, to stimulate the critical thinking of projects' users (Kerridge, 2016). Design Fiction can be defined as a design practice that creates provocations about possible futures, narrated through designed and diegetic artefacts (Kirby, 2010). The aim of Design Fiction is to facilitate and foster conversations regarding issues of interest, related to alternative presents and near possible futures (Coulton et al., 2017). Finally, Experiential Futures refers to a set of approaches to make alternative futures present, cognitively and culturally understandable (Candy & Dunagan, 2017) and to produce multisensory, transmedia, and diegetic representations of images of the future (Candy & Kornet, 2019).

Compared to what has been previously stated, the last approach presented turns out to be the most interesting for the research, which aims at integrating the knowledge derived from the study on imagination and immersive experiences, together with those related to alternative pasts (explained in the next part), to further discourses related to alternative and sustainable futures.

Immersive and experiential counterfactuals

Counterfactual thinking, a concept already explored in relation to imagination, is a psychological concept that indicates the human tendency to create and explore alternative situations to events that already occurred, and it is usually based on "what if" questions. One of the most interesting and important characteristics of counterfactual thinking is the analysis of past errors in order to avoid them in the future, revolving around the idea that similar situations may take place again (Epstude & Roese, 2008). Another important aspect is its capacity to facilitate behavioural change (Scholl & Sassenberg, 2014), and to drive collective actions, since they can increase the level of group identification and efficacy (Van Zomeren et al., 2010).

Yet strongly dealing with past experiences and the potential of "what if" questions in exploring alternative situations, it is clear the connection between counterfactual thinking and future thinking, and, consequently, the link that exists between pasts, alternative pasts and possible futures, which is a still poorly researched subject by future scholars and practitioners (Bendor et al., 2021).

Like the future, also the past may be seen as a plurality and a sort of repository for opportunities and possibilities (Bendor et al., 2021) that can deepen and strengthen the engagement with alternative futures and their potentiality in shaping, in return, new worldviews and mindsets in the present. Therefore, past-facing approaches are a tool to extend the imagination and, with it, the realm of possibilities, to reflect on past decisions, events and situations (Bendor et al., 2021). Furthermore, past-facing approaches are extremely useful to learn from the past in order to understand all the paths undertaken throughout the histories of humankind (Voros, 2019), and the influence that every timeline (pasts, presents, futures) have on the others (Poli, 2018). They can also be seen as a temporal device that creates an interesting context for considering anticipation, due to their capability in providing forks in the past from which futures may flow forward (Light, 2021).

The Immersive and Experiential Counterfactuals framework is to be intended as a set of tools and guidelines which, in the first steps, facilitate the process of scenario and alternative situation building, exploiting counterfactual thinking and what if questions, filtered by the above-mentioned strategies, and simulating the typical approach of Experiential Futures; while in the second stage, drawing on the designed scenarios and alternative situations, it proposes guidelines to design immer-

sive experiences, mediated by augmented reality and useful to make more tangible what has been hypothesized (Fig. 3).

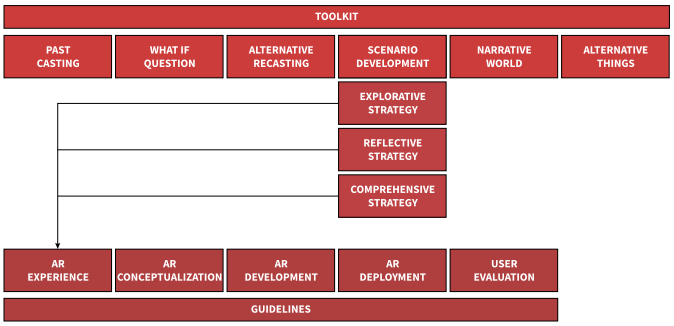

Figure 3. The general view of Immersive and Experiential Counterfactuals framework.

Conclusion

The contribution suggests the definition of a framework entitled Immersive and Experiential Counterfactuals, which is based on counterfactual thinking, an integral part of the imaginative process, and on Augmented Reality technology as a medium to make temporal alternatives and new possible points of view more livable and tangible, capable of building new relationships with the natural world and non-human actors.

The framework, consisting of a series of tools and guidelines, is positioned within the field of Design Futures - and in particular stands as an integration to the framework of Experiential Futures - a design domain that aims at building alternative and future visions concerning issues of interest, often related to the concepts of sustainability and regeneration of more balanced relationships with nature.

The design of this framework attempts to address two gaps inherent in the discipline of interest: a historical gap, which can be further defined as a lack of comprehensive research and literature, within the field of Design Futures, regarding the correspondence between counterfactual thinking and future thinking and, consequently, between the past, alternative pasts and futures scenarios construction; and an experiential gap, conceivable as the challenge in making experiential events and situations that happened far back in time or have not yet happened.

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Applying human-centered system design to the development of a tool for service innovation

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Abstract

According to the 2019 Revision of World Population Prospects, by 2050, people aged 65 and above will account for 25% of the population in Europe and Northern America. The number of people aged 80 or above is estimated to triple to 426 million by this time. Global aging has widespread implications for our society. With the emergence of technological and biomedical advances, people now hold higher expectations for their physical and mental health throughout their longer lifespans. People expect to live not only longer, but also better, calling for improved quality of living and working environments to support later adulthood (Coughlin, 2017). This new longevity presents complex opportunities for participatory and systems-oriented design thinking and processes (Nightingale & Rhodes, 2015; Lee, Zhu et al., 2020). It has become more important than ever for multidisciplinary teams of designers and engineers to contend with older age, including considering the role of immersive empathy and service tools in educating innovators on the importance of global aging and moving them towards collective action in making more inclusive decisions in their work. The purpose of our study is to rebuild and refine a current age empathy tool, AGNES (Age Gain Now Empathy System), through the application of a Human-Centered System Design (HCSD) framework (Lee et al., 2021; Lee, Rudnik et al., 2020).

This age empathy suit was originally developed by a team of social scientists, designers, engineers, and an occupational therapist to simulate the physical constraints associated with certain parts of the body and their possible functions in older age (Lavallière et al., 2017). For example, AGNES empathy suit can mimic common changes we may experience in an aging body such as changes to balance, stride length, joint mobility (e.g., wrist, elbow, shoulder, and cervical spine), muscle loss, tactile sensation, and vision and hearing loss. In this study, we propose a new age suit with modular components and a focus on service design to more accurately simulate various physical and cognitive functions associated with specific body conditions. HCSD consists of design thinking paired with systems engineering approaches; a focus on participatory design will be used to create a new age empathy suit. This case study will explore and prototype a more immersive simulation experience of older age for people and with people. This study intends to not only redesign a new AGNES suit, but also to examine the role of the HCSD framework and participatory design process in contributing to the development of empathy and service tools in pursuit of an age-inclusive society.

Keywords

Human-Centered System Design; AGNES; Service Design; System Design; Design Methodology

Introduction

A world of longevity is already here. By 2050, the U.S. Census Bureau has predicted that people aged 65 and older will outnumber people 18 and younger. Human beings' lifespans have become longer (Golden, 2022), which comes with huge potential business opportunities across industries (e.g., smart home, fintech) to reshape our society. We need to learn how to live meaningfully, not just survive, in the era of a longevity economy (Coughlin, 2017) and to re-frame and solve the complicated, systemic social-technological problems associated with population aging. Therefore, we introduce the AGNES (Age Gain Now Empathy System) age empathy suit, a learning tool to simulate common, chronic physical conditions that are associated with older age, build empathy, and provide education for younger generations, multidisciplinary teams and others to better understand the physical lived experiences of older adults.

AGNES was designed and developed by human factors engineers, health scientists, physical therapists, mechanical and electrical engineers, and product designers at the Massachusetts Institute of Technology's (MIT) AgeLab. In the following study, we explored service-related components embedded in the AGNES suit's design experience by considering four actions: 1. prepare, 2. transport, 3. engage, and 4. maintain, across the journey of service recipients (participants who wear the empathy suit) and service providers (MIT AgeLab

researchers who guide participants in their use of the AGNES suit). This study was driven by the desire to re-design and update the age empathy suit experience through a service innovation lens. A modified service blueprint approach based on the concept of Human-Centered System Design (HCSD) can be used to frame this study's approach to iterating on the immersive empathy-learning experience (Lee, 2022).

Literature Review

To build a more immersive empathy simulation and service-driven experience with AGNES, the suit's development history and existing features and the literature surrounding HCSD is reviewed.

The AGNES (Age Gain Now Empathy System) Suit

Empathy training originated from experiential learning theory (Kolb, 1984), which indicates that people can learn from transformational experiences. AGNES, as a suit, was designed for age and ability empathy training. The suit was designed to simulate physical limitations commonly experienced by older adults including impaired vision and hearing, increased muscle fatigue, postural imbalance, reduced joint range of motion, and limited dexterity (Lavallière et al., 2017). The suit becomes an impactful educational tool through engaging its users in an immediate total body experience of sensory loss through visual, auditory, olfactory, and tactile systems (Lavallière et al., 2017).

In addition to the AGNES suit, there are similar types of simulation tools that have been used similarly in educational contexts (e.g., pregnancy, impaired driving) (Empathy Resources LLC, 2019). Existing academic studies with AGNES have focused on measuring the effectiveness of the suit's specific simulation components: a rock-climbing harness, coverall suit, knee and elbow braces, resistance band straps for arms and legs, helmet, neck brace, yellow glasses, earplugs, shoes modified with foam, gloves and wrist braces (see Figure 1) (Gennis & Godfrey, 2011). In contrast to the functional focus of this work, we explored the design of the AGNES age empathy suit through the lens of HCSD to better understand the whole experience design of the suit from the perspective of its service providers and service recipients.

Our motivation to redesign the AGNES suit lies in considering the suit-wearing experience not only from the suit's participants or users' angles, such as its level of comfort or 'simulative realness', but also thinking through the lens of the suit's service providers, such as the experiences of lab scientists who guide participants through the journey of wearing an AGNES suit. In addition, we applied the service design process to help us gain a more comprehensive and in-depth view of all the service touchpoints across the user journey to better inform us of the potential parts (e.g., different product features or instruction design) of the AGNES suit that we can prototype and refine.

Figure 1. Explanation of an AGNES empathy suit (adapted from Lavallière et al., 2017)

Human-Centered Design, System Thinking and System Engineering

Human-centered design (HCD) is a creative problem-solving process for understanding target users' needs, brainstorming ideas, making physical and digital prototypes, testing selected concepts, and refining final design solutions to address target users' pain points (IDEO, 2022). Tim Brown, Executive Chair of IDEO (an international design consultancy) has said that HCD is a design-thinking approach to innovation (Brown & Katz, 2019). System theory, including system thinking and system engineering (SE), was established after World War II to solve complicated systemic engineering challenges that emerged from military, aeronautics and astronautics industries, and other relevant engineering fields (Leveson & Thomas, 2018). Crawley et al. (2016) has said that system thinking is not a call to think systemically, but rather to view each thing as a system to analyze. It also helps us understand and differentiate between systemic design, system design, and system thinking. De Weck, for example, has encouraged engineers, educators, and scholars facing hypercomplex and large-scale sociotechnical and economic systems to be aware of, consider, and learn system thinking and system engineering to address human needs to build a better world adapting to the requirements of digital and organizational transformation (De Weck, 2022; De Weck et al., 2012).

Human-Centered System Design (HCSD)

Human-Centered System Design (HCSD) is the intersection of HCD and SE to curate a set of problem-solving processes to give designers, engineers, and researchers guidance to understand which of the various selected methodologies to use, when and how (Lee et al., 2020). For example, one experimental study applied the 5E experience model (Sontag, 2018) integrated with Object-Process Method (OPM) from SE to solve campus tour experience design challenges (Lee et al., 2020). In another experimental case study, the researcher used user journeys combined with ConOps (Concept of Operation) to envision a moon-based conceptual space project hosted by NASA (Lee et al., 2020). MIT AgeLab designers have previously used HCSD to redesign smart footwear for an aging population, including initiating early concepts, product prototyping, and experience simulation as applied to innovative business models and platform design (Lee, 2022; Lee et al., 2022). The intention of applying HCSD is to help researchers have enough innovative capabilities to solve problems by zooming in and out while dealing with the various complexities of social-technological challenges. Therefore, in our study, we integrated HCSD with a modified service blueprint to model AGNES' service providers and service users' journeys across four critical experience actions: 1. prepare, 2. transport, 3. engage, and 4. maintain (Figure 2).

Adapted Human-Centered System Design (HCSD) Service Blueprint

A service blueprint is an informative mapping tool to help researchers visualize the participant journey from frontstage (user-facing side) to backstage (operational side) and organ-

ize the relationships between different service touchpoints including people, props, and process (Gibbons, 2017). A service blueprint can also be viewed as an advanced version of the journey map, which extends the scope from individual customers and users to other people in the experience ecosystem: businesses, operations, and other service providers. In this study, based on the structure and definition of HCSD and service blueprint, we modified the five terms: time, participant journey, frontstage, backstage, and support process and applied them to describe the subsystems and components in the journey of preparing, transporting, engaging with, and maintaining an AGNES age empathy suit. Further study can focus on how to improve the modified HCSD service blueprint in a more precise manner considering the dimension of time (e.g., pre, during, and after) and space (e.g., different environmental conditions or user scenarios) within various service touchpoints in the context beyond the four suggested experience actions: prepare, transport, engage and maintain (Figure 2).

Research Methods

The study's research approaches are based on the concept of HCSD, integrating the theory into a modified service blueprint to visualize an AGNES empathy suit experience through the lens of systems and subsystems. This section includes an overview of this approach, including: 1) identifying four actions of using the AGNES suit, and 2) modifying the definitions of five key terms from the service blueprint, which both significantly improve the research quality and its result.

Study Context and Interdisciplinary Research Team

We selected the retail (demo restroom) and home (dorm restroom) environment as two environments often the most relevant to people's lives. Two field studies were conducted in an in-store Kohler demo restroom and in a standard restroom in a three-bedroom apartment. Each study's testing process followed AGNES age empathy suit protocols, and each study was approximately three hours in length. We observed a five-person design team consisting of two product designers, one design strategist, one social worker, and one university lab researcher to see how the team interacted with the AGNES empathy suit to evaluate the users' experience of the restroom.

Four Actions of Using the AGNES Age Empathy Suit

We defined, observed, and documented the participant journey containing the four interconnected and non-linear actions: 1. prepare, 2. transport, 3. engage, 4. maintain (Table 1).

Five Modified Key Terms from Service Blueprint

Based on the structure and definition of the service blueprint, we modified five terms: time, participant journey, frontstage, backstage, and support process to make them relevant to the context of the AGNES age empathy suit (Table 2).

Table 2. Explanations and examples of five terms applied to AGNES.

Term	Modified definition in the context of using the AGNES age empathy suit
Time	Estimated time of each section that participants use an AGNES age empathy suit to interact, experience, and engage with people, activities, or services.
Participant Journey (Action)	Key engaging moments when participants wearing the AGNES age empathy suit interact, including different activities, decision-making, and reactions.
Frontstage	Incidents that happened directly in the view of the participants, including various types of interfaces: interacting with people or technology.
Backstage	Events or processes that operate behind the scenes to maintain and support the AGNES age empathy suit, services, and systems.
Support process	Internal activities that support participants using an AGNES age empathy suit to experience empathy simulation experiences and services.

In addition, we identified the participants' journey based on the two field studies and the four defined actions (Table 1) as a starting point to capture insight, summarize takeaways, and analyze opportunities to contribute to the suit's future re-design by using a modified service blueprint and HCSD.

Research Results

After synthesizing the available data, we propose an AGNES-related service blueprint that connects the service providers and service users' pain points and innovation opportunity areas (Figure 2). Visualizing the whole service of using the AGNES suit can effectively empower us to re-think some of the design aspects. For example, based on the four participants' journeys (actions), we can consider creating a new age suit with more adaptive and flexible modular components that cater to each action/touchpoint and focus on service design around the AGNES suit to more accurately simulate various physical and cognitive functions associated with specific body conditions.

Proposed AGNES Age Empathy Suit Service Blueprint

Based on the five terms in Table 2 and four actions from Table 1, we propose the AGNES empathy suit service blueprint depicted in Figure 2. In the study, the term "modified service

Table 1. Explanations and examples of four actions.

Action	Prepare	Transport	Engage	Maintain
Explanation	Focuses on under-standing partici-pants' learning objectives to better prepare to docu-ment and evaluate the process of expe-riencing the AGNES empathy suit.	Includes a discrete time period and way the research team packs, organ-izes, transports, and unpacks the AGNES empathy suit and its toolkits to the site for a study.	An interactive touch point when participants are using the AGNES empathy suit to experience aging, discussing their observations, and documenting their learnings.	Cleaning and organizing all components of the AGNES empathy suit before and after using it to maintain the principles and instructions of using the suit.

blueprint" means we simplified the original service blueprint structure by emphasizing five key elements for analysis: time, participant journey, frontstage, backstage, and supporting process. Arrows in the diagram indicate the relationships between components and subsystems to clarify their dependencies. We clustered these components and subsystems and mapped them into three lines by different interfaces: 1. interaction: the direct interactions between the participants and the AGNES suits, 2. visibility: what participants can see and experience from the frontstage apart from backstage, which is not visible, and 3. internal interaction: people who do not have direct contact with the participants.

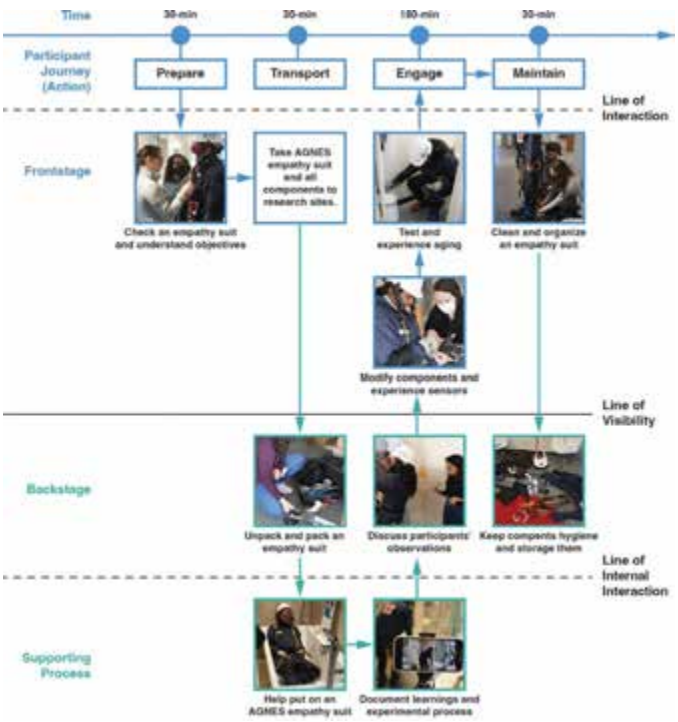

Figure 2. A modified service blueprint to describe AGNES empathy suit and services.

Further Research

Based on the research results and onsite observations, further research is needed to expand the current study's focus to diverse service experiences and service users. Leveraging mixed methodologies with the service providers might also be useful to gain a deeper understanding of these users' experiences with the four actions. Additional research will enable us to better shape a context-driven and human-centered system service model for the next iteration of AGNES.

Applying Materials Science to Make Fabrication Smarter and more Adaptable

The latest applications from materials science can provide more flexibility, adaptability, and accuracy to control, prototype, and simulate multiple scenarios with participants of different ages. For example, Tangible Media Group from the MIT Media Lab applied a reconfigurable fiber technology to control thin fluidic fiber actuators in a closed-loop strain design for movement-based interactions. The invention of artificial muscle-based devices, sensors, and research have demonstrated the potential application of these materials to empathy-learning tool design (Chandler & MIT Media Lab Tangible Media Group, 2021). The advances in materials science and its potential applications can offer us emerging opportunities to innovate the AGNES suit and even further encourage us to envision service strategies and business models to help not only improve the suit design but also promote the importance of the empathy suit globally and integrate it to various industries to make a positive social impact.

Suggested Research Directions

Three further research directions can be proposed from this study: 1. cognitive performance, 2. virtual tools, and 3. service design education. Although the field of cognitive science has already conducted many studies with older adults, we want to further understand how we can accurately simulate older adults' cognitive performance (e.g., stress, declining memory, emotional problems) in AGNES' embodied experience. How do we establish a matrix of measurement to evaluate the effectiveness of such a simulation? Emerging technologies like AR, VR, and IoT wearable smart devices have already transformed our lives. How can we re-think how to leverage AR or VR as useful simulation tools to help make experiences with AGNES even more technology-enabled, immersive and authentic? Ultimately, education has played a critical role in service design, and design generally. As a next step, we consider leveraging and emphasizing empathy-tool experiences and consider the modified design aspects from shifting the view of the AGNES age empathy suit as a *product-design* to an *experience-design* process considering the engaging moments of before, during, and after using the AGNES age empathy suit.

Discussion and Conclusion

The following three key takeaways: 1. product, 2. process, and 3. platform can be understood from this study to illustrate the future of empathy-learning tools and services. Future research approaches should leverage HCSD and systemic service innovation.

Product: An Age Empathy Suit as an Experience-Driven Service

In this study, four actions were applied—prepare, transport, engage, and maintain—across the journey of service providers and service receivers to review the AGNES age empathy suit design. This approach considers not only the physical product design, but also the service around the product that can benefit participants who put on the AGNES age empathy suit (service recipients) and the lab scientists who maintain and use the suit (service providers).

Process: A Modified Service Blueprint Approach Helps Identify Service Touchpoints

The service blueprint approach was modified by integrating the HCSD concept, which gave us more room to play with creative methodologies and system thinking. It has greatly benefited future AGNES empathy suit design since it blurred the boundary between service and product design. The methodology itself can involve more participants in the co-creation and co-development process of the AGNES age empathy suit. A modified service blueprint can help make future iterations of the empathy design process more interactive and engaging.

Platform: Service Innovation Takes Many Aspects to Consider

Re-designing the AGNES empathy suit through the layer of products, services, and experience considers many aspects. The platform can be considered a vehicle to the right conditions to deliver a full age empathy experience for participants. Platform thinking and awareness can equip designers and researchers with comprehensive views of creating immersive empathy product design, service innovation, and user experiences for an increasingly aging population.

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Pulse approach: integral design management to empower transformative processes

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Abstract

This article proposes the basis of an *integral design project management* approach as a strategy to empower transformative processes. It is believed that in a context of humanitarian crisis it is vital and urgent to think of design guided by spirituality, and this as a means, facilitator of transformative processes to favor the recovery, flourishing and continuity of life. The study takes place within the framework of design project management, an area that currently does not sufficiently recognize dimensions of spirituality. The *Design Thinking* design project management approach and the *Theory U* management methodological framework are critically discussed, promoting possibilities to develop prototypes for future testing and implementation. It is proposed that the spiritual dimension should be a fundamental component of a design project management strategy that intends to be integral: multidimensional and holistic, where spirituality is presented in an expanded, defragmented and contemporary vision. The concept of *integral design project management* is presented as a differentiation from the two aforementioned models: it draws on different classical and contemporary outlooks. Theoretical references on wisdom for contemporary complexity, design and spirituality, spirituality for contemporaneity and the *Souths* communities are analysed. These become a source of inspiration for design, as well as the identification of components of spirituality for empirical and theoretical construction. Following a qualitative, deductive and inductive approach, the fieldwork takes place in an online and face-to-face ethnographic and auto-ethnographic format with three *Souths* communities from Portugal and Brazil that have implicit spirituality-driven design project management approaches. As a conclusion, we propose the *Pulse Approach* model, based on the ancestral wisdom philosophies of *quilombola* and Afro-Brazilian communities from Brazil, and of a family farming community that preserves ancestral wisdom philosophy around the linen cycle in Portugal. The proposal is grounded on the observations and experiences in the fieldwork, as well as with special emphasis on Mãe Beata de Yemonjá (Costa, 2000, 2002, 2017), Bispo dos Santos (Santos, 2015, 2018, 2019), Steiner (1962; Lanz, 1983), Buber (1923), Osho (Jain, 2012) e Escobar (2016, 2018), also based on 13 main and common components of spirituality identified in the activities of the three *Souths* communities that collaborate with our study, namely: the present (the here and now), presence, organicity (the circularity, the spin, the circle), interdependence among all that exists, relationality, the feminine, matriarchy, love, affection, care, ethics, intuition and ancestry.

Author keywords

Contemporary wisdom; Integral design project management; Design and spirituality; *Souths* communities; Pulse Approach.

Introduction

This article proposes the basis for an *integral design project management* approach as a strategy to empower transformative processes. These processes aim at the recovery, flourishing and continuity of life. Transformative processes are understood as those that promote diversity; respect; self-development; quality of life; health; education; cultural sustainability; environment preservation; human rights protection; socio-economic transformation. They also encourage territoriality; autonomy; organic, creative and circular wisdoms, economies and communities. The objectives are: 1) contributions to a critical discussion on *Design Thinking* and *Theory U* towards a definition of *integral design project management*; 2) presentation of a theoretical framework based on authors who address themes of design and spirituality as well as spirituality for contemporaneity: sources for empirical and theoretical construction. 3) reflection on the themes of wisdom for contemporary complexity and the *Souths* communities, and legitimisation of communities of this nature as learning references; 4) identification of main and common spirituality components through the work with three analysed *Souths* communities; 5) the proposal of *Pulse Approach*, based on ancestral wisdom philosophies of *Souths* communities from Portugal and Brazil.

The focus of the research is design project management, an area currently lacking in recognising dimensions of spirituality. We propose that a spiritual dimension should be a fundamental component of design project management strategy that intends to be integral. This is regarded as a research gap as, to date, the present study has yet to identify the existence of *integral design project management* approaches with ref-

erences to *Souths* communities from Portugal, Brazil and/or the Community of Portuguese Language Countries. We believe that in contexts of humanitarian crises, it is essential to consider forms of design guided by spirituality. To promote such forms and to remedy the aforementioned theoretical gap, the *Pulse Approach* is hereby proposed: it is based on the ancestral wisdom philosophies of *quilombola* (Conaq, n.d.) and Afro-Brazilian communities from Brazil, (Batiste, 1961; Santos, 1988) and of family farming community that preserves the ancestral wisdom of the linen cycle in Portugal (Oliveira, et al, 1991).

Theoretical foundations

Humanitarian collapse and wisdom for contemporary complexity

Over the past 40 years, we have observed a dominance of Western, Anglo and Eurocentric values and practices by force of capitalist, neoliberal, industrial, colonialist, Christian, patriarchal, racist, massified and globalized thoughts (Gutierrez, 2015b, 2021; Santos, 2009; Santos, 2015). These have promoted, and continue to promote, environmental devastation, climate change, failures of economic development together with extreme social inequality, conflicts, exclusions, wars, and migrations (Latour, 2020). As a result, we find the 21st century is largely characterised by broad humanitarian crises that may more accurately be described as a collapse, as they no longer seem transitional or reversible.

As a framework for the above scenario, we closely follow the writings of the following authors:

- **Ailton Krenak** – who highlights the importance of realizing that *"we are going through a transformation (...) our collective dream of the world and the insertion of humanity in the biosphere will have to happen in a different way (...) (Krenak, 2020: 44)"*. Krenak refers to the praxis of indigenous peoples, the use of our body as the main tool for observing the earth, the sky, to bring out the feeling that we are not disconnected from other beings (Krenak, 2020: 45), the importance of dreams as *"(...) a place for the transmission of affections (...) (Krenak, 2020: 37)"*;
- **Antônio Bispo dos Santos** – who signals the importance of being inspired by the organic and circular wisdoms, looks and attitudes of the *quilombolas* and native peoples from Brazil that refer to being, to relationships, to community, to see the other and to the relationship with the cosmos. These are rooted in the understanding and implementation of beginnings, means and new beginnings based on the wisdom of their ancestors (Santos, 2015, 2018, 2019);
- **Bruno Latour** – who suggests *a repolitisation of the soil*, it is necessary *"coming down to Earth"* (Latour, 2020; Costa, 2020 In: Latour, 2020: 154, 155);
- **Donna Haraway** – who affirms our duty to build collaborations as *"humus", "to live well as terrestrial beings", "to make muti-species relations"*, in the here and now, without projecting towards the future, while understanding that the present moment enables our responses to the now in turbulent times (Haraway, 2016; Haraway, 2020 In: Torres, 2020);
- **Anna Lovenhaup Tsing** – who shows us that through disturbance we find the beginning of action, the possibility of transformative encounters. Tsing presents the now as an opportunity *"to realize the precariousness and in the process, looking around, without looking ahead"*, also in collaboration and coordination with other terrestrial beings, we provide *"the possible life"* (Tsing, 2022: 227, 229, 233, 234; Tsing, 2021 In: Gonçalves Brito, 2021).

Design project management

Within the scope of design project management for sustainability, *Design Thinking* (Brown, 2010) is often used to facilitate the creation of creative and collaborative projects that can promote social innovation and sustainability. In the area of management, the closest reference oriented by spirituality is known as *Theory U* (Scharmer, 2009). Its basic concept is *presencing*, merging the words presence and sensing: it refers to the learning of collectivity and intuition to enhance new visions and intentions.

Both of the above promote the development of prototypes to be tested and implemented in the future. This study performs a critical reading on Brown and Scharmer, as *Design Thinking* is a design project management reference that uses collaborative, collective, social, human, and empathy aspects, but does not acknowledge extended and contemporary dimensions of spirituality in its approach. Inversely, *Theory U* is a *head (think) – heart (sense) – hands (act)* management methodology, inspired by anthroposophy spiritual science founded on its *presencing* base concept, and is geared towards implementing future projects. As a dynamic and differentiation from these two references, we propose the concept of *integral design project management*, and define it as a design project management with an integral vision, i.e. multidimensional and holistic, recognizing spirituality in an expanded, defragmented and contemporary perception. Its foundation on the philosophies of ancestral wisdom of the *Souths* communities (in this study, from Portugal and Brazil) facilitates ideas, approaches, processes, systems and projects in the present as well as in organic and circular format.

Design, Spirituality and Contemporaneity

The subject of design and spirituality was analysed from the perspectives of Papanek (1995), Schumacher (1974), Walker (2011, 2020), Margolin (2014), and Escobar (2018). In this analysis, we identified 66 components of spirituality, and their concepts were interpreted (Lopes, Franqueira, Alvelos, & Parente, 2021). Further analysis was subsequently performed on Bispo dos Santos (2015, 2018, 2019) and Krenak (2019, 2020). Furthermore, key contributions by Mãe Beata de Yemonjá (Costa, 2000, 2002, 2017), Steiner (1962), Buber (1923), Kumar (2017), Osho (Jain, 2012), Lovelock (2014, 2020) and Margulis (2014) are summarised below. We identify three more components of spirituality in their thoughts: organicity (the circularity, the spin, the circle), matriarchy and the feminine.

- **Beatriz Moreira Costa (Mãe Beata de Yemonjá)** – Spirituality lived in her life through myths, dreams, poetry, imagination, intuition, wisdom, and connections with nature and ancestry, grounded in *Candomblé* (Batiste, 1961; Santos, 1988), in the matriarchal and feminine care that promotes affection and love with ourselves, our fellow human beings, and communi-

ty action. Costa nurtures the concepts of plurality in worlds, environment, and cultures, promoting human rights, health, education, and the fight against sexism and racism (Costa, 2000, 2002, 2017; Silva, 2008; Costa, Ilê Axé Omiojuaro, n.d.; Costa, Criola, n.d.).

- **Rudolf Steiner** – Spirituality based on the trinity *Think, Sense, Act/Action*, corresponding to the triads *Head, Heart, Hands; Culture, Legal/Political, Economic; and Freedom, Equality, Fraternity*; it advocates the preservation of the environment, the protection of human rights, socio-economic transformation, and promotion of education for freedom (Carlgren & Kilingborg, 2006; Lanz, 1983; Steiner, 2008).
- **Martin Mordechai Buber** - Spirituality is witnessed in life experience, in community, in the openness to listening and dialogue through relationships, in experiencing and caring for the present other, and in encounters devoid of prejudice (Bartholo Jr., 2001, 1994: 7; Buber, 2003).
- **Satish Kumar** - Spirituality based on the promotion of social justice, local and community life, non-violence, wellbeing, kindness, relationships with nature, poetry and art, preservation of the environment, and care for social relationships (Kumar, 2017).
- **Rajneesh Chandra Mohan Jain (Osho)** – Spirituality is based on life experience, connected to intuition/deep consciousness, dreams, wisdom, myths, love and imagination. It uses the right hemisphere of the brain (the feminine side), which speaks through stories, anecdotes and parables, devoid of theories and doctrines. It is connected with the here and now, with the poetics of life, with the fluidity of thinking beyond logic (Jain, 2012).
- **James Ephraim Lovelock and Lynn Margulis** – Spirituality translated through the experience of life, of the human being in interaction with Earth as a living organism, on interrelations and interdependence between everything that exists, and the changing dynamics of the natural world (Lovelock, 2014, 2020; Margulis, 2014; Kumar, 2017: 23).

From this work we identified 69 components of spirituality; these were employed as research indicators to guide, interpret and prove the field work observations. We have named them as *Components of Spirituality to Safeguard Life*, and propose a map of connections and inter-dependencies (Table 1).

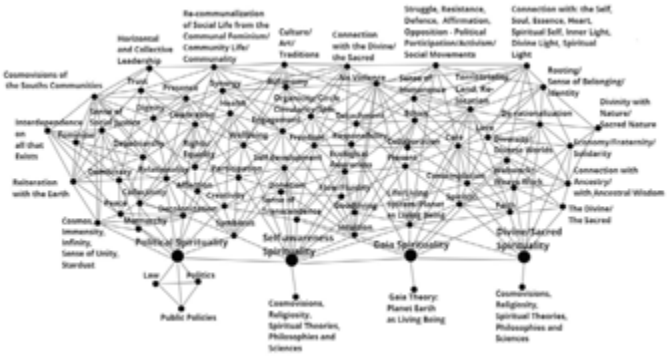

Table 1. Components of spirituality to safeguard life, created by the authors, 2022.

The Souths

The focus of the research has been on learning from the *Souths*, as presented by Gutierrez (2015b; 2021). The term *"South"*, or *"the Souths"*, does not refer exclusively to the geographic south, includes *"the silenced"*, the peripherals: people, communities and groups that have been *"excluded, denied, ignored"*, considered *"defective, backward, underdeveloped, and in need of progress"*, due to a dominance of Western, Anglo-Eurocentric values and practices. Gutierrez expounds on the concept of designing the world from the vision and practices of the different worlds that permeate these *Souths*, equally proposed by Escobar's *"pluriverse"* (2018). Gutierrez states that *"the South, the Souths, the Others* and *by Other NameS* (DESSOBONS - DEsigns of the South, of the Souths, Others, By Other NameS)" should be considered as central references of wisdom, knowledge and worldview in a concept that involves collective, communal, ethical, ecological, human, social, cultural and justice values and praxes. These are considered useful as a way out of totalitarianism, unsustainability, uniformity and massification of the industry and development projects proposed by the Western Anglo Eurocentric capitalist world (Gutierrez, 2015b; 2021). We observe that, inspired by Freire's libertarian philosophy and pedagogy (1987, 1992), Gutiérrez, Escobar, Bonsiepe and Santos question western domination along with the hegemony of the North, while signaling the need for the decolonisation of knowledge - focusing on looking, listening and learning from the voices and wisdoms of the *Souths* that experience social practices (Gutierrez, 2015b, 2021; Escobar, 2018; Bonsiepe, 1985, 2011, 2012; Santos, 2009; Santos and Meneses, 2009). We consider the *Souths* as learning references in that they convey ancestrality, wisdom and knowledge towards recovery and flourishment and continuity of life. Within this scope, we posit that design has the possibility of finding informative clues to promote transformative processes.

Methodology

Fieldwork has taken place in online and in-person, ethnographic and autoethnographic formats, through participatory experience. The qualitative methodology of inductive and deductive nature implied a proximity to the studied communities; moreover, complex data collection was performed among direct and participant observations, along with conversations, and exploratory and semi-structured interviews. We identified *Souths* communities from Portugal and Brazil that reveal implicit spirituality-driven design management approaches, as selection criteria for the learning objects of our research. They are:

i) Association of Women Farmers of Castelões (Associação das Mulheres Agricultoras de Castelões - AMA Castelões, Tondela, Portugal);
ii) Quilombola Association of Conceição das Crioulas (Associação Quilombola de Conceição das Crioulas – AQCC, Salgueiro, Pernambuco, Brasil), and
iii) CRIOLA NGO (CRIOLA, Rio de Janeiro, Brasil).

An added factor in the choice of communities in Brazil was proximity based on collaborative work previously carried out between the years 2002-2004 and 2006-2008. The community in Portugal was identified contextually, in a leather craft workshop held in the village of Castelões in September 2020.

They are comparable due to the presence of a *Souths*, ontology, as presented above. A brief presentation of the three learning cases and associated methodologies follows bellow.

Learning cases and the fieldwork development process

- **AMA Castelões** is a Portuguese association formed by a group of women artisans over 65 years old, who for more than 20 years has ensured the viability of the linen cycle tradition in the region of Castelões, Tondela, Portugal. They meet weekly to produce linen fabric pieces with embroidery and crochet, perpetuating ancestral wisdom and knowledge contained in local linen cycles (AMA Castelões, n.d.). Field work began on 29 September 2020, and ended on 8 March 2021: it consisted of 21 face-to-face meetings (approximately 3 hours and 30 minutes each), totalling 69 hours and 30 minutes of participatory experience; 52 pages of field diary; 795 photographs; 221 videos, a sum of 3 hours and 11 minutes of recorded images and speeches; and 40 audio recordings, a total to 14 hours and 23 minutes of recorded audio material.
- **AQQC** is a Brazilian association created in 2001 to promote the development of the community of Conceição das Crioulas along with its ethnic and cultural identity, as well as the fight for the *quilombola* cause (AQCC, n.d.). Field work began on 30 May 2020 and ended on 15 July 2022. 12 meetings were held: 3 face-to-face meetings with the community, 1 via WhatsApp and 8 online via Google Meet: 56 hours, 12 minutes and 15 seconds of participatory experience; 18 pages of field diary; 204 photos; 36 videos, totalling 1 hour, 11 minutes and 10 seconds of recorded images and speeches; and 16 audio recordings totalling of 5 hours and 57 minutes of recorded audio material.
- **CRIOLA** is a Brazilian civic organization created in 1992 in the defense and promotion of Black Women's rights within social values of justice, equity and solidarity. Its mission is to empower black women in face of racism, sexism, lesbophobia and transphobia, acting as agents of transformation in public spaces (Criola, n.d.). Field work began on 26 April 2020 and ended on 22 September 2022. We held 7 meetings, 6 online via Google Meet, 1 face-to-face in Rio de Janeiro: 9 hours, 23 minutes and 30 seconds of participatory experience; 8 pages of field diary; 46 photos; and 5 audio recordings, a total of 6 hours, 23 minutes and 30 seconds of recorded audio material.

Experience through direct and participant observations, together with conversations, exploratory and semi-structured interviews, provided us with the awareness of implicit, potential spirituality-driven design project management components in the activities of studies communities. The outcome is a set of 13 main and common components of spirituality: present (the here and now), presence, organicity (the circularity, the spin, the circle), interdependence on all that exists, relationality, the feminine, matriarchy, love, affection, care, ethics, intuition and ancestry.

We came to realise that the communities' representatives, teams and artisans plan, create and implement their projects in synchrony with the needs that are being experienced in the present, as well as in an organic and circular format. Project planning, creation and implementation are anchored in ancestral wisdom philosophies of the *quilombola* and traditional African matrix peoples, as well as women linen artisans. These are empirically experienced in lived life, and rooted in the aforementioned *quilombolas* (Santos, 2015, 2018, 2019), *Candomblé* (Batiste, 1961; Santos, 1988) and Portuguese linen cycle traditions (Oliveira, et al., 1991). Thus tangible actions become transformative towards cultural sustainability, environmental preservation, health, socio-economic transformation, territoriality, as well as creative, circular and organic economies and communities. Especially in the scope of the CRIOLA and the AQCC, we also observed actions towards protection of human rights and promotion of education, citizenship, diversity, respect and good living of the black people.

Preliminary conclusions and grounded theory developments

Based on the aforementioned 13 spirituality components, empirically grounded on developed field work and literature review, we posit the *Pulse Approach*. As an ongoing formulation, the *Pulse Approach* is currently founded on the ancestral wisdom philosophies of the *Souths* communities from Portugal and Brazil. We present it as a head (think) - heart (sense) - hands (act) *integral design project management* approach towards the empowerment of transformative processes. It may facilitate strategic planning, project management, group and team development, self-development, and complement other design project management and/or management tools for the above purposes.

The *Pulse Approach* operates as follows: with a relaxed and open mind set, sensory receptivity and active processes; in the here and now; in authentic presence; in connection with relationality (with humans, non-humans, forces of nature, the cosmos); in interdependence with all that exists (terrestrial beings and life energies); in organic and circular forms; sensing intensely at the core: matriarchal and the feminine love,

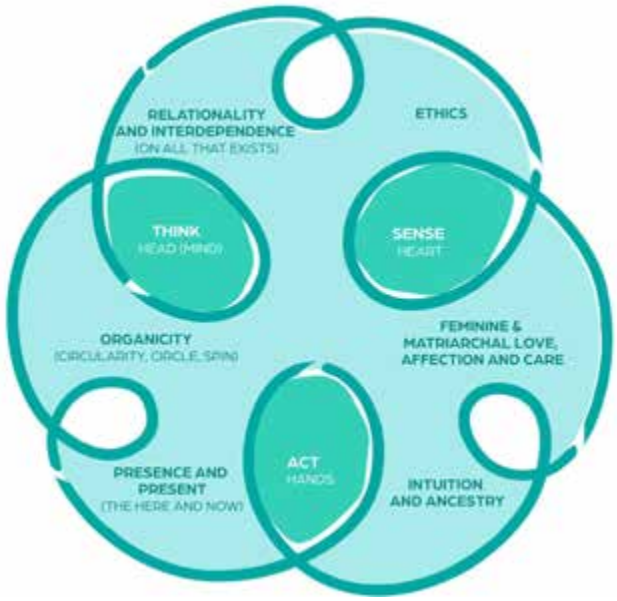

Table 2. Pulse Approach, created by the authors, 2022.

affection and care, ethics rooted in the intuition and ancestry (intelligence, consciousness, wisdom, deep confidence).

We propose the application of the *Pulse Approach* at this developmental stage in precariousness and turbulent times. Further research will be performed regarding its implementation. In addition, elaborated design will include the knowledge acquired in two sensory experiences that have meanwhile been developed with Conceição das Crioulas and Castelões.

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Research on design sketch from different disciplines: overview and directions

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Abstract

The sketch plays an essential role in different disciplines and industries, not only to visualize the ideas of designers and professionals but also to promote innovation and increase opportunities for reflection. The sketch is also a widely researched approach or tool that stimulates the generation of design thinking using representation, which is different from rational thinking and can facilitate effective communication between different disciplines. However, with the fragmentation of the traditional design disciplines, the boundaries of the traditional design disciplines have gradually become blurred.

In this context, the gaps and conflicts that have always existed in the design disciplines have been exacerbated, such as the huge gap between the traditional educational model with clear disciplinary boundaries in the design disciplines and the rapidly evolving design market, and the increasing conflict between the designers trained in this traditional educational model and the design talent required by the current market. And these conflicts characterize the current state of development of design disciplines, including conflicts between disciplines, within disciplines, and between design tools. Therefore, to improve the situation where these gaps and conflicts are intensifying, this study takes the sketch, a design representation method used in almost all design disciplines, as the object of study.

This study conducts a literature review of taxonomies of sketch in traditional design disciplines and design tools associated with sketch in contemporary design disciplines. Traditional and contemporary design are then categorized according to several empirical classification criteria proposed in this study, followed by a qualitative analysis around the use of sketch in different design disciplines in terms of stage, form, complexity of processing, fidelity, and other parameters. Consequently, differences in the habits, variations, and role of sketch in the context of traditional and contemporary design disciplines were identified.

The study provides recommendations for future models of design education and specific questions about the skills required by future designers, suggesting ways to mitigate and improve existing conflicts between design disciplines and suggesting possible new directions for future research to connect the different design disciplines.

Author keywords

Design sketch, multidisciplinary, traditional design, contemporary design, literature review.

Introduction

In a context where the boundaries of what was once recognized as discrete design disciplines, such as architecture, product, graphics, and fashion design, have been and continue to dissolve (Rodgers, 2008), education and practice in the design disciplines have been experimenting with [the cultivation of knowledge and collaboration across disciplines] (Irizarry, et al., 2016; Elżbieta, 2016), and the split between different disciplines in the field of design has led to a shift in creative practice from being 'discipline based' to 'issue or project based' (Heppell, 2006). We propose that this shift is related to the shift between traditional and contemporary design disciplines in terms of designers, design objects, constantly developing design environments, etc.

We present that traditional academic research-oriented education programs can no longer meet the need for interdisciplinary practical talents in contemporary design disciplines. As educators are asked to be more innovative in today's commercial environment, it becomes critical to weigh in on design thinking (Dym, et al., 2005; Mabogunje et al., 2020), design doing (Sanders and Stappers, 2013), and trans-disciplinary domains (Leavy,2016; Fawcett, 2013). With social development and economic growth, the world continues to promote innovative design, and interdisciplinary disciplines are becoming popular (Norman, 2004).

In the above context, we argue that the field of design research and its investigation methods continue to change and extend beyond the boundaries of the traditional design discipline while also noting the uneven development of the various parts within the design discipline. Therefore, this study argues that several important gaps and conflicts currently characterize the current state of development of the design discipline: (1) conflicts between disciplines (macro level: ambiguous disciplinary boundaries); (2) conflicts within disciplines (meso level: education and business environment); and (3) conflicts between specific tools (micro level: changes in the skills required for design). Therefore, to clarify the above-mentioned gaps and conflicts, this study confines itself to the micro-level of (3), i.e., the gap between the professional skills required by traditional design tools and contemporary design tools as boundary objects. By conducting a multifaceted comparative analysis of sketch-related tools in several typical design disciplines, we expect to contribute to identifying (1) and (2) from the side. Design sketch was chosen for this study because it plays an important role as a method specific to the design discipline, not only in design education and design practice

but also permeates almost all design disciplines. As current research on sketch in the design disciplines is discrete, and contributions are always from different disciplines, research contributions on sketch are mostly scattered in cognition (Tovey, 1989; Schön and Wiggins, 1992), creativity (Hua, 2019; Goldschmidt and Smolkov, 2006), reflective activity (Schön and Wiggins, 1992; Bilda and Demirkan, 2003; Wu, et al., 2012), visual thinking and visual communication (Goldschmidt,1991; Goldschmidt, 1994; Vistisen,2015), human-computer interaction (Buxton, 2007), and digital technology.

For understanding and analysis, we propose to divide the design disciplines into two categories - traditional and contemporary - according to certain criteria, and to analyze the role and use of the sketch in the different design disciplines and design tools from this new perspective. Through this new perspective, the role and use of sketch in the different categories of design disciplines and design tools are analyzed. The review and analysis suggest more specific conflicts and gaps in the design disciplines and a series of issues that need further research. Finally, it is expected that the results of this study will contribute, directly or indirectly, to the resolution of the wider conflicts of (1) and (2).

This paper is structured as follows.

Firstly, the history of the design disciplines is briefly reviewed, and the disciplines are broadly divided into two categories based on the empirical classification criteria provided in this study, and their relationships and trends are discussed.

Secondly, an overview of the taxonomy and related tools for sketch in traditional and contemporary design disciplines based on the same set of parametric criteria is discussed.

Finally, through a qualitative analysis of the use and trends of the sketch in the context of the same set of parameters in both traditional and modern design disciplines, some results are derived and summarized in terms of the respective developmental strengths of the two classifications, as well as attributes and experiences worthy of mutual reference between them.

The transition between Design principles

The disciplines of design and design research are rapidly transforming. The definition of design disciplines with a history is constantly changing and expanding in the scope of application. For example, industrial design has traditionally been seen as an applied art and science that seeks to improve a product's aesthetics, ergonomics, functionality, and usability (Noblet, 1993). Moody and Stanley defined industrial design in 1984: 'Industrial design seeks to relate hardware to the dimensions, instinctive responses and emotional needs of the user, where these are relevant requirements' (cited in Design Council of India, 2016). However, this definition seems to limit the potential impact and influence of the creative skills and methods taught to designers.

A moderately expanded version comes from the Industrial Design Society of America (IDSA, 2013), which currently defines industrial design as 'the professional service of creating products and systems that optimize function, value, and appearance for the mutual benefit of users and manufacturers'. This definition encompasses an increasing inclusion of industrial design and shows the expanding boundaries of the traditional design disciplines and the growing importance of multi-scientific and interdisciplinary design. The work of design firms and designers such as Ronan and Erwan Bouroullec (2003) Marti Guixe (2002) and IDEO (2005) now routinely transcends historical disciplinary frameworks such as interior design, fine art, product design and graphic design. In particular, the boundaries between product and service design (SD) are becoming increasingly blurred. Furthermore, because of the increasing relationship between IT engineering and design disciplines, there is a certain overlap and mutual inclusion between the education and practice of Interaction Design (IxD), UX Design (UXD), and SD.

In summary, it can be observed that the relationships and boundaries between the design disciplines of different eras are still blurred. Therefore, this study argues that before summarizing and analyzing sketch-related methods in different design disciplines, it is necessary to make a general categorization of the changing design disciplines. We refer to those disciplines that have clear boundaries between them as 'traditional design disciplines' and those that are inherently intersectional and inclusive as "contemporary design disciplines". A classification principle with several parameters is given for this (Table 1).

Table 1. Classification principle between traditional and contemporary disciplines.

Aspect	Traditional	Contemporary
Historical	Relatively long history	Relatively short history
Educational	The theory is quite well established a full range of courses at the univer-sity	Theoretical research is evolving Gradual integration into curricu-lum
Practical	Examples of practice are abundant	Fewer actual cases but increasing
Boundary	Once clear boundaries between disciplines are beginning to blur	The discipline itself was created with a multidisciplinary background

As the problems that design can address become increasingly complex (Latour, 2008), design research shifts towards a user-centered approach to problem-solving. The emergence of integrated design based on a wide range of disciplines has prompted discussion and exploration among participants. Collaboration and communication between various fields and professions have become more frequent and complex.

In addition, interdisciplinary collaboration has been emphasized in traditional design disciplines. For example, Pierre (2003) argues that integrating interdisciplinarity into the industrial design process can solve the problem of establishing sustainable design and consumerism. And according to Doerry, et al. (2001), in the 21st century, modern engineering design is approached as an interdisciplinary endeavor, which requires each engineer to work as part of a team that includes a range of specialists. We consider that the contemporary design discipline's ongoing value on multidisciplinary, interdisciplinary, and even trans-disciplinary collaboration is a major reason for this trend. There are also overlapping fields between their disciplines, such as theory and design process, as is recognized by the overlap between fields such as UX and service design (Forlizzi, 2010). Furthermore, excellence in experience creation and customer value in contemporary design projects requires 'design team members' to bring in expertise from their disciplines, such as service management, UX design, SD, and technology, among others (Khambete, 2011). Don Norman (2016) is critical of traditional design courses when discussing design education because they focus on craft skills rather than requiring a broader systems view, i.e., involving social or scientific competencies.

Parameter	Definition	Detailed Explanation For Criteria				
Dimension	The dimensions used in sketch, which are classified according to Gillian Smith	1D	2D	3D	4D	
		thoughts, words	paper sketches, images, journey maps, scenarios	modeling, rapid prototypes, mock-ups, object theater	enactments, video, animation	
Complexity	The complexity of handling sketch in the design process	Level 1	Level 2	Level 3	Level 4	Level 5
		just collect	just select and print/ create	devise for ease of understanding	categorize and prioritize what you create	identify relationships between selected outputs
Fidelity	This parameter only considers the extent to which the sketch reflects the design of the final product, not the proximity to the final design	Design	Low	Middle	High	
		Traditional	ideal to quickly solidify ideas, to estimate effort on concepts and to test navigation	ideal to show a high functional version of the concept, while still quick to design and cheap to discard	ideal to get feedback on visuals, estimate effort on interactions (e.g., animations) and to help as guide for implementation	
		Contemporary	simple in form and function but can be represented to some tent by imagination	simple in form, but reasonably represents the form and structure of the final deliverable	except for function, the form or structure may be fairly close to the final deliverable	

Figure 1. Certain criterias for dimension, complexity, and fidelity of sketch proposed by this study.

The direction of contemporary design education and research has shifted from artifact-based design and production to integrating different knowledge and disciplines at each stage. Thus, both traditional and contemporary design disciplines, from the focus on the cultivation of multidisciplinary and interdisciplinary models in design education and the increase in inter- and trans-disciplinary design projects in design practice, show a consistent trend towards the dissolution of boundaries between design disciplines.

Sketch as a universal method in design disciplines

Sketch, one of the most important conceptual design tools, is the most widely used in design practice and is the design representation most often associated with designer activity (Bar- Eli, 2013; Goel, 1995). It is generally accepted that design representation through sketch is fundamental to conceptual design activity (Cross, 1990; Lawson, 2006). Most designers have adopted freehand sketching as a valuable part of the design process (Lawson, 1994; Pipes, 1990). This study aims to use the role and use of sketch in different design disciplines as an entry point to further observe the similarities and differences between design disciplines born in different eras, as well as the design patterns and directions worth learning from each other from an unusual, microscopic perspective.

To fully understand the purpose and changing history of the use of sketches in the design discipline, we begin by reviewing and analyzing the sketch taxonomy that has evolved from the traditional design disciplines. This is done by identifying the different sketch taxonomies in terms of design phases and design purposes, including the role and use scenarios in the traditional design disciplines. In 3.2 we present an overview and analysis of design tools in contemporary design disciplines that use the sketch method according to the same criteria as in 3.1.

Domain	Authors	Sektch taxonomy	Investigation phase	Ideation phase	Prototyping Phase	Dimension	Complexity	Fidelity
Archite--ctural Deisgn	Fraser & Henmi (1994)	Diagram; Referential; Design; Presentation; Visionary Drawings		○	○	1, 2d	-	-
	Lawson (2012)	Presentation Drawings			○	1, 2d	3~4	Low
		Instruction Drawings			○	1, 2d	4	Low, middle
		Consultation Drawing		○	○	2d	3~4	Low
		Experiential Drawings	○	○		1, 2d	2~3	Low
		Diagram	○	○		1, 2d	2~5	Low
		Fabulous Drawings		○		1, 2d	2~3	Low
		Proposition Drawings		○	○	1, 2d	2~3	Low, middle
		Calculation Drawings		○	○	1, 2d	2~3	Low, middle
Engine--ering Design	Ferguson (1994) & Lugt (2005)	Thinking Sketch	○	○		1, 2d	3	Low
		Talking Sketch		○		1, 2d	4	Low
		Prescriptive Sketch		○	○	1, 2d	4	Middle
		Storing Sketch		○		1, 2d	2	All
	Pei (2009)	Personal Sketch	○	○		1, 2d	2	Low
		Shared Sketch		○		1, 2d	4	Low, middle
		Persuasive Sketch			○	2d	3~4	Middle
		Handover Sketch			○	2d	5	Middle, high
Industrial Design	Tovey (1989)	Diagrammatic Drawings		○		1, 2d	2~3	Low
		Ideas sketches		○		1, 2d	3	Low
		Concept drawings		○	○	1, 2d	3	Low, middle
		Measured drawings			○	1, 2d	3~4	Middle
	Olofsson & Sjolen (2005)	Investigation Sketch	○			1, 2d	2~3	Low
		Exploration Sketch		○		1, 2d	2~3	Low
		Explanatory Sketch			○	1, 2d	3~4	Middle
		Persuasive Sketch			○	1, 2d	4	Middle

Figure 2. Review and analysis of sketch taxonomies in traditional design disciplines.

Sketch used in traditional design disciplines

The design sketch originated in the academic discourse of architecture and industrial design (Schön, 1992). As different applications of the sketch taxonomy have been proposed and discussed in the traditional design disciplines, it is considered necessary to compare the different taxonomies to understand the role and use of sketch in the traditional design disciplines. Therefore, this chapter begins with a review of the role and use of sketch at different stages of the three traditional design disciplines - architectural, engineering, and industrial design.

In this study we have categorized the design process into 3 general phases. The RESEARCH PHASE includes investigation and problem definition, the IDEATION PHASE includes ideation and developmental design, and the PROTOTYPING PHASE includes detailed design and prototyping. We then summarized the phases in which each sketch taxonomy would work and classified them according to certain criteria for dimension, complexity, and fidelity (see Figure 1 for criteria).

For each of the three traditional design disciplines that are the subject of this study, we selected the most representative sketch taxonomies as the object of analysis. Two of these taxonomies are from the field of architecture (Fraser & Henmi, 1994; Lawson, 2012). There are also two taxonomies from the field of engineering design, one of which was first proposed by Ferguson (1994) to classify sketches according to their function in the design process, while Lugt (2005) builds on this by adding " storing sketch ". Another taxonomy was proposed by Pei (2009), based on the needs and intentions of designers when sketching. Finally, there are taxonomies from industrial design, one of which is Tovey (1989) classified sketches according to their functions and corresponding forms, while another, like Pei's, is based on Olofsson & Sjolen (2005) classified sketches according to the designer's needs or intentions when sketching.

Sketch adopted in contemporary design disciplines

As the contemporary design discipline represented in this study, UXD is about shaping the experience of using a product. Much of this experience involves some interaction between the user and the product. Although these contemporary design disciplines all have different origins, there is a mutual inclusion between their respective fields. Given that IxD is generally considered to be contained within UXD and UXD within SD, we follow this hierarchical classification to review and analyze the design tools that include sketch. The analysis results are then compared with the results of the traditional design sketch.

Here, this study follows Buxton's (2007) suggestion that sketch is not just an archetypal way of using paper and pen to support what Kolko (2009) and Brown (2009) and Martin (2009) call the 'reductive feeling' of design but can be used as a much broader way of thinking. As such, this study decided to adopt the approach proposed by Vistisen (2015) from the perspective of the spatial and temporal dimensions involved in the sketch, using Gillian Smith's (Smith in Moggridge 2006) classification of dimensions in IxD, between 1D-4D, as a suggestion for what designers can call 'sketching' of dimensions (1D: thoughts, words; 2D: paper sketches, images, scenarios; 3D: modelling, rapid prototypes, object theatre; 4D: enactments, videos, animations). In addition, UX designers usually create content such as wireframes, personas, and prototypes. Service designers end up creating service blueprints, customer journey maps and service ecosystem maps, but many of the tools they use are the same.

Considering that the definitions and descriptions of these design tools involving sketch vary somewhat from publication to publication, for the sake of consistency we will focus on the following two highly recognized publications as references for the analysis of sketch-related tools in contemporary design: a guide to service design practices by Marc Stickdorn et al. -- "This Is Service Design Doing: Applying Service Design Thinking in the Real World"; and the workbook by Buxton et al. – "Sketching User Experiences: Getting the Design Right and the Right

Domain	Authors	Design Tool	Investigation Phase	Ideation Phase	Prototyping Phase	Dimension	Complexity	Fidelity
Contem--porary Design (e.g., IxD, UXD, SD)	Research data	Research wall	○			All	3	Low
		Journey, system map	○			1, 2, 3d	5	Low, Middle
		Key insight	○			1d	3	Low
		User story	○			1d	5	Low
	Journey map	Storyboard (value, activity, interaction)	○	○	○	1, 2d	5	Middle
		Persona	○	○	○	1, 2d	4	Middle
		Service blueprint		○	○	1, 2d	5	Middle
	System map	Stakeholder map	○		○	1, 2d	5	Middle
		Value network map	○		○	1, 2d	5	Middle
		Ecosystem map	○		○	1, 2d	5	Middle
	Prototyping tool	Desktop walkthrough			○	2, 3d	4	Low
		Cardboard prototyping			○	2, 3d	4	Low
		Paper prototyping			○	1, 2d	4	Low
		Wire framing			○	1, 2d	4	Low
		Business model canvas			○	1d	5	Middle
	Others (various storyboards)	Sequntial storyboard		○		1, 2d	4	Low
		State transition diagram		○		1, 2d	4	Low
		Branching storyboard		○		1, 2d	4	Low
		Narrative storyboard		○	○	1, 2d	4	Low
		Animation-based sketch		○	○	4d	4, 5	Low, Middle

Figure 3. Review and analysis of sketch-related design tools in contemporary design disciplines.

Design", which introduces how sketching can be considered as a concept and used flexibly in UX design.

The result of the analysis between traditional and contemporary design

This chapter compared and discussed the results of the analysis in Figures 2 and 3. Relatively deep insights are gained into the transformation and differences in the roles and functions of the sketch in different design disciplines, and a contribution is made to improving and resolving possible gaps and conflicts in all design disciplines.

Firstly, no clear trends or differences were observed in the use of sketch in the different design phases. This may be due to the fact that designers have developed a sufficient number and variety of sketch taxonomies and sketch-related tools to suit the different design scenarios and phases.

However, there are some patterns and according to Smith's classification of dimensions in IxD, most sketch dimensions in the different taxonomies and design tools are concentrated in 2D and 1D. Traditional and contemporary design disciplines are similar in terms of dimensions. However, with the development of various smart devices and design software, the use of sketches in the ideation and prototyping phases of contemporary design has expanded to include 3D and 4D.

Secondly, in terms of sketch complexity, the taxonomy in traditional design disciplines tends to focus on 2,3,4 (with 3 being the most common). In contrast, contemporary design disciplines tend to focus on 4,5. The taxonomy of the sketch is therefore thought to favor the visualization of individual ideas about physical products and the facilitation of innovation, iteration, and communication through such easily understood visualizations. In the contemporary design discipline of design tools, however, the sketch is more oriented towards visualizing the overall structure of the system, the set of interactions of the service being provided, and so on. This makes it easier for designers and stakeholders to understand the complex relationship between the intangible service/system and the tangible product/interface in the design process. In addition, although the average of contemporary design disciplines is higher than traditional design in terms of sketch complexity, traditional design may require more sketch skills than contemporary design.

Thirdly, the contemporary and traditional designs of this paper are judged differently in terms of fidelity. Traditionally, fidelity is judged by how close it is to the final design in terms of appearance and function. Contemporary design, however, considers whether the sketch represents a system diagram or storyboard that is close to the intended composition of the final design, the expected interaction, the experience, and so on. In other words, traditionally the sketch represents the construction and form of a specific design (micro level). In contrast, in contemporary design, the sketch is used to describe the system framework of the design (macro level), the specific experience to be realized (meso level) through storyboards, etc., and the interaction required to realize that experience (micro level).

Because of the fast and rough nature of the sketch, the analysis of sketch taxonomies and design tools that use the sketch method in relation to fidelity is concentrated in the low and middle levels, with the high level rarely occurring. The reason for the high level is the application of the sketch method to the final prototype or finished product, and the reason for the middle level is the application of sketch to prototyping. In general, however, both the sketch taxonomy and the sketch-related design tool take advantage of sketch's ability to simply represent ideas or concepts and its ability to quickly externalize them. Also, as digital technology develops, sketch's property of being vague and allowing for reinterpretation and the ability to offer designers new solutions may enable sketch to be used in fields of high fidelity in the traditional design disciplines.

Whereas in the contemporary design discipline, although the design objects include specific products, most of the design tools analyzed in this study are used in the context of UX or the frameworks that make up the service. Even though the threshold for sketch use has been lowered by the addition of new technologies, it is observed that sketch fidelity is at the middle level in most tools, besides the general low level, according to our definition in table1. Despite the differences in design objects in different design disciplines, the ability of sketch to support efficient and rapid visual representation of objects that become more complex. The ability to represent and convey a degree of fidelity (2d) may still be difficult to replace by other simpler (1d) or more complex approaches (3, 4d).

Discussion and future work

This study has explored the changes and differences in the role and function of the sketch in traditional and contemporary design. It provides some preliminary findings and insights into how to address and improve some of the current gaps and conflicts between design disciplines. It also gives some ideas about changes in design education and the professional skills or knowledge that designers will need in the future.
Regarding the dimensional expansion of the sketch. For traditional design, the techniques to be learned and the knowledge of design theory from interdisciplinary sources has increased. And for modern design, the understanding of sketch characteristics may need to be improved to save time and cost in the design process.

Based on the analysis of the complexity of sketch, some possible gaps can be identified, i.e., traditional design disciplines can be educated more towards the development of design representation skills, while contemporary design disciplines are educated more towards the development of logical thinking and the training of design tools with a fixed framework and practical team exercises. Therefore, a mutual learning process between the contemporary design disciplines, with their emphasis on logical and systematic thinking, and the traditional design disciplines, with their emphasis on practical training, could help to mitigate the conflicts within the disciplines (i.e., the gap between the slowly changing design disciplines and the rapidly changing business environment that demands design talent).

This study argues that the difference in criteria for judging sketch fidelity is largely due to the difference in design objects between traditional and contemporary design. The contemporary design discipline is more concerned with designing services to meet a range of customer needs and incorporating products that enhance customer satisfaction. In contrast, traditional design is concerned with designing products to solve customer problems, focusing on practicality, design, durability, etc. While each has a strong focus on interdisciplinary collaboration, modern design is more likely to integrate the experience and knowledge of different disciplines than traditional design, which once had clear disciplinary boundaries.

Therefore, a more inclusive and open-minded approach to the traditional design education model, such as the development of courses in modern design disciplines (e.g., Service Design, Transformative Design), may open more opportunities for future designers in traditional design disciplines and contribute to the resolution of (2) conflicts within disciplines or even (1) conflicts between disciplines.

In summary, based on the review and analysis of sketch in various design disciplines from the perspective of (3) conflicts between specific tools, this study argues that traditional design education and practice need to introduce the attributes and experiences of contemporary design disciplines that focus on multidisciplinary collaboration. And in contemporary design education and practice, there is a need to focus on developing a certain level of theory and knowledge of traditional disciplines to help build a foundation of knowledge systems in multidisciplinary collaboration.

In the future, the disciplinary boundaries between traditional and contemporary design will become increasingly blurred. The unique theories and tools of each discipline may become increasingly uncertain, ineffective, or even conflicting in their educational and practical applications. To effectively address the potential confusion and conflict of theories and design models that may arise in the future because of the dissolution of design disciplinary boundaries, this paper provides a more general review and analysis of design disciplines from different fields and origins by offering a new perspective on specific tools at a micro level. More detailed studies exploring (i) future models of design education and (ii) the skills required by designers will require more comparative studies with examples of overlaps and gaps between specific disciplines (e.g., Industrial and UX Design).

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Researching the invisible: troubling qualitative research approaches through information architecture and design thinking

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Abstract

Information Architecture (IA) is a digital design process constituting the structural design of shared information environments (originally websites and databases) through organising, labelling, and navigation systems. However, due to the complexities of cross-channel, pervasive and ubiquitous computing, IA has shifted its approach to consider the design of information spaces in larger social, cultural and technological contexts. In practice, values of universality and certainty have given place to plurality and complexity. The practice of IA can be explained as an (inter)play between the science and the art of shaping information to support usability and facilitate findability. Design Thinking (DT) is a commonplace approach in IA, and both are means to interconnected problem (re)solutions at their core. Ultimately, IA presents a method of intelligibility design which is no longer constrained to digital practice.

Censoring information and visuals by and within sub-communities and digital interactive information technologies sets a dangerous precedent and disseminates strategies of what does and does not 'matter'. The stigmatisation of lesbians often results in violent hate crimes, which are emblematic of social violence against sexual embodied diversity outside the imperial, (hu)man-, phallo-, hetero-, cisgender-norm. The vis-à-vis between the epistemic violence of communication technologies and the real-life brutality of lesbian actualities points to an expansive system of visual 'knowledge management', which needs to be addressed in discourse, technology, and technique.

A more extensive research project explored how un/intelligible lesbian representational practices recursively shape and are shaped by their interactions with the informatic architectures of Instagram's censorship mechanisms. The research argued that the search and retrieval techniques of Instagram's Explore Tab act as an agent of intelligible (dis)allowance. More so, Instagram's shadowbanning, and its predecessor, soft-banning, cannot be separated from policies that inform it and the foundation of its algorithmic architecture. However, as participants' invisibilities and concealed architectures informed the research project, particular methodological challenges became apparent. This paper responds to the methodological challenges faced when researching indeterminate problems, opaque participants, and covert knowledge management of vulnerable materialities and their representations.

Comparable to research design, DT can be seen as a strategy, a method, or even an epistemology. IA and DT are inherently interdisciplinary, and the collision between traditional approaches with novel techniques offers the potential to overcome normative conventions in both fields and present alternative assemblages of support. The conceptualised methodology recursively positions conventional qualitative research practices against DT and IA-informed phases and their corresponding activities. Specifically, the research compares data collection methods to synthetic conceptualization; data analysis approaches to understanding and defining design problems; interpretation of findings to ideation; and evaluation of findings to prototyping. Lastly, the research troubles both qualitative methods of validation and solution-led approaches within DT and IA praxis.

Author keywords

Information architecture; design thinking; systemic problem solving; qualitative research; data collection methods, social media research; censorship; queer visibility; lesbian representation

Introduction

The stigmatisation of lesbians often results in violent hate crimes, which are emblematic of social violence against non-normative sexual embodied diversity. Unescapable homophobia in traditional patriarchal cultures of the global south, which makes up more than 80% of Instagram's user base outside of the United States, requires lesbians to negotiate layers of visibility due to social factors, interpersonal relationships, and economic implications (Duggan et al., 2015; Msibi, 2011; Waterhouse, 2019; Smuts, 2011). The fear of stigmatisation and prosecution often leads queer bodies to seek (visual) information and validation elsewhere rather than in mainstream media (Aslinger, 2010; Molabocus, 2010). The trouble is that this 'elsewhere' is not always there. Instagram has a legacy of censoring queer content. However, #lesbian has faced far more stringent 'management' from removing of all tagged content predating 2015 to the imposed 'soft' censorship up to 2017 and, finally, the more covert techniques of

shadow banning from 2018 onward. Censoring information and visuals by and within sub-communities and digital interactive information technologies sets a dangerous precedent and disseminates strategies of invisibility and unintelligibility. The *vis-à-vis* between the epistemic violence of communication technologies and the real-life brutality faced by lesbian actualities points to an expansive *'knowledge management system'* that needs to be addressed in discourse, technology, and technique.

The discipline of Information Architecture (IA) concerns the structural design of shared information environments to facilitate findability-come-usability. Although initially applied to the web and large databases, the practice of IA has shifted due to the cross-channel, physical and digital complexities of web 2.0 technologies. IA's fundamental interest now considers the design of information spaces in larger social, cultural and technological contexts; in other words, values of universality and certainty have given place to plurality and complexity (Lacerda & Lima-Marques, 2014). Likewise, Resemi (2014) affirms that practice-led issues of labelling, website conventions and hierarchy structures have been replaced by sense and place-making, design, cross-media, complexity and embodied cognition. Design Thinking (DT) is a commonplace approach in IA, and both are means to interconnected problem (re)solutions at their core. Ultimately, DT and IA present methods of intelligibility design, which is no longer constrained to digital practice. More so, contemporary DT and IA offer techniques to address (societal) 'knowledge management' problems.

IA solutions are not immediately clear to the end user, presenting disadvantages and challenges but also resilience and opportunity. For users, the product's interface, functionality and content constitute its user experience, and the IA is only tacitly understood. Fenn and Hobbs (2014) argue that the disconnect between IA deliverables and user perception poses an opportunity for the discipline to extend beyond its current practical application. Conversely, the opaqueness of information domains' structural components obscures the representational logic behind a design but also raises methodological challenges when researching the complexities of information domains and technologies.

When indeterminate problems present themselves, they do so as a struggle to determine where a problem-centre lie, and as with most wicket problems, the problem itself is but a symptom of a much larger and more systemic problematic (Buchanan, 1992). As such, it was essential for the research to move beyond the determinate phenomena of censorship on Instagram to identify the indeterminate problem-centre of the technological disallow through information technologies and the actors therein. The study at large explored how un/intelligible lesbian representational practices recursively shape and are shaped by their interactions with Instagram's information architecture, censorship mechanisms and value-laden, complex and contradicting terms of use. However, as participants' invisibilities and concealed architectures informed the research project, particular methodological challenges became apparent and necessitated a systemic and strategic approach to problem-solving.

Like research practice, DT can be seen as a strategy, a method, and even an epistemology in its own right (IDEO, 2018). In short, DT is a way of solving problems using a designer's toolkit, and because design, like IA, is fundamentally and foundationally interdisciplinary, it can be applied to qualitative research approaches of 'problem-solution'. Be that a way of overcoming field and methodology issues or grappling with 'problems' embedded in research questions or purpose statements. For this reason, rather than considering conventional research concepts, the research turned to an intra-disciplinary approach by interweaving the principles and processes of DT and IA with conventional qualitative research practices. In response to the methodological field issues raised above, this paper critically reframes what *can*, does and should be considered research data by employing synthetic conceptualisation. Further, through recursive feedback between DT, IA and qualitative research designs, the research compares data analysis approaches to understanding and defining design problems, interpretation of findings to ideation, and evaluation of findings to prototyping. Lastly, the research troubles both qualitative methods of validation and solution-led approaches within DT and IA praxis.

Synthetic Solutions for Qualitative Data Collection

By comparing various design thinking frameworks, Fenn and Hobbs (2014) illustrate an aggregated design thinking model with three phases: *research, ideation* and *prototyping*. Each phase frames specific but overlapping conceptual activities, and the continuum of the phases are iterative and self-regulating. Equivalently, an IA project is outlined as iterations of *research, strategy, design*, and *implementation*. IA methodologies are transient, iterative, and evolving due to temporal changes, emerging phenomena, and advanced understanding of the referential context that frames user needs (Fenn & Hobbs, 2014; Rosenfeld et al., 2015; Resmini & Rosati, 2011). Congruent to the iterative and recursive methodologies of DT and IA, Creswell and Poth (2016) posit that qualitative research activities of data collection and analysis as interrelated and frequently super-imposed.

The entry point of data collection is identifying a site or individual (Creswell & Poth, 2016). The larger study motivated both thresholds, but it is valuable to unpack how the individuals that occupy the problem domain were identified and how their 'data' was gathered. Plummer (2011) proposes a *Purposeful Identification of Persons* approach with three typologies of 'persons' to demarcate a research milieu. According to Plummer (2011), *great persons* fundamentally impact their epoch, community or discourse, *marginal persons* are embedded in conflicting cultures, and *ordinary persons* exemplify the larger culture of the research milieu. By such consideration, the research acknowledges seminal authors in the field of IA as great persons. Access to these great persons is granted through reviewing their literature and consulting their instructional texts. Identifying individuals who occupy the conflicting culture of censorship or stand as an exemplar of technological disallows is more challenging as they refer to predominantly silent and almost exclusively invisible users of a social media platform. What the research *could* do was uncover traces and utterances of marginal and ordinary persons. Published user accounts reflecting on personal experiences of Instagram's censorship mechanisms contextualised

these users as research participants. Moreso, this maneuver frames 'participant voices' in the form of their blog and Instagram posts, news articles and references in academic literature. It is worth noting that this reframing moves beyond traditional accounts of field observation, interviews and focus groups. Still, what constitutes participants and their voices in this account is no less mediated than they would be through primary data collection methods, as data generated by research activities can only ever be interpretive (Bourdieu cited in Fenn & Hobbs, 2014).

Creswell and Poth (2016, p.156) urges researchers to consider a multi-phased approach to data collection and recognise that each phase extends "beyond the typical reference point of conducting interviews or making observations." Once the research site is selected, a researcher must evaluate the most appropriate data collection approach, and due to the exponential growth enabled by (information) technologies, a researcher will have to collect multiple data from multiple sources. More so, considering the ethical representation of volumes of data across information channels, a researcher must develop a systematic but flexible protocol for capturing data. (Creswell & Poth, 2016, Ellingson 2011, Jackson & Mazzei, 2012). Rosenfeld et al. (2015) recommend a *Noah's Ark* approach when undertaking content analysis. A Noah's Ark approach aims to capture a 'couple of each species' data types. The range of formats, in turn, must span textual, audio-visual, interactive materials and resources to represent 'surrogate' records of the environment. Rosenfeld et al. (2015) locate that what you may find in a content analysis may not match the vision, techniques and technologies, strategy or quality of information put forward by an organisation. By undertaking a content analysis, a researcher can "identify and address the gaps between top-down vision and bottom-up realities" (Rosenfeld et al., 2015, p.323).

The research mapped the navigation flow of Instagram's *Community Guidelines Portal* and *Help Centre* to represent a surrogate record of Instagram's top-down vision. Additionally, the research iteratively engaged the 'voice of Instagram', *Instagram Blog*, as a representative of Instagram's organisational culture and politics. The bottom-up realities were captured by recording four biannual episodes of #lesbian content on Instagram's Explore Tab feed through screenshots and vocabulary mapping. In reference to Creswell and Poth's (2016, p.159) *Compendium of Data Collection*, the collection of audio-visual material includes "examining physical trace evidence" and "examining favourite possessions or ritual objects". Although the *Explore Tab* feed may not be considered physical trace evidence, it is nonetheless trace evidence of material representation. Additionally, #lesbian can be considered a ritual object of identification and identity representation (Palmer, 2015). Therefore, the user accounts detailed above also indicate the bottom-down realities of queer users on the platform.

While the research offered recommendations to address data collection concerns, primarily informed by IA's approach to content analysis, what to do with this data is still to be discerned. To follow is the account of how - through qualitative approaches, DT principles and IA processes - data becomes information.

(In)Forming Qualitative Methods of Data Analysis through DT and IA Research

The *research phase* in DT concerns understanding the 'societal world' within which the final design solution will exist and intervene. The user-centric approach of DT and IA maintains that meaningful solutions must acknowledge and address user needs and desires as they emerge (and evolve) from their cultural, social, economic and political contexts. Correspondingly, Fenn and Hobbs (2014) advocate that more than understanding a user's phenomenological context, a designer must consider the user's epistemological framework or how they think and justify their actions. DT research can, as a result, conceptualise the interpretation of the context from which the problem emerges and the "relational social logic" of a meaningful solution (Fenn & Hobbs, 2014, p. 14).

Alike the iterative nature of DT and IA phases and processes and the series of interrelated activities required in data collection, Creswell and Poth (2016, p.150) argues that the course of analysis and data visualisation are "interrelated and often go on simultaneously". Consequently, qualitative research conceptualises the practice of data analysis as a spiral. The entry point to the *Data Analysis Spiral* is data, or rather volumes of data produced through rigorous research exploring the complex social reality of a design or research problem. The data 'as is' is a messy and unruly collection of 'stuff' and therefore requires a sort of 'management' which constitutes the first loop on the Data Analysis Spiral (Creswell & Poth, 2016, p.185). According to Creswell and Poth (2016), a researcher typically organises data into (computer) files, followed by converting files into "appropriate text units" in preparation for analysis. It is worth noting that the preliminary stage of data analysis constitutes adding data to data. More than creating a meta-data schema for easy information retrieval as an information architect would do, adding data to data also appends meaning to the data set.

The research phase of IA entails gathering and reviewing background materials and current strategies. Put differently, IA research establishes the existing structural framework of the information site. The high-level framework, or contextual understanding of an information environment and the user's needs and behaviours, sets the foundation upon which an IA strategy builds. Similarly, once the unruly collection of data is managed in qualitative research, the data is set to be 'read'. Reading and memo-ing present the second loop in the Data Analysis Spiral. In this phase, the researcher immerses themselves in the data set to develop a holistic understanding of the information before abstracting it (Creswell & Poth, 2016).

At "the heart of qualitative data analyses" is the third loop of the data analyses spiral, where a researcher describes, classifies, and interprets data into codes and themes (Creswell & Poth, 2016, p.186). Detailed description entails recounting what the research 'sees', but of particular importance is that the detailing is provided within the context of the persons, places or events. Between analysis and interpretation, the designer, information architect and researcher stand as a conduit. The tension of data becoming information through the conceptual activities of the designer or researcher is best described in DT and IA's ideation phase. Furthermore, ideation, as framed by DT and IA, is comparable to the interpretation of qualitative research findings.

(In)Forming Qualitative Interpretation of Findings through DT and IA Ideation

A key characteristic of the *ideation phase* in DT and IA is that activities of constructing, understanding and creating a design connect in a mutual relationship. In the seminal text, *Dilemmas in A General Theory of Planning* (1973), Rittel and Webber argue that one cannot understand and then solve. To this account, a researcher, a designer and an information architect cannot understand a problem without first understanding its relational context. Moreover, these actors cannot meaningfully find information without a form of orientation. Rittel and Webber define the pivot that enacts useful information gathering as a "solution concept" (Cited in Fenn & Hobbs, 2014, p.14). By placing the context of a problem and the potential solutions in an iterative loop that cyclically and reciprocally edits the understanding of both fields, an artificial solution transforms into a problem/solution conjecture. Through multiple cycles of recursive feedback, a corresponding problem-solution pair become apparent. Fenn and Hobbs (2014, p.15) elaborate that the conceptual process of formulating matching problem-solutions allows solutions to emerge from a "designer's analysis, categorisation, structuring, organisation, prioritisation and consideration of the rich data.". The evolving solution, or best-matched problem-solution pair, reciprocally reduces the range of relevant data. In this way, only the data that will impact a more advanced understanding of the problem-solution conjectures amalgamate to form new meanings and develop better possible solutions.

Haverty (2002) presents a corresponding interconnected and iterative process in the practice of IA, known as Constructive Induction (CI). CI employs two intertwined searches to generate a design solution. The first search requires identifying the most adequate representational framework for the problem. The second search involves locating the best design solution within the representational framework. The intertwining is how the synthetic design solution translates back to the problem now situated in a representational framework (Haverty, 2002). In the context of CI, a representational framework signifies the constraint on user interactions through information platforms, technologies, and policies. This research argues that the concept of a representational framework can extend to qualitative research approaches (such as ethnography, narrative, phenomenological, grounded theory, and case study designs) or theoretical lenses (such as post-classical discourses) employed by the researcher, as they frame both the research question and approaches necessary to address the research question.

The interpretation of qualitative research requires abstraction beyond codes and themes into more amassed meanings or better problem-solution pairs. To demonstrate, Creswell and Poth (2016) posit that the information is further abstracted once thematically coded by organising and categorising them into larger 'meaning units'. In qualitative research, what reifies the interpretation of data is representing or visualising the data-now-information in text, tabular or figure form (Creswell & Poth, 2016). In the practice of IA, the data gathered and interpreted as (relevant) information is developed into a high-level strategy. The high-level strategy, in turn, informs IA design. In the design phase, an information architect creates detailed visual representations of the high-level strategy through conventions such as sitemaps, wireframes and metadata schemas (Rosenfeld et al., 2015). What follows ideation in DT and design in IA is prototyping and implementation. Similar to qualitative research's evaluation of findings, prototyping is not a concluding action or phase. These conceptual activities rather stand as a trigger for further iteration until a meaningful problem-solution pair emerges or solid hypotheses are crafted in response to a research question.

(In)Forming Qualitative Evaluations of Findings through DT and IA Prototyping

The iterative conceptual repositioning of problems and solutions informs the generation of design outputs. Generating becomes generative, and the feedback between the research and ideation phases develops into the *prototyping phase*. Equivalently, the *implementation phase* prescribed by IA is where information architecture is built, tested, and launched through organising and tagging content, improving processes, and developing policies. The implementation phase ensures that the information architecture can be maintained and improved over time as prototypes are iteratively validated against context, content, and users' needs and behaviours (Rosenfeld et al., 2015; Harverty, 2002). Haverty (2002) argues that this process ensures the quality of an IA solution as it avoids reductionism which manifest through a series of abstractions.

Criteria that evaluate qualitative research findings are replete with strain, not because the concept of quality is subjective but because it is contextual. Therefore, Howe and Eisenhardt (cited in Creswell & Poth, 2016) suggest that broad, abstract standards are the only way quality can be assessed. Conversely, evaluating quality in DT and IA is antithetical to broad, abstract terms because the synthetic concept is reified in each iteration to be the most appropriate, but not necessarily the only, solution within the conceptual framework of the problem. Moreso, evaluating the quality or appropriateness of a design solution by broad abstract standards proposes that the design solutions respond to broad abstract problems rather than contextual and often systemic problematics.

According to Fenn and Hobbs (2014), DT and IA are oddly framed in product-led fields, and systemic design problems are often obscured as product problems in briefs drafted by stakeholders. If products, as opposed to 'appropriate' solutions, are automatically applied in response to a design problem, they fail to engage with the complexities that emerge from design research and early ideation. Applying a generic product as a solution further implies that design problems share the same data and research setting. Consequently, a generic product effectively erases the design and research concerns which emerge from particular histories, cultures, knowledge systems and narratives. What is obscured is often tied into socio-political actualities, and more than undermining cultural values, generic responses to contextual and systemic problems may be ecologically and economically unsustainable (Fenn & Hobbs, 2014).

Truisms of universality and generality also encumber qualitative research. Referential to product-led disciplines, hard sciences often question the reliability and validity of qualitative enquiry, and in response, some qualitative research designs will adopt positivist and constructivist terminology

to facilitate acceptance by the harder sciences (Creswell & Poth, 2016). Conversely, other qualitative enquiries aim to recontextualize the universal underpinnings of validation by substituting the criteria with more naturalistic research terms such as credibility, authenticity, transferability, dependability, consensual validation and referential adequacy (Creswell & Poth, 2016; Lincon & Guba, 2011; Eisner, 2017). Two things are worth noting. Firstly, the substitution of generic universality through qualitative criteria, as listed above, draws parallels to the conceptual activities of ideation, where representational frameworks are evaluated against problem-solution conjectures. Secondly, supported by the critical repositioning of solution-led design instead of product-led approaches, DT and IA strategies can reframe qualitative 'assessment' away from abstract *criteria* to iterative validation *strategies* such as prolonged engagement and persistent observation, triangulation, and thick description.

Conclusion

In summation, the research required to understand a design or societal problem produces vast amounts of information, and understanding the complexities of design research data through synthesis can be considered the critical act of problem resolution. The conceptual process of formulating matching problem-solutions allows design solutions to emerge through analysis, categorisation and prioritisation of rich research data. In this way, information architects and designers *research to discover* and *organise information to be understood* by others in a meaningful way (Fenn & Hobbs, 2014). Therefore, the tools and techniques employed by DT and IA mediate complexity in a way in which vast and varied accounts of information can be discovered, understood and resolved.

This paper aimed to offer workable solutions to the methodological challenges faced when researching indeterminate problems, opaque participants, and covert knowledge management of marginal and vulnerable identities and their representations. In closing, introducing the technique of formulating problem-solution conjectures firstly acknowledges that 'indeterminate' design and research problems present themselves as a symptom of a larger and often more systemic problematic. More so, the conceptual activities required to generate appropriate problem-solution conjectures make clear that problems do not disappear in the advent of a solution but persist in the overlay. Therefore, employing approaches that mediate systemic problems, such as DT and IA, allows for a better understanding of the relational social logic of a societal design or research problem. Lastly, embedding design thinking and information architecture in systemic problems (re)solution allow culturally sensitive, ecologically, and economically sustainable solutions to emerge from their relational context.

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T+ designers: a case for transdisciplinarity in design higher education by way of a South African case study

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Abstract

In recent years, the term 'transdisciplinarity' has been widely applied to a range of collaborative design approaches ranging from inter- to multi-disciplinary co-production. While each of these forms of co-production have their place, many of these approaches are branded, tokenistically, as transdisciplinary. According to Toomey et al. (2015), a transdisciplinary mode of collaboration is one that looks beyond bridging divides within academia, to engage directly with the co-production and use of knowledge from within and outside of the academy. Within the context of design specifically, the term 'T-shaped designers', championed by IDEO's Tim Brown, is often used when promoting design thinking to tackle complex problems, which comprises multiple stakeholders and typically occurs within a team setting. The vertical leg of the 'T' represents disciplinary depth (such as the various skills in design) and the horizontal bar suggests the application of these skills across a breadth of other contexts.

For this paper, we extend the interdisciplinary nature of the T to a transdisciplinary one. That is, we move from the traditional T-shape as a base, and propose how transdisciplinarity can be used not only to foster a heightened sense of social awareness in students, but to inculcate civic values that will be transferable beyond the academy, ultimately in their professional practice. In this way, as the vertical stem deepens, civic graduate competencies are nurtured and the T transforms into a plus. We illustrate this transformation by presenting an exit-level BA Information Design curriculum-related project. As a collaboration between the University of Pretoria (UP), South Africa (SA), and the University of Roehampton (UR), United Kingdom, the project was delivered in a meaningful transdisciplinary way, whereby students co-produced a series of accessible and engaging infomotions (information visualisations in motion) - a visual toolkit of sorts. The infomotions, which disseminate strategies for effective partnership, are aimed at early childhood intervention practitioners in South Africa. Specifically, the infomotions serve a communicative and mediative role between therapists and health practitioners, early childhood educators and family and or caregivers as they collaborate on various early childhood interventions that help young South African children (0 to 6) who may have or be at risk of developing special educational needs, disabilities and/or developmental challenges; challenges that were highlighted at the height of the Covid-19 pandemic. At its core, the project serves to highlight the value in transdisciplinarity as an effective model for collaboration in ECI in South Africa and indeed across the globe.

Author keywords

Design education; transdisciplinarity; information visualisation; South African design; design for development; early childhood intervention.

Introduction

As a reflective practice (Schön, 1983) that's adept at tackling humanity's wicked problems – such as climate change, education, equality, health, and wellbeing – design is inherently collaborative and social in nature. Now more than ever, Herbert Simon's (1969, p. 129) seminal definition of design that "[e]veryone designs who devises courses of action aimed at changing existing situations into preferred ones" speaks to the transformative potential of design. For example, in contemporary design practice, cross-disciplinary partnerships are evident across a myriad of design practices; co-, participatory-, social-, transformative- and service- are just some adjectives that are used nowadays to denote that design approaches transcend predefined, historical silos of working independently.

Cross-disciplinary partnerships have also increased, given the popularisation of design thinking as a problem-solving methodology. While design and designers increasingly occupy a space in the front-end of innovation, the application of a design thinking approach is sometimes more of a fad to drive innovation (Johansson-Sköldberg et al., 2013). As such, collaborative design approaches are sometimes conflated with being inter-disciplinary and multi-disciplinary, and are thus labelled as being transdisciplinary. Using this critique as a springboard for investigation, we aim to elucidate a transdisciplinary approach specifically from a South African design education perspective. To this end, the paper presents a triangular interest in contemporary design practice, transdisciplinarity and design higher education. The paper begins by outlining the history and nature of T-shaped professionals as it appears in extant literature. Next, we provide a working definition of transdisciplinarity before presenting a curricu-

lum-related BA Information Design (ID) project. Ultimately, the analogy of shifting from a T-shape to a T+ guides the discussion for transdisciplinarity in design higher education.

Doing things to a T

According to Ing (2008), the term "T-shaped skills" is credited to David Guest in an article that appeared in London's The Independent newspaper in 1991. This was followed by its use by Marco Iansiti (1993) in an article titled Real-World R&D: Jumping the Product Generation Gap. Citing Iansiti, the term was subsequently used at length by Leonard-Barton (1995); the context was a study "of R&D groups in system-focused companies, emphasising skills within a team as a whole" (Ing, 2008). The term was also related broadly to problem-solving instances. During the 1990s, the focus on T-shaped professionals shifted towards a more specific role, namely T-shaped managers. This shift was informed by a move away from a more linear form of management style during the industrial age (Ing, 2008). It became necessary for professionals to not only have depth of knowledge of their discipline or area of specialisation but increasingly a breadth of knowledge or understanding of other disciplines too. Hence, this dual need informs the pictorial representation of the T-shape where the stem of the T represents disciplinary or functional skills, and the crossbar of the T connotes application of knowledge across a broader range of contexts, and end-users.

Owing to the scope of skills required to address wicked social and cultural problems, the general concept of T-shaped professionals has since been adopted in design, management and innovation discourse. In particular, the term gained popularity by Brown (2010) who championed the notion of designers as T-shaped people when promoting design thinking, the nature of optimal work teams (which alludes to co-creation) as well as organisational culture and hiring employees. Peter's (2012, p. 65) explanation of Brown is that "the T-shaped designer possesses a principal skill of, let's say, industrial design (vertical), as well as an empathic or inquisitive nature that encourages branching out into other skills, such as anthropology (lateral)".

What's significant with regard to T-shaped designers is Brown's argument that the horizontal crossbar of the T is composed of empathy "... because it allows people to imagine the problem from another perspective - to stand in somebody else's shoes" (Brown in Hansen, 2010). Furthermore, Brown highlights "active listening" as a form of empathy. Active listening is a trait that is seminal to our argument, and we return to it in more detail in the case study section.

The concept of T-shaped individuals is also evident in education-related discourse, which traverses different disciplines. For example, it can be found in design (Peters, 2012), medical (Donofrio et al., 2010), STEM (Conley et al., 2017), and engineering education (Tranquillo, 2017). The recurring theme in educating T-shaped students across different disciplines concerns nurturing students who will become graduates with attributes that will not only support them in advancing professionally, but also personally as critical citizens.

Transdisciplinarity and the higher education landscape

Transdisciplinarity in education is not always a categorically distinct term; it is often used interchangeably with inter- and multi-disciplinary practices. However, in a recent literature review study titled "Higher education, the arts, and transdisciplinarity" van Baalen et al. (2021, p. 24) present a continuum "moving from buzzwords to a theoretically delineated usage – to make sense of the use and conceptualization of transdisciplinarity". While it is not our intention to unpack this continuum, we align our research with an intentional theoretical usage of the term and not merely as a tokenistic adjective to describe our case study. Moreover, we show how design did not occupy an "instrumentalized position" where design approaches were used by other disciplines. Instead, a transdisciplinary approach was adopted whereby a new space of interaction was created beyond the traditional disciplinary bounds. Thus, the following understanding of transdisciplinarity, ineducation, serves as our working definition: "Trans-disciplinary work moves beyond the bridging of divides within academia to engaging directly with the production and use of knowledge outside of the academy" (Toomey et al., 2015, p. 1). A visual comparison by Jensenius (2012), as seen in Figure 1, makes explicit the differences between the broad range of disciplinarities.

Figure 1. Visualisation of the nature of different disciplinarities (Jensenius, 2012).

Transdisciplinarity is fast gaining ground in institutions of higher education both globally and locally. This is not surprising as higher education is also expected to evolve and adapt to changes to prepare graduates when applying their skills in the real world. Consequently, there is a universal move to outline graduate attributes, which aim to strengthen the links between what is taught and what skills are necessary not only for graduate employment but also in context of the socio-economic-political needs. At our home institution, "[t]ransdisciplinary research has long been part of the University of Pretoria's [UP] key strategic vision" (Kupe, 2022). It is also clearly noted by UP's Department of Institutional planning that graduate attributes "are aligned with the human capital needs of the economy and society, need to encapsulate both universal and particularly South African demands and develop in students critical citizenship" (University of Pretoria, 2023).

Case study: infomotion

Following this imperative, we introduced transdisciplinarity in our undergraduate ID programme. The ID course appreciates that design does not exist in a social vacuum; rather, it affects and is affected by larger social concerns and consequently, students are encouraged to appreciate the outcome of their work within a broad socio-cultural environment.[1] This means

1 One of a kind in South Africa in terms of its broad-based approach, the BA ID programme promotes design thinking through the exposure to and integration of various communication design disciplines. The philosophy in ID is to consider teaching and learning strategies that centre on learning by doing, hermeneutic enquiry, experiential learning, balancing theory with practice, and encouraging both individuality and civic responsibility

that the pedagogical strategy aims to prepare students to work within the expansive domain of humanist or socially-oriented design.

Keeping the social underpinnings of the course in mind, the following section provides an intimate overview of a fourth (and final) year student animation project conducted in 2022. It was delivered by a team of lecturers, led by the authors and Alexander Melck (Phlogiston). The project serves to highlight the value in transdisciplinarity as an effective model for collaboration in early childhood intervention (ECI) in SA and across the globe. As we demonstrate, the practice-lead project, whereby students engaged with and gained valuable field insights from ECI practitioners as well as the project team, is fundamentally transdisciplinary in its conception and execution. That is, it is not merely an interdisciplinary project in which students engage with different fields of expertise at different points in the project. At its core, the stages of the project are led by two principal lecturers, who not only provide a sense of continuity in facilitating these ongoing interactions, but also help students to filter and leverage the diverse perspectives and focus their project outcomes in order to create innovative and impactful design solutions. Moreover, although our focus is on this practical project, it is worthwhile pointing out that it formed part of a larger ECI research initiative. That is, in its broader conception, the design contribution lies in distilling complex, dynamic and interconnected ideas gleaned from the research.

The research initiative, led by Dr Susana Castro-Kemp (UR), sought to identify current practices and challenges faced by ECI teams in delivering interdisciplinary provision for young, vulnerable children. In collaboration with Prof Shakila Dada (UP) and Dr Alecia Samuels (UP), the initiative looked specifically at ECI in SA. A national survey with ECI practitioners across disciplines was conducted, followed by more in depth virtual focus groups and telephone interviews .

The team identified a range of challenges specific to the local ECI context. Notably, the researchers found that owing to the high level of poverty, 30-50% of households are not able to meet basic nutritional needs, let alone consider any sort of specialised medical treatment for children with significant developmental needs (May et al., 2020). Moreover, the study notes a significant shortage of ECI practitioners available to the public health sector. At least two million children in SA live with disability. Unfortunately, as of 2019, 70-80% of children with disabilities (CWD) are reliant on the public healthcare sector, which accounts for less than 20% of the registered ECI practitioner workforce (Kathard et al., 2020). To respond to these challenges, the research outlines three overarching strategies. Firstly, the researchers address the efficacy and resource intensity of different modes of collaboration in ECI and suggest that a transdisciplinary model is more sustainable in terms of manpower and continuity in treatment. Secondly, in order to achieve effective transdisciplinary collaboration, the research promotes various modes of open and constructive communication involving active listening and joint decision-making as a way of building trust between practitioners and reaching consensus about the child's needs. Finally, the researchers found that collaborative ECI is most effective when it is family-centred, whereby families are considered as part of the team of experts and are empowered in the decision-making process with regard to care for their children so that intervention is more likely to continue at home.

With these strategies in mind, the researchers collaborated with our ID division, to develop a series of motion graphics that unpack these strategies in a meaningful and accessible way. The aim was to produce a series of infomotions (information in motion) - a toolkit of sorts - that serve a communicative and meditative role between therapists and health practitioners, early childhood educators and caregivers as they collaborate on various interventions that help children (ages 0 to 6) who may have or be at risk of developing special educational needs, disabilities and/or developmental delays.[2] As a set-up for the practice-based project, students were divided into nine groups of five. The research and findings gathered in the first phase of the project were distilled into nine abstracts (divided into three categories) each subsequently informing the respective student groups as they progressed into the research and conceptualisation phase of the project.

During the conceptualisation phase of the project, students were encouraged to conduct supplementary research in a variety of ways. To start with, students took part in a story-building workshop, where they unpicked the key elements of good storytelling. The idea of the workshop was to develop a sense of narrative thinking; to gain insight into the way we internalise information so that students produce meaningful stories, as opposed to stale, instructional videos. From there, groups worked through and pitched several ideas, each revolving in some way around metaphorical analogy; comparing the core problem statement in their research to an accessible or relatable phenomenon.

The next phase was scriptwriting, where students began to translate their concepts into a workable, tangible structure. While still exploratory in nature, groups untangled structural concerns such as logical flow, repetition, abbreviation and integrating case study examples. Students were also given further classes on script-writing practice, again with an emphasis on narrative storytelling. The focus here was to develop a story arc, through writing and structure, the rhetorical nuances in narrative writing and lessons on the value of micro-editing to inject voice and texture to a piece. For example, the first group was tasked with describing not only what the concept of collaboration is in theoretical terms, but also *show* in a meaningful way, how this concept has practical and immediate value to their practice. [3] In order to do so, the group used inversion as a rhetorical strategy to contrast the practice of 'do-it-yourself' (D.I.Y.) versus collaboration. In the script, the designers flesh out statistics that describe, with some whimsy, the follies of D.I.Y. in day-to-day home improvement; construction gone awry, broken bones and missing appendages. At the halfway point in the script, these 'mishaps' are described as reasonably 'fixable' since one is always able to "rebuild, repaint and reattach."

2 To view the nine infomotions, visit https://youtube.com/playlist?list=PLMKCPojH7a7lyQ83LDsOnWpAWUR8CETmn (Information Design, 2022).

3 To view the infomotion entitled *Why collaboration matters in early childhood intervention*, visit https://youtu.be/p81buijyxPI (Information Design, 2022).

In contrast, the script concludes that this is *not* the case when it comes to ECI, since the first six years of a child's life are developmentally fundamental and are not as easily 'redone' if a mistake is made. Hence, ECI is not a do-it-yourself project, but requires timely collaboration.

Importantly, at this point in the project, the groups were put in touch with ECI practitioners, via an online chat platform, Slack. This proved to be helpful to the script-writing process, since students were able to use the insights and real life stories they gleaned, to help ground some of the more abstract research concepts they were dealing with and that had to be distilled in an accessible way. A good example of this is in the case of one group who tackled the topic of 'why families are important to ECI.'[4] The students' research exposed them to a myriad of occupational and physical therapy intervention techniques that can be continued at home. In order to avoid simply negotiating different viewpoints by listing an overwhelming array of techniques in the script, students depict a simple scene that mimics an actual scenario of an occupational therapist teaching parents of a CWD a mirroring technique to help with physical and mental coordination. Interestingly, in recalling the experience to the students, the practitioner also happened to mention that owing to the particular child's difficulty with maintaining eye-contact, it was the child's mother who suggested that the activity be modified to where they do it without facing each other. After months of initially stalled treatment, this slight modification had a substantial impact on the child's uptake of successive techniques.

Working with various ECI practitioners also brought to light an incongruence in the initial narratives across the first four research themes. Initially the second and third infomotions were meant to be summaries of three models of collaboration (multi-, inter and transdisciplinary collaboration) with the fourth as a conclusion that transdisciplinarity is the preferred model. What became clear however, was that there was an assumption that transdisciplinarity may be viewed as the preferred model simply because it is listed as the third mode. Therefore, in the interest of accessibility for knowledge dissemination, it was important to first unpack the strengths and weaknesses of the former models, but specifically as a point of *contrast*. And so, in discussion with the groups, the disciplines came together to find a consistent, overarching metaphor, of modes of water-dissemination, as forms of collaboration that occur in nature.[5]

After several iterations of the scripts, students recorded a rough edit as a prototype to present to the project lecturers, researchers and ECI practitioners.. The prototyping was used to gain a bird-eye view over continuity between the nine scripts as a whole. That is, how certain concepts described in earlier infomotions are ultimately clarified, picked up on or circulated without unnecessary repetition in later ones. Secondly, the researchers and practitioners were particularly helpful in identifying incongruencies in use and application of terminology. Upon finalisation of the scripts, students collaborated with sound producers and a voice over artist from UP's local radio station to record the scripts. At this point, students were taught how to direct the voice over artist in terms of tone, texture, mood and pronunciation to ensure that the target audience receives the message in an accessible and engaging way.

Next, students begin to consider and develop a visual style for their infomotions that is not only conceptually appropriate to the research theme, script and narrative, but appropriate for the intended audience. At the same time, students are required to consider scene-to-scene animation by way of a storyboard. Storyboarding, as a type of visual shorthand, helps students to work through and prototype the relevance and meaning of several narrative ideas fairly quickly, without committing to hours of work that goes into just a few seconds of animation.

Students then moved onto the audio-mixing phase. This is arguably the most important technical aspect to an infomotion since, in most cases, the audio guides the pacing and rhythm of the animation for the viewer. Where syncing to the voice-over most obviously guides the pacing of a motion piece, students are taught to pick up on, enhance and add audible changes in the backing track to help create drama through climax and anticipation. Moreover, backing tracks and sound effects were also employed to help shape the atmosphere for a piece.

Students then begin to animate. As a form of animation, infomotion affords the designer time and sequencing as tools to unfold a meaningful narrative. Motion graphics need to evoke rhetorically powerful signs and symbols quickly in order to effectively and intelligently communicate complex concepts. Therefore, they should communicate singular, accessible concepts. In other words, in promoting accessibility in the production and dissemination of knowledge, students were encouraged to simplify the scene-for-scene depictions to produce focused ideas, one at a time. If more than one idea is communicated per scene, there is a chance that the animation may confuse or overwhelm the viewer.

As part of the ID degree, there is a strong emphasis on the value of reflection as an analytical and developmental tool. For this reason, students were briefed, at the onset of the project, to document their research, critical thinking and design processes; from concept, storyboarding and animation to working with and across disciplines. Students had to consider moving from their initial insights to developing a more robust and thoughtful concept. Students had to consider, for example, what they might have originally assumed would be an appropriate conceptual solution compared to what was ultimately gathered from the transdisciplinary interactions . Ultimately, owing to the transdisciplinary focus, students reflected on how, if at all, consultation with fellow group members, project leaders, the client and ECI practitioners helped to evolve their thinking and design approach.

Developing T+ designers

The aim of the transdisciplinary project was both pedagogic and practical. The project facilitated epistemological development of design students. More significantly, they learnt about

4 To view the infomotion entitled *Why families matter in early childhood intervention*, visit https://youtu.be/KLRPnFKBFIQ (Information Design, 2022).

5 To view these three infomotions, visit https://youtube.com/playlist?list=PLMKCPojH7a7JcapKaSIH04Fsv_UIOJcbZ (Information Design, 2022).

the co-production of knowledge as it relates to the idea of design as a relational practice, comprising reflective as well as reflexive processes. Students engaged with research for design from a different perspective, to script a 'new' narrative.

Although the project constitutes various research phases, the reason we focussed on the practical component specifically is twofold; as design is a field invested in critical thinking and problem-solving it is typically the case that designers are required to develop a deep understanding of the problem at hand in order to thoughtfully consider the research initiative and its initial findings and strategies, but then also to communicate these findings to the end user in an accessible, intelligible and meaningful way. Through a real-world project, students experienced first-hand that design serves as a throughway between the research and end users, and is able to distil possible communicative gaps in both the acquisition, dissemination and uptake of research.

With regard to the traditional T-shape, the design education context of the project facilitated areas of professional design practice; students were expected to apply disciplinary depth by synthesising and building on their design skills, scaffolded over their former years of study (the vertical leg of the T). Perpendicular to this, the complex nature of ECI in SA introduced different contexts, stakeholders - including research and end-users - and disciplines to the students (the horizontal bar). The breadth of engagement required students to broaden their worldviews; it highlighted that their design decisions need to be informed through cooperation, collaboration, prototyping, and dissemination and not only imagined by their preconceptions.

Social change is at the heart of knowledge creation – not only within the bounds of this project, but also in terms of fostering a sense of social and ethical design citizenship that is maintained, paid forward and extended further as design graduates enter their chosen professional field. What this project showed us was how to nurture "citizen designers" (Resnick, 2016). Through facilitation of the project, we recognised a transformation in the students' problem-solving approach; an empathic outlook was evident, which from a civic point of view, gives them a sense of agency in making socially impactful messages heard. This conscious approach to transdisciplinarity was also carried over in subsequent ID projects. More importantly, the deep social awareness and civic responsibility that students gained will hopefully extend beyond the classroom, like the stem of the T extending upwards to shape a plus (+); a T+ shaped designer. This is not to say that social awareness and civic responsibility is not part of the traditional T-shape. Instead, it is our position that (1) more attention on *strengthening* the link between design education and design practice, and (2) on encouraging the design student to strive for civic responsibility beyond the classroom, might strategically extend the core tenet of the traditional T. Over time the experience of transdisciplinary design practice may become transferable graduate attributes that designers embody not only in their professional trajectories but also social, cognitive and basic values that contribute to a more socially-just world. Given SA's apartheid past, the socio-economic inequalities that still plague the country will indeed benefit from solutions developed from within and for a local context.

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In transition: material knowledge, commons, and design education

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Abstract

In reflecting on two teaching units, this paper analyses the relation of design to environmental awareness, thus gaining arguments to combine speculative approaches with designerly material knowledge and the social practice of commoning in design education. Criticising the linear paradigm of existing design programmes, it argues for redefining design education as an agent for change furthering transformation in the design field.

Starting from the perception of the current socio-ecological crises, condensed in the disputable term Anthropocene, the paper discusses how to open new ways of conceptualising design education through redescribing the situation, adapting a critical notion of design history, and reevaluating the speculative heuristics of design in a MA Design programme.

The second part discusses combining circular design strategies with 'designerly material knowledge' in the same educative setting. As an explorative approach, designerly material knowledge is based on the findings of material sciences integrating a historical and cultural understanding of materiality. Assuming design unlocks and redefines materiality through experimental, creative, and prototyping approaches, the question arises of how to validate this knowledge in the design process and pass it down to future students. Inscribed with the urgent need to counter «de-futuring» practices of unsustainable design (Fry, 2020), we should speculate about «futuring» design education. Thus, conceiving a material-based design methodology of circular design practices and processes could lead to a revision of design education and practice and a deeper understanding of the role of materiality in the design process.

The third part builds on the assumption that design education should heighten the experience of the social embeddedness of each design task in place and time. Instead of designing discrete objects, design students learn to conceive relationships, interactions, and experiences for and within complex social systems to achieve potential systems-level change (Irwin, 2015). Therefore, design is best described and trained as a co-design activity involving various actors (Manzini, 2015). Understanding any short and long-term ramifications of using resources could benefit from a closer reading of commoning as a social practice, as discussed in a Bachelor's teaching unit. Commons are historically contingent (Ostrom, 1990). How Commons are organised signifies how societies understand their embeddedness in any (natural, social, planetary) environment. Thus, a historical perspective on commoning as a social practice could help students acknowledge that environmental issues and eco-conscious practices always form part of socially regulated and therefore designed systems.

In conclusion, the paper discusses the ramifications of those two specific teaching experiences on their potential to transform design education into a more circular practice of educating.

Author keywords

Transition design; Design education; Materiality; Commoning

Introduction

The human-caused altering of the chemical composition of the Earth's atmosphere, the unfolding climate change, the dramatic loss of biodiversity, melting glaciers, or continuing acidification of the oceans is threatening the critical zone, i.e., the thin layer allowing all life forms to live on the planet (Latour, 2018). These crises threaten societies and environments, mainly caused by the Global North (United Nations, 2015). As an inextricable part of the history of industrialisation, design finds itself in the middle of the debate and, with it, the crucial role of design education.

Witnessing such crises is no longer just a matter of scientists. 'Eco-anxiety', the chronic fear of environmental doom, despite not yet being considered a diagnosable condition, gained recognition, as was its disproportionate impact on children and young people (Rao & Powell, 2021). Fueled by debates in mass media and illustrated by memes on social media, the feeling of loss hits people from all backgrounds. Teenagers and young adults brought the fight against climate change to the streets in Western societies and into the highest governmental institutions in the late 2010s thanks to social movements like Fridays for Future or, on a more desperate urge, Extinction Rebellion, Last Generation, or Renovate. Design students are particularly concerned by this. According to a traditional understanding that still widely grounds design education, its methodology remains defined by the linear approaches of industrial production and consumption patterns. Therefore, design holds responsible for the damage caused, as Victor Papanek summed up famously when he decried designers as "creating whole new species of permanent garbage to clutter up the landscape, and choosing materials and processes that pollute the air we breathe." (1971, p. XXI) Hence, design does not create the future, according to its distorted but cherished self-image; it takes our future away, as Tony Fry (et al., 2015, p. 9) denounced: "In particular, industrial society has brought these, and a myriad other defuturing things and forces, into being."

How can we, as design educators react to this situation? Even more so, we are affected by the same feeling of profound loss and confronted with losing credibility as part of an older generation that could have known better, at least since the 1980ies. Transforming design education entails a thorough self-assessment of educators, questioning the intensely linear paradigm of prevailing design programmes and coming up with alternatives. Thus, in reflecting on the debates with students during two teaching units on BA and MA levels at Basel Academy of Art and Design, this paper argues for combining speculative approaches with designerly material knowledge and the social practice of commoning in design education.

Starting from the perception of the all-encompassing socio-ecological crises, condensed in the disputable term Anthropocene, the first part of the paper discusses how to open new ways of conceptualising design education in a project-based teaching unit at MA levels. The need for this is twofold: First, as educators, we are often confronted by students asking about design's social and environmental responsibility. Such questions gain acuteness at the end of their basic studies when they have learned designing skills and methodological principles. Thus, their unease relates to the foundations of the professional field for which they are being trained. How can design education help to transform a professional field perceived as not future-proof? Second, if we define design as mediating technology, resources, and policies, our practice indirectly affects existing and creates new environments. Therefore, design is deeply integrated into sustainable and unsustainable everyday living, defining behaviour, access, or norms defining design as always political (Mazé et al., 2013). Given this entanglement, the question arises if and how the policies of design education can contribute to resolving the crisis.

The second part discusses how the same MA students combined circular design strategies with 'designerly material knowledge' in the project-based teaching unit. Conceiving a material-based design methodology could lead to a revision of design education and practice and a deeper understanding of the role of materiality in the design process.

The third part of the paper builds on the assumption that design education should heighten the experience of the social embeddedness of each design task in place and time. Understanding any short and long-term ramifications of using resources could benefit from a closer reading of commoning as a social practice, as discussed in an interdisciplinary theoretical BA teaching unit. In conclusion, the paper discusses the ramifications of those two specific teaching experiences on their potential to transform design education into a more circular practice of educating.

Positioning design education in relation to environmental crises

As Latour (2018) reflected, it is high time to define our situation in what he considers a fundamental crisis of modernity detached from its material constraints. Beyond the much-needed political activism (in which design educators could take a much more active part), the crises urge us to redefine where we are in temporal and spatial terms. To discuss the situation on a planetary level without nurturing deeply disturbing perspectives and prevailing feelings of helplessness and doom, Latour's notion of *atterissage* is of great help. If included at the beginning of a teaching unit, this opens an ongoing debate about making meaning in times of uncertainty.

We thus collectively developed a project-based teaching unit at the master's level led by Evelyne Roth, Jörg Wiesel, and the author. The interdisciplinary teaching unit 'Thinking and acting in circles' collaborated with a Swiss outdoor sports company to develop circular design propositions in the Autumn Semester of 2022. The 15 master students with an international background and BAs in Industrial Design, Textile Design, Fashion Design or Scenography worked in groups. They aimed to research on how design propositions can help transform a linear methodology into circular processes and practices. Together, we structured the teaching unit according to a standard design process and integrated theoretical inputs on debating definitions, historical perspectives, and the heuristics of speculation. We started with an explorative investigation of the company's products and objects. We immediately integrated practical design experiences and reading, open questions and knowledge gaps into the discourse. Not all students were familiar with the debate on the Anthropocene or had read the founding texts on circularity. Nonetheless, they reacted positively to the opportunity to ask wide-ranging questions about the current crises, the difficulties in describing them, and how this affects their positioning in design.

It is no easy task to subject the canon of designing to critical revision, i.e. to solve or address in a still very linear way clearly defined problems. The underlying rationale of design education is still governed by the belief that creation is exclusive to humans and a means of self-expression for the better of other humans. Reworking such definitions by learning to describe the planetary situation otherwise and looking back to find inspiration in counter-narratives of design history presupposes a cognitive level only reached in the MA programme. Here, it is no longer about understanding design-related terms, methodologies and theories but about critically examining the underlying notions, even if this may deconstruct long-held beliefs.

What words? Relearning to describe the current situation

Perceiving a crisis calls for new terms describing the situation in its singularity. From a geological perspective, there are good reasons to rename the current epoch in which significant changes to the structure and functioning of the Earth System, including the climate system, are to be observed. Naming this still disputed new geological epoch 'Anthropocene' refers to the realisation that human beings have become a global geophysical force.

Besides terminology, beginnings are much debated in historiography, even more so in geological time frames. The ratification process is still ongoing, and thus the beginning of this epoch remains to be decided definitively by the experts. Of higher interest, though, is the fact that in the meantime, the term Anthropocene has become an environmental buzzword coined by the late atmospheric chemist and Nobel laureate Paul Crutzen in 2000. In his view, the outcompeting of natural processes started "about two centuries ago, coinciding with James Watt's design of the steam engine in 1784", linking the beginning of the Anthropocene with the industrial revolution. (Crutzen, 2006). In an equally influential later publication, he and his co-authors proposed dividing the Anthropocene into three stages. The Industrial Age 1800-1945, the Great Acceleration since 1945, followed by a future phase to gain joint responsibility for the Earth's system by the global community in 2015 (Steffen et al., 2007).

Alternatively, the beginnings of the Anthropocene are traced back to the Great Acceleration period after the Second World War and the advent of the nuclear age (McNeill & Engelke, 2014). This hypothesis will probably prevail as the stratigraphic and Earth System approaches assess this period as crucial. Since then, geologists have detected the increasing worldwide use of synthesised fertilisers in strata, as well as aluminium, heavy metals and techno-fossils. Microplastics, which pollute regional waters and oceans, are entering the food chain and will probably still be detectable in sediments thousands of years from now (Waters et al., 2016)

Altering the Earth's system will inadvertently affect us with all other living species and non-living entities. Thus, 'Anthropocene' has vast philosophical and historiographical implications beyond its geological significance. It designates a shift of perspective from living in the "new world" and being dependent on it (Holocene) to adopting an active role in (re-)designing or even creating a "human-made new world" (Anthropocene).

Thus, reflecting critically on the term Anthropocene with the MA students entailed two propositions, as we collectively worked out in one of the theoretical inputs during the project-based teaching unit. First, the hubris engraved in the term forcibly leads – especially Western thinking – to a turning point in the definition and perception of the relation between the environment and human beings, acknowledging that humans are more deeply entangled with it on a factual and epistemological level. Therefore, as Donna Haraway points out, alternatives to describe the situation are much needed. She proposed another definition for this new age and coined the term 'Chthulucene' (from the Greek *chthonos*, meaning "of the earth"), describing it as an age "made up of ongoing multi-species stories and practices of becoming-with in times", an age in which we must decenter humans from their adopted central place: "We are at stake to each other." (Haraway, 2016). It is urgent to deconstruct the historiographical implications of the term Anthropocene, suggesting that human beings are still moving forward in their conquest of space and (geological) times, according to Crist (2013, p. 132). More so, the term wrongly suggests that humans are controlled by fundamental biological and geological processes or even creating them.

Second, we need to understand better how the present crises are related to their political and historical causes. We live amidst a full-fledged ecological and socio-political crisis unfolding unfolding as massive global inequity. Such inequity forcibly leads to reflecting on the discursive aspects of the rather generic term 'Anthropocene' as it tends to blur causes and effects. Sociologists, therefore, oppose it, arguing that the current environmental crises derive from overshooting the capitalist economy rather than the mere fact of being human. (Malm & Hornborg, 2014). The term wrongly reduces "the mosaic of human activity in the web of life" to an abstract "homogeneous acting unit", essentially removing "inequality, commodification, imperialism, patriarchy, racial formations, and much more" from consideration, as Jason W. Moore criticised (2015, p. 170). Thus, using the term 'Anthropocene' in non-geological contexts bears the potential to de-politicising the ongoing crises. Therefore, Latour (2018) urges us to redefine how and with whom we can sustainably live in what he describes as the 'critical zone', i.e. the fragile layer allowing all life forms to live on the planet. He suggests that we must shift our focus to sustain this critical zone and become 'terrestrial', a status he explicitly links to a fundamental critique of modernity, its underlying paradigm of progress, and contemporary politics. He further extends this notion to a critical, participatory relationship to our living world in unprecedented danger, defining the worldwide situation as the 'new climate regime'. This regime is not limited to ecological crises but touches on questions of politics, cultural history, and ethical and epistemological perspective changes. Scrutinising design's role in this process is vital to reformulating a new ontology of design (Fry, 2020). Design gained critical attention through the sense of hubris in the term Anthropocene's meaning and its oppressed question of liability.

Counter-narratives of design and its history

The debate on the Anthropocene was further contextualized during theoretical inputs by a thorough reflection on the historical roots and the canonized, predominantly western understanding of 'design'. As an inextricable part of industrialisation, design – defined as an 'interface' to make technology available (Bonsiepe, 1999) – finds itself in the middle of the debate. Crutzen's reference to James Watt's invention of the steam engine in 1784 underlines the crucial role of technology at the root of the current environmental crises. With the invention of steam power, the change from agrarian to industrial societies in Europe and North America soon made itself visible in many areas, including the landscape. Before industrialisation, people used natural forces – wind, running water, or gravity. With the steam engine, the releasing of chemically bound energy began, and the new machines were driven from within, for which they needed fuel, be it wood, coal, or coke. Energy consumption massively increased starting the era of extractive industries intricately connected to colonialism, which today puts the primary responsibility of urgent decarbonisation on the Global North.

The need to protect the forests through sustainable silviculture concerned not only foresters but broader sections of the public (Radkau, 2011). A hitherto unprecedented burden of pollutants on the environment became apparent in the 19th century. In the big cities, people could hardly breathe; the air was full of smoke, and toxic sulphur dioxide compounds led to forest dieback on a larger scale. However, as in the Middle Ages, technical and legal protective measures were still limited to containing visible and malodorous substances. The belief in the almost unlimited self-purifying power of nature continued to dominate. Thus, according to a traditional understanding that still widely grounds design education, 'design' is seen as primarily defined by the processes of industrialisation and therefore held co-responsible for the damage caused by it.

Still, there is a counter-narrative to the role of industrialisation in design. Besides debating the role of design history in design education, such alternatives open a different grasp on the potentialities of design in the current situation. The social and environmental costs of mass production did not go unnoticed by design itself, from William Morris's utopia News from Nowhere, published in 1890 (Morris & Kumar, 1995), critical systemic thinking (Fuller, 1969); (Rittel & Webber, 1973) to socially integrative (Papanek, 1971), feminist (Buckley, 1986), or decolonial (Escobar, 2018) approaches that all define alternative design methodologies considering environments of all sorts. In the last two decades, criticism of design in the service of an industry that externalises environmental damage and privatises profits intensified, lately propagating approaches like Transition Design (Irwin, 2015).

The role of the prototype: Making potentialities tangible

It turned out to be crucial embedding both discursive undertakings – redescribing where we are and re-writing the history of design on the model of existing counter-narratives – in non-linear, openly discursive didactical settings integrating them in the ongoing practical explorations of circular design practices in a predefined and real situation. In this setting, the MA students were invited to activate their design skills in reformulating longtime undisputed design practices and thus free themselves of the negative and unproductive feelings of 'being ashamed' as designers.

On a theoretical level, this led to rethinking the defining problem-solving paradigm. Design entails the promise not only to create solutions to existing problems but to undo or redo the effects of decisions taken in the past. Thus, the current and much debated hopes for technical approaches like geoengineering to deal with the devastating effects of Global North's overconsumption on the climate. In a crisis, however, the problem-solving paradigm of design concedes to designers the invidious role of coming after the shock: They seem obliged to repair the debris and thus save the world. Should we, therefore, compare design to the Red Cross, treating but "a few wounds that capitalism inflicts" and therefore "prolongs capitalism like the Red Cross prolongs war", as German sociologist Wolfgang Fritz Haug (1970) criticised design as serving the needs of a capitalist society. His unfair and blatantly wrong comparison is just one of many criticisms of design-as-embellishment of capitalist interests in the 1970ies. The most salient aspect is the basic notion of timing that undergirds Haug's critique: If we limit the scope of action for design to mending what has gone wrong, we miss one of the central heuristics of design of opening possible futures. We should better conceive of design as a vital resource for transformation. Such a notion relies on attributing design with an intrinsically speculative potential.

Speculative methodologies extend to multiple disciplines linking art, design, technology, or strategic thinking. An epistemological axis of the unconstrained connects them to the constrained (Montgomery, n.d.). Speculative design makes potential futures tangible and, therefore, negotiable, shown amongst others in the work of Anthony Dunne and Fiona Raby. Their impact in the early 2000s was liberating for designers, even if the approach was rightfully criticised as binary and too biased on western notions of design (Bardzell & Bardzell, 2013). Opposed to affirmative design as problem-solving reinforcing the status quo in the industry's service, Dunne & Raby (2013) characterise speculative design as problem-finding in the service of society, asking how the world could be.

'Proto-typing' is a means of trying out solutions beforehand. In contrast to other critical practices, it mainly uses prototyping to gain knowledge. Iterative processes go on until stakeholders agree on the result. Thus, prototypes are not only futuristic but deeply discursive objects. They bring a proposal to the table, as preliminary as it may be. Embracing such a heuristic instead of dismissing design once and for all because of its undisputedly capitalist and colonialist heritage could help overcome future crises.

In the one-term MA teaching unit setting, speculative design approaches helped the students greatly free themselves from the burden of delivering ready-to-implement propositions. In activating their exploratory and observational skills, they nonetheless gave valuable inputs to the company regarding their repair processes or managing their leftovers, amongst others. At the same time, the students achieved a practical understanding of the difficulties of transforming linear into circular production and consumption processes in real life.

Hands-on: Understanding materiality in project-based teaching units

Circular economy formulates another promise for design which plays a central role in the upcoming transformation of society and production systems (Irwin, 2015). This role also implies 'repairing' instead of inventing 'the new' with its modernistic notion of starting from scratch on a white sheet of paper, but at the same time, subscribes to design to adopt a much more active and integrative role along production and consumption cycles.

The drawbacks of the Circular economy on the systemic level, i.e. the real danger of keeping an unsustainable system of overconsumption in action, were easily discerned by the MA students particularly critical of greenwashing. Therefore, focusing on the crucial role of design decisions to make a service, a product, or a system more 'circular' – in any of the different circles drawn by, i.e. Ellen Mac Arthur (Ellen MacArthur Foundation, 2013), Braungart McDonough (2002), or others – entails a better understanding of both systemic flaws like rebound effects that also affect design decisions about materials or production processes. Design educators, therefore, are called upon to reconceptualise the temporal dimension of designing from a linear to a circular understanding.

Parallel to designing proposals for the specific company, the students began to reflect on what does it need to be able to anticipate practices of usage and beyond in designing? How does this broaden definitions of stakeholders? Do we have to redefine co-designing, considering the environment on a planetary level at stake? Do we have to redesign 'design' as a whole? Such questions lead to a thorough redefinition of material's role plays in everyday life.

Designerly material knowledge forms part of the long-lasting entanglement of design and environment(Fallan, 2019). Knowing of and about materials is based on the findings of material sciences integrating a historical and cultural perspective on materiality. As a transdisciplinary practice, design needs a deeper understanding of materiality to expose hidden meanings and historically rooted use and misuse of materials. Combined with a speculative design approach, this leads to a broader understanding of materials-in-use meanings. Assuming design unlocks and redefines materiality through experimental, creative, and prototyping approaches, the question arises of how to validate material knowledge in the design process and pass it down to future generations. Thus, conceiving a material-based design methodology could lead to a revision of design education. The demand for sustainable design based on material knowledge and acknowledging where materials-as-resources come from is anything but new. Given the foreseeable depletion of resources, the report 'The Limits to Growth' (Meadows & Club of Rome, 1972, p. 177) called on designers to create easily repairable and durable products to minimise resource consumption despite higher (design) costs. To "improve the functioning of a society in a state of equilibrium", the report called for, among other things, efficient recycling techniques to reduce resource depletion, a better design to extend product life and promote repairability so that capital depreciation rates are minimised. The methodologies need-

ed to achieve this have since been differentiated with Green design (Burall, 1991), Circularity (Stahel, 1996); Ecodesign (Braungart & McDonough, 2002); (Charter & Tischner, 2017); Co-Creation (Meroni, 2007), (Manzini, 2015); Circular Economy (Ellen Macarthur Foundation 2013) and Transition Design (Irwin, 2015). Not all of them extend material knowledge in historical and cultural dimensions.

Materials are central role in circular design methods (Oberhuber & Rau, o. J.). Therefore, the teaching unit with the MA students began by exploring the outdoor sports company's textile leftovers and used and damaged products. The students realised how time-consuming it is to undo consumer goods like highly functional sports apparel, high-end rucksacks, or jackets and how many different textiles are combined in just one product. At this moment, they experienced hands-on how crucial the conceptual phase is for assessing the life cycles of artefacts and processes.

Theoretically, this perspective called for a redefinition of the design process. Instead of conceiving a project and searching for the most sustainable materials and production processes, students learned to focus first on materials and then on their design tasks. It required researching materials and their origins, perceived cultural values and entanglements in colonial discourses. Finding out how to keep materials in circulation led the students to a different understanding of materiality. If their design project should keep materials in circles, it only 'borrows' materials for a limited time before transforming into something else. Such a metaphor can reverse the design process upside down with lasting effects on design education.

One potential outcome for future project-based teaching units on the MA level is reevaluating of material libraries and project archives. Assuming the informed choice of sustainable materials and production processes is crucial for designing sustainably, using such archives becomes an integrated part of practice-based teaching units. Material samples and artefacts from design processes convey applied know-how. They are usually stored in material and sample collections or project archives. To use them fruitfully, students must reflect upon them critically, as they, too, have a complicated history of their own.

Model and pattern collections were an integral part of arts and crafts schools at the end of the 19th century, from which art and design education developed. They were considered an effective means of enforcing design standards. As the core of the emerging arts and crafts museums, they served to educate general taste. (Pazaurek, 1919) We must critically evaluate archives' canon and existing structures to build up a designerly material knowledge. Archival systems should extend to materials and the implicit knowledge gained in design processes. Material collections combine cognitive information with haptic experience conveying material, technical and cultural knowledge through samples and descriptions of processes. Materials and their use are culturally coded. As such, they form part of discourses that need to be re-read from the perspective of decolonisation and sustainability. Therefore, archives could lead us to a historically and culturally informed mode of dealing with materials as a prerequisite for creating a more circular design.

The theory of the Commons in design education at the BA level

Undergraduate design students learn to base their design process on thorough research to determine its speculative potential. In doing so, they acknowledge the embeddedness of any design proposal in a pre-existing world. Thus, they lead their practice-oriented projects on mostly given briefs. In the process, they rely on generic descriptions of design processes as a work frame. However, questioning the base of such practice needs other settings or moments in a predominantly project-based education. Usually, theory classes seem to allow reflecting on methodology, but in doing so, we push the unfortunate division between theory and practice even further. To overcome such divisions at least partially, an interdisciplinary teaching unit at BA levels allowed developing a broader definition of acting as designers using the commons theory.

Commoning sense: Acting as being part of something bigger

Instead of designing discrete objects, designers should drive systems-level change in conceiving relationships, interactions, and experiences for and within complex social systems (Irwin 2015). Therefore, we can best describe design as a co-design activity involving various actors (Manzini 2015). In the view of the all-encompassing ecological crises, the 'actors' involved are not only human beings but all living beings and non-living entities of the critical zone, entailing a multi-species vision. Speculating about a sustainable future includes all entities now and in the future. Understanding any short and long-term ramifications of sustaining through using limited resources could profit from a close reading of commoning as a social practice.

Commoning reflects a social practice within limited resources, maintaining long-term use of Common pool resources. Historically, the discourse about common goods had a revival at the time of the Great Acceleration, coinciding with the Peak Oil theory first presented by Marion King Hubbert at a meeting of a branch of the American Petroleum Institute in 1956 (Gosh & Prelas, 2009). Hubbert predicted that global crude-oil production would peak in about 2000, decline quickly, and eventually disappear in the 22nd century. Such outlooks were perceived as disturbing in an economy heavily relying on fossil fuels. In his widely debated article 'The Tragedy of the commons', Hardin (1968) combined political economy with neo-liberal "life-boat-ethics" (Oakes, 2016, p. 238). Furthermore, an irritating lack of historical accuracy determined Hardin's notion of the commons (Cox, 1985). On the other side of the political spectrum, the need to discuss systems and rules was pervasive when the environmental movement was emerging, and the need to limit the damage of industrialisation was broadly recognised (Radkau, 2011, p. 124ff)

If resources are limited, we need consensually established rules for their use. Rules to preserve the commons and the ways of breaching and sanctioning such misbehaviour are historically contingent. They have always been formulated as coexistence systems and religiously or morally based intentions. Elinor Ostrom famously scrutinised them in her comprehensive study of the underlying principles of Common pool resources (Ostrom, 1990). The survey that posthumous got her the Nobel Prize in Economy in 2009 aimed to show how essential actors are in determining the regulations of sustainable use to prevent the debatable notion of the "tragedy of the commons". Based on many case studies, Ostrom analysed long-enduring Common-Pool resources (CPR). Her study shows why some sustained and others deplete over time and how self-organised systems help to solve two of the significant real dilem-

mas of the commons, namely "the problem of commitment and the problem of mutual monitoring." (Ostrom 1990, p. 59)

As a social practice, commons are historically contingent; they are negotiated, structured, and embedded in rituals, virtually present in the minds of their participants and life-changing for them. They can be read as the changing notions of the lived embeddedness of societies in their natural environment. Therefore, the history of the commons explains how the conception of the intricate connection between the environment and societies is established and how it changes over time. As such, commons are comparable to systems design (Ernst, 2021). Understanding how they were designed and what policies – that historically also led to the exclusion of the have-nots and the socially vulnerable — had to be put in place for their long-term functioning shows the deeply collective task of designing sustainable environments. Thus, a historical perspective helped the BA students understand how environmental issues and eco-conscious practices always form part of socially regulated and therefore designed systems. In hindsight, one of the most efficient ways to teach the difficulties of designing a sustainable environment was to let students experience and discuss the value of cooperation with the help of the prisoners' dilemma formulated in the form of a short detective story by the American mathematician Albert W. Tucker (Mérő, 1998).

While the BA students were activated in debating the theory of the Commons in reading a syllabus of foundational texts, exploring game theory and the prisoner's dilemma, amongst others; the whole teaching unit was acutely lacking a practical exploration of commoning as a social practice in design. Nonetheless, the students appreciated debating an approach heightening the understanding of designing as a collaborative practice that questions the still widely uncontested creative paradigm of the (mostly male) designer-as-author.

Conclusion

While critically reflecting on traditional design education based on a linear understanding of designing, we should not refrain from design's potential to bring past, present, and future together. Based on its heuristics, design entails the promise not only to create solutions to existing problems but to undo or redo the effects of decisions taken in the past. Similarly, the current debate hopes for technical approaches to deal with the multiple crises due to rampant CO2 emissions; geoengineering is the latest resource. They inscribe themselves in Herbert Simon's definition of design as devising "courses of action aimed at changing existing situations into preferred ones." (Simon, 1988) Still, we must be aware that design is profoundly and methodologically entangled in the problem leading us into an unsustainable state. Therefore, it cannot offer quick solutions. Nevertheless, we could start redefining design by considering the embeddedness of design in the critical zone. Then, it would no longer be defined as a linear practice of framing a single problem and iteratively coming up with the best possible solution, as singular as it may be.

Designing may help us to reimagine and conceptualise the way of living together in the 'critical zone'. Therefore, due to its heuristic qualities, we should not refrain from design's potential to bring the past, present, and future together. To be grounded entails knowledge of situatedness and how to preserve it in the future. In other words, designing helps us to project possible futures without losing ground.

In criticising traditional design education based on linear notions of designing, we should try to develop easy-to-grasp metaphors of a different understanding. So instead of using a simple geometric operation that rounds a linear structure of iteration in a circle as in Circular design methods (and aptly performed by Tim Brown in his video on Circular Design), we should better use a spiral as inspiration. This form clarifies that we will have to rework what is already there on different levels. Replacing a linear representation with a spiral may sound meagre as a result. However, behind this insight lies a thorough and collective examination of the often disguised, unaddressed assumptions that shape undergraduate design studies, whether in the curricula, semester projects, or mentoring. Breaking through these underlying figurations seems to be a first step towards perceiving design education and practice differently.

Although designing is by no means limited to conceiving tangible material objects, design students on both BA and MA levels must learn to come up with discursive objects that may stand the test of a debate, anticipating possible futures. Prototyping, therefore, is a central aspect of design, relying significantly on designerly material knowledge. Such knowledge allows designers to act embedded and more conscious of one of the essential aspects of sustainable design processes and practices: Materiality. Unless materials are to be conceived of as Common pool resources, design education risks perpetuating unsustainable design practices even if they teach Circular design methods. Materials are always sourced in the critical zone; they are always considered precious and limited. Therefore, designerly material knowledge correlates with the theory of the Commons. 'Material Commoning' may serve as a further model for transition design, bringing together social issues, embeddedness in the critical zone, and a futuring prospect.

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Representing and shaping regenerative futures: a context-specific approach to art and design education

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Abstract

We live in a time of accumulating economic, environmental, social, political, and cultural crises. The current systemic crisis demands various transitions: from linear to circular, destructive to regenerative, and individual to collective. As we face uncertain times, we must consider new and diverse perspectives about how the future may look and feel. These possible futures help us better understand their potential and make decisions about the futures we wish to embrace. In this paper, we will highlight context-specific art and design practices to create regenerative imaginaries and prototypes for the future. This context-specific approach fundamentally builds on comprehensive fieldwork and participation to interact profoundly with the environment and its actors. In particular, the paper focuses on how we embed these practices from our research in higher art and design education. We will discuss two practice-based master-level courses that introduced art and design students to specific societal challenges. Both courses engaged students in representing and shaping regenerative futures by learning to connect with specific local manifestations of global issues. The sensibility of real-world locality allowed them to develop skills in exploring, collaborating, and reimagining contextual issues through art and design methods and artifacts. Our ambition as researchers and educators working in this context is to develop an educational system that is locally embedded but globally connected. Our agenda is focused on developing methods, strategies, and tools focussing on challenges that are close to us but simultaneously reflect and resonate globally about wicked problems.

Author keywords

regenerative futures; art and design education; context-specific learning; fieldwork

Introduction

Our society finds itself in a turbulent and complex transition period characterized by friction and failing economic, political, social, environmental, educational, and cultural systems (Rotmans, 2017). The accumulation of these crises can be characterized as *wicked problems* (Rittel & Webber, 1977) that create uncertainty about the future and lead to conflict and social resistance to change (Latour & Weibel, 2020; Morton, 2018; Adam et al., 2019). The wicked nature of accumulating crises are symptoms of a system that no longer provides sustainable prospects for the future. This system, which is organized on a global scale, risks neglecting its impact on local people and their living environment. Rather than withdrawing to a closed-off localism, focusing our efforts on the concreteness of locality will allow us to open horizons to the complexity of the global (Latour, 2018).

To facilitate the transition towards a regenerative future, we focus on a context-specific approach to address wicked problems on a local scale to develop diverse perspectives on regenerating regional ecosystems (Gibbons, 2020). Wicked problems require an approach that goes beyond the traditional problem-solving process, as we see, for instance, in industrial design where marketable solutions are created from the single perspective of a client (Cross, 2000). Rather, Haraway describes a mission to "generate problems, elicit powerful responses to devastating events, calm troubled waters and rebuild calm places" (2016, p.19)

We argue that art and design practitioners can represent and shape regenerative futures and thereby contribute to the development of desirable futures. To represent these diverse and inclusive futures, a context-specific approach is required that includes the viewpoints of various actors embedded in these contexts. Art and design languages allow us to make complex challenges tangible and give us tools to engage with these actors. Moreover, including different points of view is a way of embracing the uncertainties and complexities of the situation and obtaining a holistic perspective.

Art and design education plays a central role in this discourse, as it will shape the ideas, objects, and narratives that can shape the future. Therefore, it is important that we ask ourselves the following questions: How can we teach students

to think, act, and design in uncertain contexts? How can we unlearn commonplace paradigms that prove insufficient to deal with the complex challenges of contemporary crises? And how can we prepare new generations of students to take on a role in imagining and creating regenerative futures? (Whitehouse et al., 2020) As educators focused on artistic and design research, we feel it is our responsibility to ask these questions and to co-develop diverse perspectives on education and strategies to deal with wicked problems.

Context-specific education

In this paper, we elaborate on two case studies where we engaged with this context-specific role in art and design education. The courses were organized in and around our college campus which is located on a former coal mining site in Genk, Belgium. The city has had to reinvent itself several times over the last hundred years due to the combination of local and global crises. Genk transformed from a small village with vast heathlands around 1900 to a highly industrialized mining town in the sixties. The coal mining industry's demise in the late 1980s and the closure of a large Ford car manufacturing plant in 2014 forced the city of Genk and its residents once again to transform. Today, Genk is still the third largest industrial city in Flanders, and the surroundings of our campus transformed from an abandoned mining site to a creative and cultural hub. Nevertheless, the city is still struggling with complex issues such as pollution, biodiversity loss, high unemployment rates, poverty, global pandemics, and resource depletion. Our ambition as researchers and educators working in this context is to develop an educational system that is locally embedded and globally connected. Therefore, the art and design academy should not be an island but instead act within and with the communities in which it is spatially located while making global connections.

By integrating critical and profound context-specific learning in our educational system, we aim to educate a new generation of students who can contribute to the transformation towards a regenerative future (Hagenaars & Hendriks, 2021). Our approach is a way to unlearn and deconstruct mechanisms in art and design education that perpetuate the paradigms that prove insufficient to deal with the complex challenges of contemporary crises (Morton, 2018; Latour, 2020). When solutions are detached from the cultural and ecological context in which they are implemented, they can impact the local ecosystem in unforeseen ways and timescales (Fry, 1999). When human-centered design processes focus explicitly on problem-solving for generic personas, they result in generic solutions that neglect the social and natural ecosystem in which they are implemented. (Morton, 2018; Schwartz & Krabbendam, 2013) These insights, emerging from our art and design research practice, helped us develop two practice-based educational courses—*Post Ford Genk* (case 1) and *Shifting Grounds* (case 2)—focusing on working and learning in specific contexts. Their goal was not to teach in a linear top-down form but to explore and research collectively with our students and other actors in a specific context. This way of collaborative inquiry-based learning creates an inspiring, dynamic, and participatory learning environment of our living environment. (Ingold, 2019)

Case study 1: Post Ford Genk

The Post Ford Genk course focused on the industrial heritage of the car manufacturing facility of Ford in Genk. The company started producing cars in Genk In 1964. At its peak in 1994, Ford Genk employed over 14.000 people living in and around the city of Genk—which had a total population of 60.000 at the time. In 2014, the production was relocated to Valencia, and Ford Genk was forced to close permanently, resulting in a major social crisis and mass unemployment. Today, Genk is a Post-Fordist environment where residents, policymakers, and local industries collaborate to reimagine its future. The city invested in an r&d campus focused on the development of renewable energy systems to attract new types of industry. The city policymakers also aspire to transform the recycling industry into a circular manufacturing industry.

Left: **Figure 1.** Newspaper: *The Post Ford Genk* designed by participating students. / Middle: **Figure 2.** Robotic metal shaping inspired by traditional crafts by Cas Reynders. / Right: **Figure 3.** Flax fibers as a natural alternative to carbon fiber by Kato Herbots.

In this context, we challenged a team of master-level product design students to create regenerative futures for the city of Genk, local industries and its residents. The course was organized during one semester and divided into a collective and individual assignments. The collective assignment was focused on the development of a fictional newspaper, *The Post Ford Genk* (see Figure 1). The purpose of this collective assignment was to immerse the students in the local context and history. They interviewed several local actors to write articles from cultural, political, economic, and technical perspectives. While the interview conducted with the mayor was oriented to the future of Genk as a decentralized and circular economy, the former factory workers reminisced about the past and explained their struggles to find a new job.

The starting point of the individual assignment was an op-ed that was a personal answer to the research question: What type of products, services, and systems can be designed based on the remaining resources post-Ford Genk? The op-ed was translated into several prototypes suggesting several future scenarios based on the industrial heritage of Ford Genk (see Figure 2-3). The role of these future prototypes is not to solve a specific problem but to create new possibilities that can kickstart new connections in the local ecosystem. To facilitate the debate the newspaper was published by the city of Genk and presented to a union for industrial manufacturers located in Genk. Through this public process, we aimed to set up new collaborations between local citizens, policy, and industry.

Case study 2: Shifting Grounds

In the interdisciplinary course *Shifting Grounds*, we challenged master-level art and design students to engage the issue of the invasive plant species Japanese knotweed within their practice. Originally from East Asia and brought to Europe as a highly desirable ornamental plant for gardens, Japanese

knotweed has quickly become perceived as a significant invasive ecological and economic threat. Through its rapid spread, the plant is not only straining our local biodiversity, but the issue also extends globally. Although *Shifting Grounds* mainly focused on the context of Genk and its surroundings, we collaborated with other organizations such as Trajna (Ljubljana, Slovenia) and Timelab (Ghent, Belgium), and researchers such as Antia Iglesias (Vigo, Spain) who are working with Japanese knotweed in their local context. This way of working exposed the opportunities between local action and global thinking for our students.

The course started with an intensive three-day immersion to introduce students to the context of Japanese knotweed and the many perspectives on this issue. The first day consisted of presentations on the general context of Japanese knotweed by (international) experts and a guided tour of a nature reserve in Genk by members of a nature preservation group. We also did a walk through the city to observe knotweed's presence in the built environment. On the second day, we introduced students to the potential of art and design practices in these kinds of contexts. A curator gave a lecture and held a group discussion on how contemporary art deals with topics like nature and the Anthropocene. Afterward, we shared our own research into the domain of Japanese knotweed and how we approached certain topics through art and design. This consisted of theoretical conceptualizations (including Anthropocene, rewilding, and vernacular design) and practical knowledge. We shared the latter through a workshop on dye extraction to gain familiarity with the materiality of the Japanese knotweed. All these activities were ways to have continuous conversations on the assumptions and ideas of the students and their relation to the natural environment and knotweed in particular. During the third day of immersion, we formalized these conversations during group discussions (sometimes in the field) and coaching sessions. From this point, the students started conceptualizing their own point of view through the eyes of their discipline and practice. Group-coaching sessions guided them to develop work over the following five weeks, culminating in a group exhibition.

Left: **Figure 5.** Speculative knotweed biolab scenario by Esmeralda Mertens and Alexsandro Celea. / Middle: **Figure 6.** Photograms on knotweed paper by Kevin Vaesen. / Right: **Figure 7.** Lamp object with knotweed stems by Tijl Custers.

The student work of *Shifting Grounds* was diverse and ranged from visualizing speculative scenarios (see Figure 5) to projects focusing on plant material research (see Figure 6), architectural interventions in the landscape, and knotweed-based products (see Figure 7). Other projects had less tangible outcomes such as a knotweed weaving co-creation workshop, a generative game model study on the plant's growth, and a knotweed tea ceremony. As a summary, we made the 'Not in my backyard' publication, where color analysis, conceptual background, matter research, photography and graphic design experimentation are presented through different voices that help us better understand our vegetal partner. (Vrancken and Kosten, 2021)

Discussion

In this discussion, we compare the methods used in our case studies that apply a context-specific approach to art and design education, and discuss the challenges we encountered. Both cases are characterized by fieldwork; researching the ecosystem of local actors. In both cases, fieldwork was essential for understanding the complexities related to a specific context and translating them into regenerative futures. The methods for including the ecosystem of local actors differ because of the nature of the actors that were involved in the two cases. In case 1, diverse perspectives of local actors were mapped by interviewing former workers, the local mayor, industry leaders, and the team of product design students. Actors here are people representing different viewpoints on the topic *Post Ford Genk*. In case 2, the term "actor" is expanded to more-than-human actors in line with the conceptualizations of Latour (2018). The lead actor in the case 2 scenario is the plant species Japanese Knotweed. As plants can't be interviewed in a traditional method, including the perspective of the Japanese Knotweed required a tailored method inspired by anthropology, such as participative observation (Ingold, 2013).

Representing the diverse perspectives of humans and more-than-human actors required methods tailored to the specific nature of the actor. In case 1, this was done through articles, pictures, drawings, and prototypes bundled in a newspaper. A format that could represent the political, economic, social, and environmental layers of the Post Ford Genk context. In case 2, this was assembled in a publication that showed the research process and the various futures it represented. Although case 1 was organized within the curriculum of one specific discipline and case 2 was organized across the curricula of various disciplines, both cases benefited largely from a multidisciplinary approach to represent and shape diverse perspectives. The role of the art and design students in this process clearly diverts from the traditional problem-solving perspective. Our context-specific design approach is more focused on problem framing, understating the ecosystem of which they are part before proposing solutions. The added value of the art and design students in the process was the representation of the complex issue at hand in visual and tangible ways.

The challenges for developing a context-specific art and design practice relate to temporality and locality. The context-specific nature requires a tailor-made approach and preparation, as these challenges can vary greatly from context to context. Identifying these challenges can be a labor- and time-intensive process for both lecturers and students. Because much time has to be spent on exploring the context and dealing with uncertainties in the research and design process, less time can be put into the outcome of the final project that students develop within the timeframe of the course. In addition to providing a realistic timeframe, a process evaluation is more appropriate for assessing context-specific assignments. Engaging local participants requires students to connect with people, which can be particularly challenging for international students who do not speak the language. But even students

who speak the language require the right social skills to connect and attune with human and non-human actors that represent the local ecosystem.

Conclusion

This paper highlighted the potential and importance of context-specific practices in arts and design education to create regenerative futures. This context-specific approach fundamentally builds on comprehensive fieldwork to interact profoundly with the environment and its human and more-than-human actors. By immersing our students in context-specific situations and confronting them with wicked global problems on a local scale, we aim to develop their skills in representing and shaping regenerative futures.

We are convinced that the future of art and design education should be organized around contexts and collectives rather than disciplines that promote unembedded and individual artists and designers. Teaching generic processes—part of globalized systems—disconnects future art and design practitioners from the real-world contexts in which they live and work.

Although it is still too soon to prove that both cases lead to regenerated futures, these context-specific research, learning, and design approaches create more conditions for qualitative collaborations between artists, designers, citizens, and other actors in our environment.

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Creative strategies for the learning spaces of the future

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Abstract

The paper discusses the role of learning spaces as an integral part of the larger educational ecosystem. Covid-19 pandemic accelerated the trends of digital transformation in education by liberating educational content in time and space and radically reformulating the process of teaching and learning. However, the current spatial archetype of the learning environment still features traditional plans with segregated classrooms and auditoriums. This model is obsolete and does not meet the new requirements of the 21 century education which is student-centred, knowledge and skill-oriented, technology-enabled, collaboration-based and personalized. The role of the teacher is also profoundly changed from transmitting knowledge towards facilitating the educational process that predetermines the wide variety of activities performed in the classroom.

The main objective of the paper is to explore how interior design can be aligned to the new learning theories and technological advances, and to propose strategies for the re-design of the traditional learning spaces. Based on the data obtained in a survey conducted with students to gain insight on their specific learning styles and needs, and a survey conducted with university lecturers to understand their teaching approaches and spatial necessities, six types of spaces were proposed. The study followed the principles of grounded theory to construct a hypothesis on the spatial qualities of each space and relate it to the pedagogical and technological requirements.

Author keywords

Learning spaces; learning environment; future-oriented spatial design; learning experience; educational ecosystem

Introduction

The implications of the social, economic and technological changes in the twenty-first century require rethinking education as an ecosystem. The educational ecosystem is defined as a network of people, educational resources, pedagogical tools and abiotic factors/components which interact to seamlessly work together (Railean, 2019). Derived from evolutionary biology, the term of ecosystem can be applied in the field of education to allude aspects such as diversity, maximum productivity, dynamic adaptability and scalability (Luksha et al. 2018). This notion not only transforms our understanding of learning but also considers how education can evolve and prepare learners for the increasing complexity and challenges of the future. The concept of the educational ecosystem takes into account the context in which learning occurs, responds to the fluctuations of the environment, withstands the treads and embraces the learning opportunities to align them to the current and emergent needs of the new generations of learners.

Learning today is no longer confined to the physical space of the classroom, it involves various learning providers who deliver both face-to-face and technology-mediated learning experiences in the physical, immersive and digital learning environment. Covid-19 pandemic played a critical role in accelerating the trends of digital transformation in education by liberating educational content in time and space and radically reformulating the process of teaching and learning. The diversification of the learning environment stimulated the development and application of varied learning methodologies to engage learners, boost their creativity and enhance the learning outcomes. However, while technology and pedagogy advance, one of the components of the ecosystem, the physical environment, has been neglected. The current spatial archetype of the environment still features traditional plans with segregated classrooms and auditoriums which support lecture-based learning and emphasize the hierarchical relationships between educator and learner. This model is obsolete and does not meet the new requirements of the student-centred, knowledge and skill-oriented, technology-enabled, collaboration-based and personalized 21-century education. The role of the teacher, which is profoundly changed from transmitting knowledge towards facilitating the educational process, encourages flexibility in teaching and predetermines the wide variety of activities performed in the classroom. Though the physical environment has been recognized as the third teacher (Edwards, 2011) and its impact on students' engagement and performance has been widely researched (Fisher, 2004; Oblinger, 2005, Jankowska and Atlay, 2008), the rigid design of the classroom conceived for traditional direct instruction remains the same since the Industrial Revolution. This not only does not respond to the educational needs but also constrains current teaching and learning practices.

The main objective of the paper is to explore how interior design as a component of the educational ecosystem can be aligned to the new learning theories and technological advances. We propose strategies for the re-design of the traditional learning spaces, based on the data obtained in a survey conducted with students at the University of Monterrey (Mexico) to gain insight on their specific learning styles and needs, and a survey conducted with university lecturers to understand their teaching approaches and spatial necessities. The study followed the principles of grounded theory (Glaser and Strauss, 1967) to construct a hypothesis on the spatial qualities of each one of the proposed spaces and relate it to the pedagogical and technological requirements.

Pedagogy in the 21st century and its spatial needs

Education in the 21 century is predetermined by the necessity to prepare students for the social reality of a volatile, uncertain, complex and ambiguous future (Fadel and Groff, 2019). In the context of a rapidly transforming world, the main goal of education is to train students to be adaptable and versatile to be able to succeed and thrive in any unpredictable upcoming situation. This requires focusing not only on the knowledge gained but on acquiring the skills of how this knowledge can be used, developing character qualities how to behave and engage in the world, and mastering meta-learning strategies how to reflect on oneself and adapt one's learning to achieve one's goals (Fadel et al., 2015). To include all these four dimensions in teaching requires innovative pedagogical practices that can ensure effective learning and active engagement of the students in the learning experiences. Scott affirms that to rethink pedagogy is as crucial as identifying the new competencies learners need to acquire (Scott, 2015). Pedagogies which support the development of higher order skills, the four Cs – creativity, critical thinking, communication and collaboration (OECD, 2012), should be based on three Ps – personalization, participation and productivity (McLoughlin & Lee, 2008). The application of approaches that give learners the opportunity of making choices driven by their own needs, creative knowledge production and interactive sharing has been afforded by digital technologies. Bringing a radical shift in education, "[k]nowledge technologies shape what is learned by changing how it is learned" (Laurillard, 2012). Being easily accessible and independent of time and space, technology promoted varied interactions with the content, the instructor and the other learners. The transition from a lecture-focused to a learner-centred education involves students in a process of doing and reflecting on what has been done, or the so-called active learning. "Active learning practices may range from simple methods such as interactive lectures and class discussion to case study analysis, role-playing, experiential learning, peer teaching, and flipped lessons. Active learning may involve problem-based, visual-based, collaborative, project-based, or game-based learning" (Misseyanni et al., 2018). It is recognized that the application of these practices needs an adequately designed physical space, adapted to the diversified needs (Baepler et al., 2014; Oblinger, 2006; Fisher, 2005).

The innovative learning environments defined by Mahat et al. as "the product of innovative space designs and innovative teaching and learning practices" can act as change-maker by stimulating educators effectively and efficiently apply active learning pedagogies (Mahat, 2018). Innovative learning environment's focus on the dynamics and interactions between the learner, the teacher, the content, the facilities and technologies (Dumont and Istance, 2010a) which once again emphasizes the systematic character of education and acknowledges the importance of the design of the physical space to achieve the goals of education. Dumont and Istance outline the core principles for designing an effective learning environment – learners are the core participants and their active engagement is encouraged; the social nature of learning is recognized and organized co-operative learning is encouraged; learning results as a dynamic interplay of emotions, motivation and cognition; the environment is acutely sensitive to individual differences and preferences and adapts in a sustainable way to both the individual and the group as a whole; each learner is appropriately challenged and pushed constantly to excel; the learning environment clearly states expectations and uses assessment consistent with the aims; horizontal connectedness is promoted across areas of knowledge and subjects in- and out-of-school (Dumont and Istance, 2010b).

Based on these premises, we as designers were interested in the design implications and how the potential of interior design can be harnessed to support the implementation of the innovative teaching and learning practices. Borri et al. identify five multipurpose spaces for the new generation of schools – group space, exploration lab, agora, individual area and informal area. The group space is given priority as the heart of the school where students build and maintain their identity. Its layout should enable flexible setting to accommodate various learning activities as collaboration and work in groups, creation of artefacts and multimedia objects, individual work, and presentation. The exploration lab is the space for learning by doing, with dedicated tools to observe, experience, explore, experiment. The agora is a community meeting space, where groups of students can gather for creative activities or discussions. The individual space is dedicated to focused work, requiring concentration and reflection, it should be equipped with pods, caves with reading and writing tools. The informal space is a recreation area with comfortable furniture for individual retreat or informal group meetings (Borri et al., 2016; Borri, 2021). Oblinger describes the elements which the spaces intentionally designed to respond to the new learning theories and student's needs should possess: flexible layout to provide ease of re-configuration to support immediate change of activities; comfortable furniture to support different body sizes and avoid distraction from learning; environment offering sensory stimulation and seamless integration of technology; decentredness and consideration of the campus as a whole with spaces conveying co-learning and co-construction of knowledge. In addition to these functional aspects, the cognitive dimension of the space and the relations between the spatial elements and the creation of a meaningful learning experience have to be considered. Strange and Banning discuss the symbolic aspects of the space which convey powerful message and subconsciously influence the behaviour and the creation of a sense of place. They propose ten features of the spaces which support the inclusion, security, engagement and community experience. To carry this into effect the space needs to be: welcoming (creating sense of belonging), inclusive (affirming identities and expression of self and others), functional (supporting key tasks and activities), sociopetal (encouraging interaction and

encounters), flexible (adapting to multiple purposes), aesthetic (inspiring creativity and uplifting the spirit), reflective (encouraging imagining and meaning making), regenerative (restoring energy and motivating persistence), distinctive (creating memorable impressions) and sustainable (supporting human experience) (Strange and Banning, 2015).

Learning spaces design – the case of the University of Monterrey

Context of the study

The current study was motivated by the urgent need to re-design the leaning spaces of the University of Monterrey (UDEM), Mexico. The strategic development plan of the university which is centred in the development of the person and his transcendence in the construction of a sustainable society, results in the adoption of a pedagogical model characterised by active learning practices, application of cutting edge technology, development of disciplinary and transversal competences, creating a warm and safe environment for the students, encouraging work on interdisciplinary projects (fig. 1).

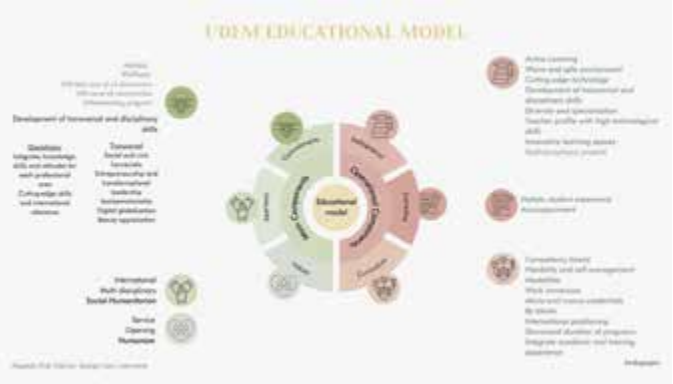

Figure 1. UDEM educational model

However, the physical environment does not support achieving the aims of the strategy. Despite the management's efforts to modernize the campus, the academic buildings where classes are given have not been substantially changed since their inauguration in 1984. The architectural project has been elaborated by the US firm Caudill Rowlett Scott – renowned at that time for their expertise in school design. William Caudill was researching educational spaces and authored the book "Space for Teaching" (1941) and John Rowlett had degrees in both architecture and education. The project they proposed met the needs of the growing student population while taking into account the specifics of the local context. The building consists of four interconnected volumes, featuring open circulation areas adapted to the hot climatic conditions of the region. The façade is treated with vertical concrete panels which function as sun screens blocking the sun from penetrating directly into the classrooms. Nevertheless, the layout is based on standardized cellular classrooms which responded to the lecture-based teaching practices of the past but in the current context hinder the implementation of the aligned to the digital age educational model adopted by the university.

Research method and data collection

To propose spatial solutions for the re-design of the current learning spaces which will be relevant to the pedagogical model and the strategic development plan, a more holistic understanding of the mindset, behaviour and the specific necessities of the UDEM community was necessary. As we aimed to propose strategies for the design of the learning spaces as an inductive process based on the identified gaps between the current and the desired learning experience, grounded theory was selected as a research methodology. The first phase of the research included user surveys and observations, followed by data coding, categorization and scenario mapping and ultimately, development of hypothesis on the spatial qualities of the learning spaces of the future. To gain insight on what kind of learning spaces will best meet the needs and to inform the development of design strategies providing a more meaningful learning experience, two questionnaires were distributed among students and teachers. The purpose of the student survey was to acquire deeper understanding of their specific learning styles and spatial preferences. The teacher survey intended to collect data about the most commonly used teaching approaches and learning activities and the respective spatial needs. In addition, a workshop was conducted with students in the creative field (architecture, industrial design and interior design) with the aim to create scenarios for the future use of the learning spaces and to identify opportunities for future-oriented innovation.

The surveys were implemented in the 2022-2023 autumn semester when 70 % of the classes were delivered face to face and the remaining 30 % were offered online. Responses were obtained from 93 students and 25 teachers. Each questionnaire was designed to collect both qualitative and quantitative information. The questions were predominantly open-ended to encourage the respondents to reflect on the spatial aspects which have a positive or negative impact on the learning experience. Students were asked to describe situations and spaces where they have acted in a very creative way, have concentrated successfully, and where they have been fully immersed into collaboration with others, so that the desirable features of the spaces supporting these activities are revealed. Another important question we were interested in was how a sense of community is fostered so we asked students to speculate on the spatial elements which create a sense of belonging. Teachers' questionnaire focused on their current pedagogical practices, the frequency with which activities are changed during a typical class, which spatial elements of the current environment support or hinder the implementation of these activities and which are the desirable spatial characteristics to freely implement their teaching approach. The technological tools which they usually use or would like to use in the future were also required to be listed.

Mapping the learning experience

Survey results indisputably indicated that the physical space has a great impact on the learning process. Respondents pointed that it influences concentration, creativity, the emotional and physical well-being and the dynamics of the interaction during the class. When comparing which activities are preferred to be performed face-to-face, interaction with the teacher and peers, hands-on activities and presentations are predominant, while listening to a lecture and individual work are preferred to be done online. Among the mandatory re-

quirements towards the space were mentioned the connection with the outdoors, smart technologies, availability of silent areas, comfortable furniture, good lighting and flexibility of the environment.

To triangulate the data obtained from the survey, we organized an intensive workshop where 11 students were challenged to define the needs of the student in 2030 and to envision a better learning experience for the future. By applying design thinking methodology the participants were pushed to generate a wide variety of ideas about learning spaces which meet the future needs of the students. After several critique rounds they were encouraged to visualize the most prominent ideas by giving them a distinct shape by translating the goals and motivations of the users into specific spaces and contexts. The scenario of the future learning experience was visualized into two collages representing the experience in the physical space and in the digital space (Figure 2). The collage technique was selected because of its possibility to provide insight on what students will do, think and feel while pursuing their learning goals.

Figure 2. Collage of the physical and digital learning experience of the future (Developed by B. Elizondo & D. Gamboa)

Conceptualizing the learning spaces of the future

The empirical analysis of the survey data was done together with consideration of the related literature advising that the learning space should support creativity, critical thinking, communication and collaboration (the 4 C's) and allow personalization, participation and productivity (the 3 P's). The development of the spatial typologies of the future learning spaces and the definition of the preliminary design principles for each type was informed by mapping the problematic points of the current physical environment and its comparison with the identified desired future state. Six different spatial types were suggested (Figure 3):

Formal Learning Spaces: Dedicated to scheduled instructor-led classes, where students are encouraged to move and use the different settings, which are most suitable for the various activities performed and always supported by integrated technology.

Individual Area: Informal learning space dedicated to individual focused work and self-directed learning in both open and closed spaces to ensure the student will concentrate undisturbed.

Group Area: Informal learning space dedicated to the collaborative work of small groups of students both in open and closed spaces to encourage dialogue and the individual participation in the group activities.

Webinar / 360°: Formal learning space dedicated to presentations and webinars, designed with a circular layout and flexible LED screens so that the presenter can be seen from all angles of the space.

Arcade / E-learning: Formal/informal learning space dedicated to collaboration. Designed hand in hand with technology, with a LED floor, interactive screens, tables for augmented reality and virtual reality pods, so that students can take their learning to the next level with the aid of technology.

Encounter Area: Informal learning areas activating the transition areas with additional functions, dedicated to the coexistence and interaction between students, designed with comfortable and flexible furniture to support relaxation and well-being. Integrated interactive screens ensure students will be always connected to the community.

Figure 3. Spatial typologies: Formal learning space; Individual area; Group area; Webinar / 3600; Arcade / e-learning; Encounter area (Developed by B. Elizondo & D. Gamboa))

Conclusion

Technological advances and the change in current pedagogical practices are drivers for the change of the physical space where learning takes place. As teaching methods continue to evolve, spatial design also needs to remain open for changes and empower their implementation. Furthermore, design can play a transformative role enabling changes in the educational ecosystem. The proposed spaces break away from the rigid teaching model of the past and encourage the dialogue between teachers and learners, turning them into co-participants in the educational process and co-creators of knowledge. Such radical transformation is needed to initiate a process of liberation and awakening of students as critical thinkers and creators. The design aims to make students immerse into the environment, to activate the participation in the performed activity, to challenge the imagination, to arise curiosity, to inspire new ideas, to create a sense of security and inclusion in the campus life. Though the floorplan is not fully opened and the enclosed rooms are still preserved, their uniformity is broken as various sizes and various functional areas are proposed to provide optimal conditions for learning. The conventional classroom is converted into a new configuration of flexible spaces which satisfy the current needs but are opened to experimentation so that they easily adapt to the needs of the future. Both teachers and students are stimulated to explore the space and find new ways to interact and establish new relationships. By identifying opportunities for future-oriented spatial design innovation we expect to support the self-directed learning, promote the active participation of the students in the educational process and provide a more meaningful learning experience.

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Implementing SDGs in a product design curriculum, or: the value of tap water

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Abstract

How can universities in the field of product design anchor a sustainable, future-oriented approach in their curricula? How can they do it in a long-term way that goes beyond individual current topics and can be communicated well both internally and externally? How is a sustainable attitude compatible with a discipline born out of industrialisation?

In the context of a curriculum development in the years 2020 to 2022 at the Lucerne School of Art and Design, the opportunity arose to include the Sustainable Development Goals (United Nations Department of Economic and Social Affairs 2015) in every single module description of our product design bachelor's degree course. The project discussed in this paper served as an important reference in this development, as it succeeded to combine a structural attitude based on the SDGs with the most diverse aspects of product design education, such as design goals, manufacturing techniques and external partners.

This paper has been written to gain an overview of how other schools and programmes in the field of design and art deal with the demand for sustainable and future-proof education and to learn from the methods they use. The aim is to exchange experiences and discuss collaborations for exchange programmes or collaborations, but as well to find out how independent the path we have chosen is.

Author keywords

Product Design; Sustainable Development Goals; SDG; Curriculum Development; Glass; Water; Digital Fabrication; Gastronomy

How to include sustainability into a product design education?

Product design surrounds us everywhere - almost everything we touch during our daily routines has been designed as a serial product.

As a discipline, product design emerged with industrialisation and is closely linked to it. Currently, product design needs to emancipate itself from industrialisation: how can we define our attitude and values in such a way that the side effects of industrialisation do not stand in the way of a future worth living? Nowadays, there is probably no product design education at Bachelor or Master level that does not talk about sustainability. Sustainability, however, is an extremely elastic term – is there a structure that we can follow without losing sight of our core competence of product design?

Our department at the Lucerne School of Art and Design currently offers 13 courses at Bachelor level. Over the past two years, the department has been engaged in curriculum development across the entire Bachelor level (Holzer 2023a), starting with the new curricula in September 2022. While this curriculum development aimed at facilitating new transdisciplinary modules and transdisciplinary skills by aligning structures, it provided an opportunity for the individual programmes to revise their offerings. We, as a bachelor programme in Object Design, wanted to use the curriculum development to anchor sustainability in all modules - but how could we do this beyond lip service, without losing our focus on product development?

In the search for a guiding structure for our programme, the following factors were important:

- a broad establishment and recognition
- an understanding of sustainability that includes social, ecological and economic aspects
- the coordination within the various product design programmes at the Lucerne School of Art and Design as well as with the sustainability lecturers at our department.

We decided to orientate ourselves according to the Sustainable Development Goals (SDG), which the United Nations General Assembly published in 2015 as political goals to be achieved by the year 2030: from the autumn semester 2022 onwards, each module of the Object Design curriculum will focus on one or more SDGs, which will be communicated at the beginning of the module. For the basic modules in the first semester, the SDGs are the same in each year; for the advanced modules, the SDGs are chosen according to the respective design tasks. (Fig. 1) For the Bachelor thesis, the students themselves specify the SDGs for their self-chosen topic (Fig.2).

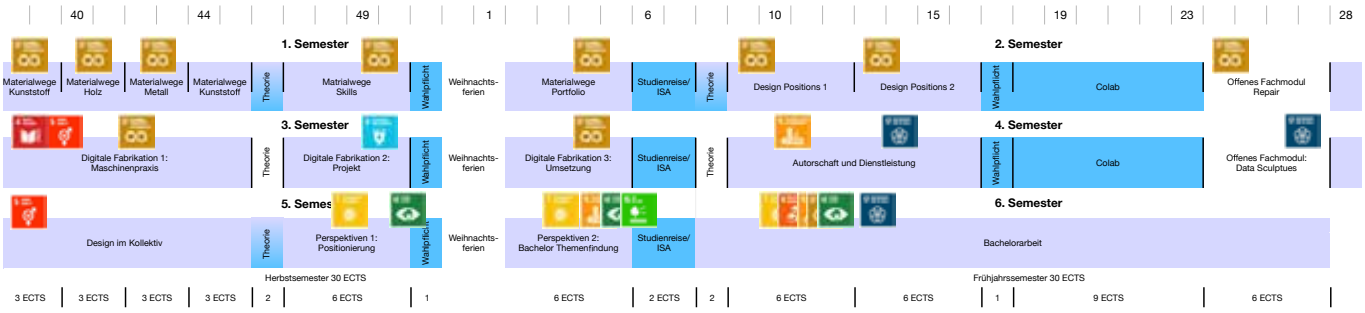

Figure 1. The Object Design Curriculum of the academic year 2022/23 with the SDGs (colored squares) year with the SDGs assigned to the respective modules: Basic modules in the first year (upper line) focus on SDG 12 "Responsible Consumption and Production", while in the modules in the 2nd and 3rd year the range grows and changes annually depending on the chosen topic. Bachelor students in the sixth semester choose the SDGs of their final project themselves.

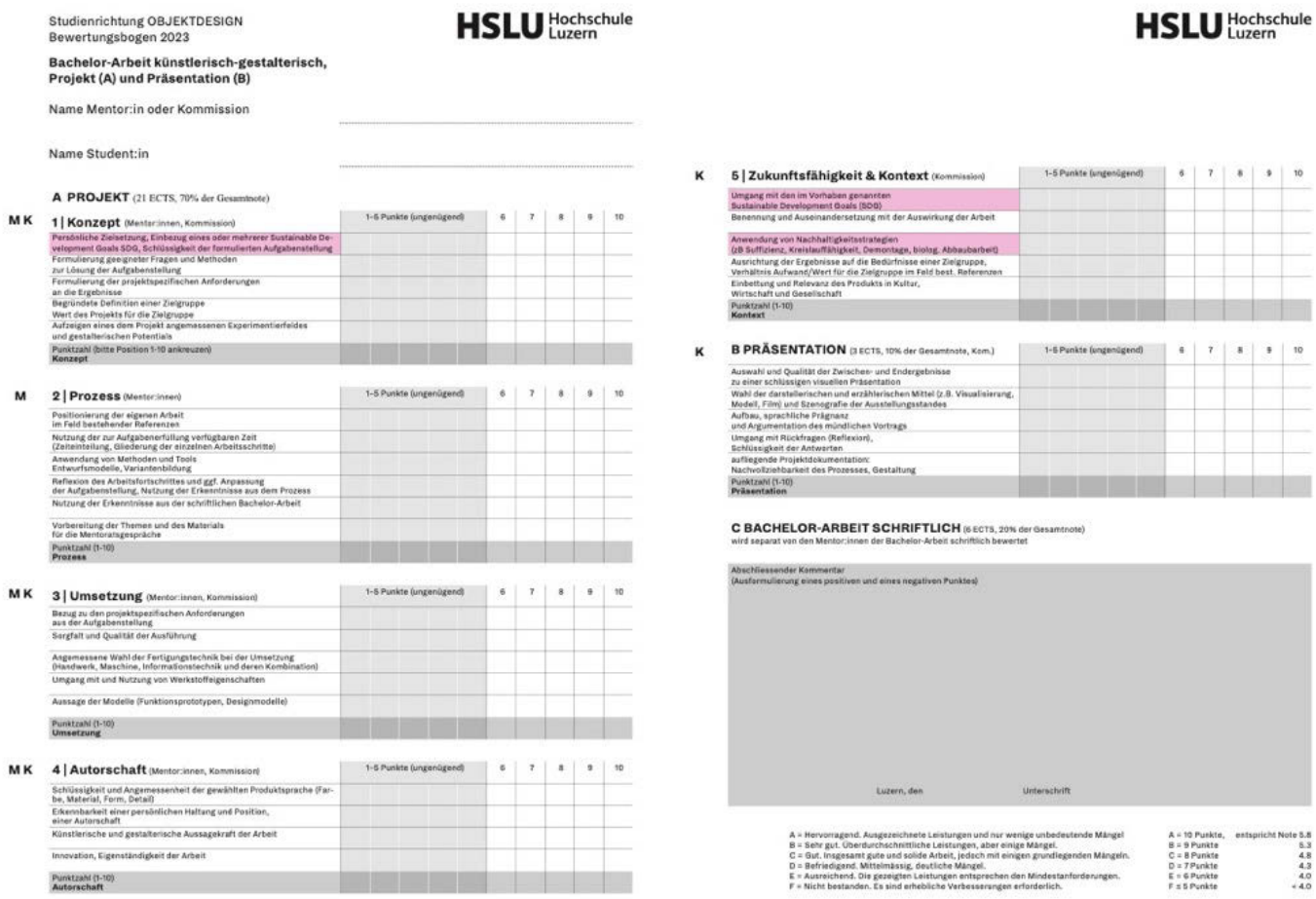

Figure 2. The SDGs are an integral part of the Bachelor's thesis without being the main focus: The SDGs are carefully but unmistakably integrated into the evaluation form of the Bachelor thesis at the points marked in pink. At the top left of the assessment criterion "Concept", the students select a "Personal objective, inclusion of one or more Sustainable Development Goals SDGs, conclusiveness of the formulated task". In the assessment criterion "Sustainability & Context", the "Handling of the Sustainable Development Goals (SDG) as mentioned in the draft" is assessed as well as the "application of sustainability strategies (e.g. sufficiency, recyclability, dismantling, biodegradability)" in general.

In parallel, the SDGs were integrated into the Textile Design programme, who had initiated the discourse about integrating SDGs into the new curricula (Holzer 2023b). This, in turn, built on a strategy of the department's Products & Textiles Research Group, which has been embedding the SDGs in its research proposals since 2017, referring to the Swiss Federal Department of Foreign Affairs "2030 Agenda for Sustainable Development" (Agenda 2030). Back in 2019, Object Design and Textile Design had already developed together the voluntary training "Sustainability for Lecturers in Design and Art" (Perret and Zimmermann 2020).

Since November 2022, the reference to the SDGs is stated on our website: "All modules in the Object Design programme focus on one or more goals of the United Nations Sustainable Development Goals (SDG). For their Bachelor's thesis, Object Design students define one or more of these goals." (HSLU Objektdesign SDG 2022).

An essential quality of a paper is to situate one's own teaching in the context of other universities. We investigated the integration into other product design programmes on four levels:

ChatGTP

This is 2023, and initially we started with ChatGTP: "Which Bachelor's or Master's programme in product design integrates the United Nations Sustainable Development Goals (SDGs) into its curriculum?" To which ChatGTP replied the following on 31/01/2023: "I'm not aware of a specific Bachelor's or Master's program in product design that integrates the United Nations Sustainable Development Goals (SDGs) exclusively into its curriculum. But many universities and institutions offer courses and programs that cover sustainability and the SDGs as part of their product design curriculum. You may want to check with specific universities or institutions for more information on their offerings."

SDGsUNi

While the SDGsUNi initiative (WASD 2023) lists a few schools in the arts, only a few of them address SDG 12 'Sustainable Consumption and Production', none of them related to product design: the Sibelius Academy in Finland (a music school), the University of The Holy Qur'an and Islamic Sciences in Sudan, and the Ghana Institute of Journalism. However, as we are not listed there ourselves, we must not assume completeness of these lists.

she ji Study

One of the reviewers of this paper kindly drew my attention to a comparative study on "Sustainable Product Design Education" published in she ji (Watkins 2021). It compares curricula from six universities in different countries. All of them teach sustainability, e.g. in studio projects, final projects, elective and compulsory modules, some of them refer in these modules to the SDGs (Nottingham Trent University, Technical University of Denmark, TU Delft). However, the study does not give any indication of a continuous implementation of the SDGs in one of their curricula.

Internal Study HSLU

Thanks to an internal, unpublished and therefore non-quotable comparative study carried out in our department last year, we got an up-to-date overview of design and art courses offered worldwide at design and art colleges in the field of eco-social innovation at BA, MA and PhD level, as well as in the field of further education. Of the 26 Bachelor's programmes, 15 could be assigned to the field of "Design", eight to the field of "Fashion and Textiles" and three to the field of "Art and Liberal Arts". Of the 15 programmes in the area of "Design", one specialises in visual communication, six focus on product design and two have a very open curriculum. For the purposes of this paper, I have only examined the six universities in the field of product design in more detail. A browser research with ChatGTP and Google brought the results in Table 1, see links in the references at the bottom of this paper.

Table 1. Overview of product design schools related to the SDGs based on internal study

Product design school	use of SDGs	reference
Universidade de Trasos-Montes e Alto Douro	lists the school's activities related to SDGs on its website since 2019	UTAD SDG 2019
Hochschule für angewandte Wissenschaften Coburg	lists the SDGs as a focus of the "ERIC - Entrepreneurship Track for Regional Impact on Global Challenges" programme	HS Coburg SDG 2022
Ecosign	no specific mention of the SDGs	
Häme University of Applied Sciences	lists SDGs as part of their "Sustainable Development Programme"	Häme SDG 2017
Falmouth University	claims to be ranked as a Top 10 Institution by the 2021 and 2022 SDG Teach In	Falmouth SDG 2021
Linnæus University	lists publications from Linnæus University that are connected to the SDGs	Linnæus SDG 2022

Even by contacting these schools directly via email and explaining the purpose of this paper, none of the six schools answered to the request. Until the moment of the publication of this paper, we could not find evidence of a structural integration of the SDGs into a product design education in any of them. Despite today's possibilities of an investigation, we are far from making a claim to its completeness and thus to a unique selling point of our curriculum. Nevertheless, seven years after the presentation of the SDGs in 2015, this is a surprising interim result for an education that has such a big impact on our use of resources.

Figure 3. Glass blowing at the Open Glass Studio with help of a digitally milled mould
Images: Raisa Durandi

Case Study: 'Value of Tap Water' Project

Institutions that use the SDGs in their corporate communication are required to substantiate these goals with concrete measures if they do not want to be accused of greenwashing. In the case of our curriculum, we would like to show what role the SDGs play in a specific module. Our case study is the module "Digital Fabrication" from the 3rd semester of Object Design:

In a country like Switzerland, we take it for granted that water of the best quality is available free of charge. Switzerland is a country of wells. Globally, this is an exception. Nevertheless, Swiss people afford themselves the luxury of buying bottled water; in 2021, for example, sales amounted to 903.5 million litres (Statista 2021). This behaviour leads to a burden on the environment, through transport, packaging and production. What does a glass container have to look like to make tap water seem more valuable than a bottle of San Pellegrino? Within four weeks, 3rd semester students designed fourteen counter-position to the culture of branded water. This resulted in fourteen glass vessels for an event of experimental gastronomy in interaction with digital tools and a

glass blower – see four examples in a project video on https://vimeo.com/771902070. The project 'The Value of Tap Water' aims to bring together five different perspectives:

1. We envisaged the appreciation of tap water as a design objective and sustainable meta-theme, closely linked to the SDGs 6 Clean Water and Sanitation, but also SDG 3 Good Health and Well-Being and the obligatory SDG 12 Responsible Consumption and Production.
2. For alumni, it is important that as many school projects as possible achieve a visual quality that can be presented in a portfolio. In case of this project the design aim was to explore the formal, narrative and functional aspects of glass carafes and vessels for water.
3. The project was developed in the module 'Digital Fabrication' in the curriculum of our programme. Students learned about three-dimensional drawing, the creation of data for the CNC milling machine as well as its handling by means of mould making for glass blowing.
4. The linking of digital woodworking with archaic glass blowing at the professional Open Glass Studio exemplified the diverse and unexpected areas of applying of digital fabrication. The contextualisation with the SDGs, as well as the application of Digital Fabrication goes beyond earlier examples of glassblowing in product design, see for instance Glanzmann L. (2012) and Scott de Martinville, A. (2015).
5. With its experimental gastronomy, our Dutch project partner steinbeisser.org offers an expressive platform for presentation, discussion and sale of the objects. Steinbeisser scheduled a prominent event with Vegan Michelin-cook Zizi Hattab and Karime Lopez in September of 2023 at the Merian Gardens in Basel (Steinbeisser 2023), where the submitted objects will be used as part of an experimental gastronomy. Following the event, the glass objects will be offered as individual pieces at their online store on www.jouwstore.com.

While the material experience of glassblowing and the collaboration with the partner steinbeisser.org were enormously appreciated by the students, there was hardly any feedback for the establishment of the SDGs in the curriculum.

Lessons we learned

As we considered the implementation of the SDGs a major step for our curriculum and perception, we started a digital survey of all object design students on the following questions:

- Has anything changed for you since we embeddd the SDGs in the Object Design curriculum - and if so, what?
- Did the SDGs mentioned at the beginning of the modules influence your design decisions - and if not, why not?
- Do you have any advice for us regarding the introduction and embedding of the SDGs in the following academic year?)

First of all, it should be mentioned that despite repeated requests, there was only little feedback from the students. Participating students of all study years stated that sustainability would have been a priority in their lives even before they started their studies. Nevertheless, they were not or only little aware of the SDGs and they would like to have a more profound, also critical examination of the SDGs. One person wrote that projects could also be based on the SDGs, instead of a later classification. Another person stated that her project research had to do with drinking water and was therefore connected to the SDGs, but rather in an unconscious way.

For the first time in 2023, the fifteen Bachelor candidates in Object Design were asked to refer to one or more SDGs in their outline of their Bachelor project (cf. Fig. 2). Although this was only done marginally in their project drafts, we noticed a considerably deeper engagement with sustainability in the topics chosen by the students.

The most concrete student feedback we received during the presentation of the SDGs in the first year, while introducing a text by Rutger Bregman on moral ambition: we had not been consistent with the gender-inclusive word endings in the German translation, and thus students told us that the presentation did not meet our own requirements of SDG 5 "Gender Equality". As a consequence, we organised a discussion on gender-inclusive language with all the lecturers of the first year and reviewed our use of language.

A little surprised, we note that the effects of the SDGs in the curriculum are only indirectly experienced by the students. At the same time, we as a study programme - as lecturers –

Figure 4. Connecting vessels with a tube: Zita Fahrländer's project illustrates the interrelations of drinking water resources
Movie still: Raisa Durandi

Figure 5. The variety of different moulds produced at the wood workshop of Lucerne School of Art and Design: most of them on the CNC milling machine in massive beech, others in plaster or even sand
Image: Andri Stadler

are aware that this step helped us enormously to integrate a sustainable attitude consistently and in all its diversity into our teaching.

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Yutaka: how do we prototype the transformative change towards nature positive designs with soil

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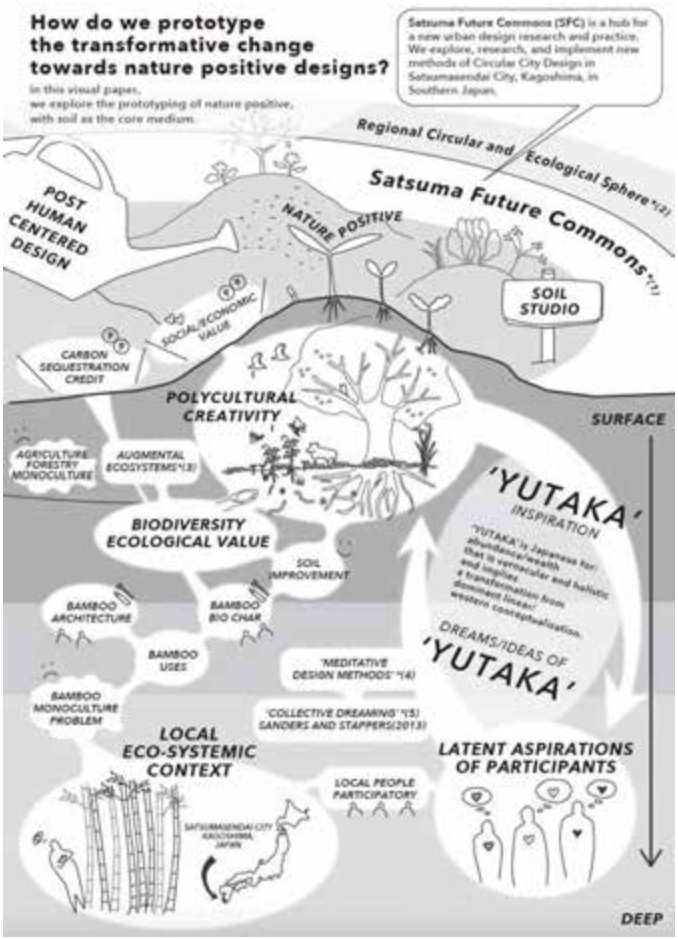
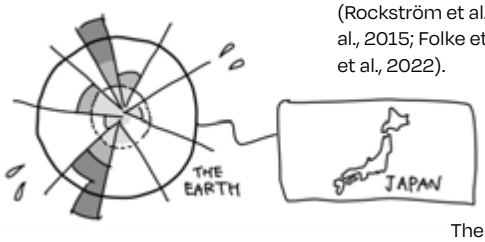
Abstract



Author keywords

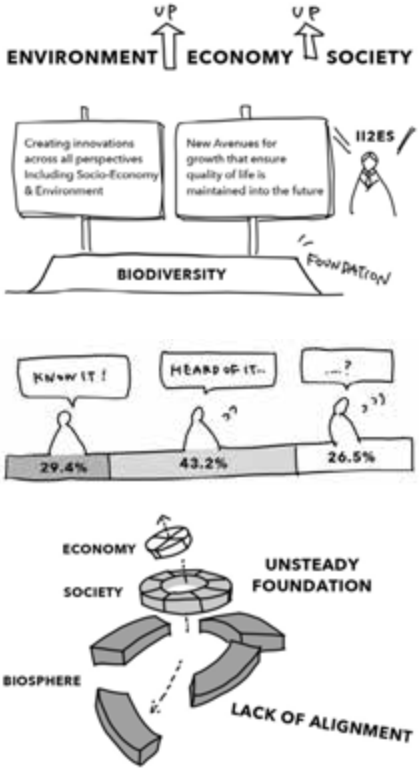
nature positive; circular design; polycultural creativity; meditative design methods

Introduction



(Rockström et al., 2009; Steffen et al., 2015; Folke et al., 2016; Persson et al., 2022).

Global biodiversity and Ecosystems threatened! We need planetary health! (Horton, et al., 2014)



Transformative change is needed! (IPBES, 2019)

The Japan Biodiversity outlook 3 issued by the Working Group for Comprehensive Assessment of Biodiversity and Ecosystem Services), Ministry of the Environment Japan (WGfCAoBaES, MoEJ), also echo's the IPBES report and urges action. In response to Japan's challenges the Ministry has launched the Circular Ecological Economy, proposed by the government in 2018 in the 5th Basic Environment Plan.

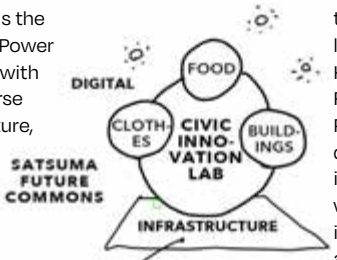
'Integrated Improvements on Environment, Economy and Society' (II2ES).
(Cabinet Office, Government of Japan ,2022) The plan aims to achieve the SDG's (United Nations, 2015).

Combining II2ES plan with sustainable use of regional resources and creating partnerships, is synthesized in the Circular Ecological Economy vision (MoEJ, 2021).

Satsuma Future Commons (SFC) Launched by the city to realize its vision of a circular city. In the background all of this initiative lies in the macro population decline in Japan as well as aging population (MoEJ, 2021).

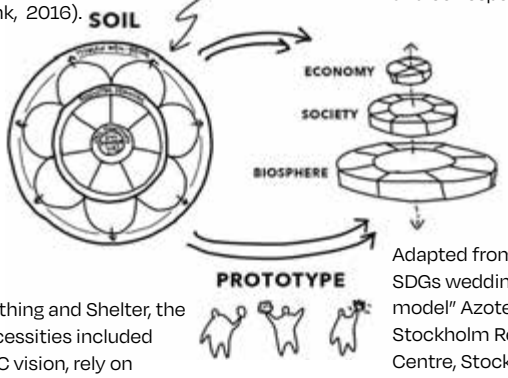
Circular economy with innovation hub located at the 240,000m² area of former unused farmland in proximity to the SNPS (Kamio, 2022).

The major economic driver however is the Sendai Nuclear Power Station (SNPS), with ongoing discourse regarding its future, alternative.



The city developed the plan with collaboration between Kyushu University, and Re:Public inc. Plans and vision were developed with expert input (incl. Inamura) with citizen dialogue including face to face, and correspondence.

Soil properties. (Adhikari & Hartemink, 2016).

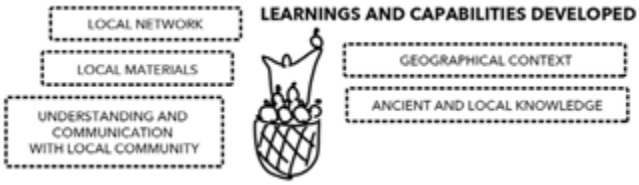


Adapted from "the SDGs wedding cake model" Azote for Stockholm Resilience Centre, Stockholm University

Wy Soil?
Food, clothing and Shelter, the basic necessities included in the SFC vision, rely on nature, such as rice, natural fibers (e.g. silk, cotton, linen) and wood. Such provisioning services are examples of ecosystem services provided by nature. Agroecological (agriculture plus ecology) practices reported to generally positively link with ecosystem services (Palamo-Campesino, et al. 2018). All such provisions rely on soil as the fundamental enabling infrastructure. Soil is the hidden nexus of food, water and energy (Hatfield et.al, 2017)

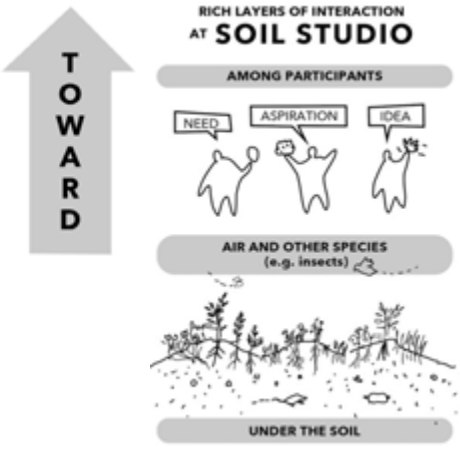
OBJECTIVE
This visual paper explores how to prototype this change from a design standpoint and introduces the Soil Studio as a means to prototype transformative change from the ground level. The Soil Studio aims to explore what is *Yutaka* in relation to soil, where *Yutaka* is a holistic and regional conception of wealth, abundance, and harvest.

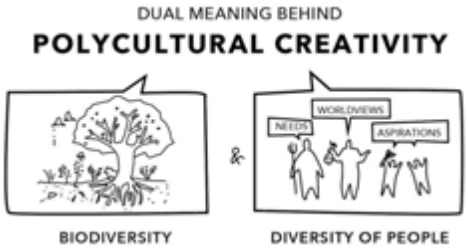
The authors conducted desk research in Augmented Ecology (Funabashi, 2016; 2018), and prominent models of agroecology.



The Soil Studio launched in September 2022, is a format where participants each plant a polyculture in adjacent plots which reflects their own needs, wants, aspirations and world views. This format has been piloted through a test bed in the outskirts of Satsumasendai city, on property provided by local citizens involved in previous projects.

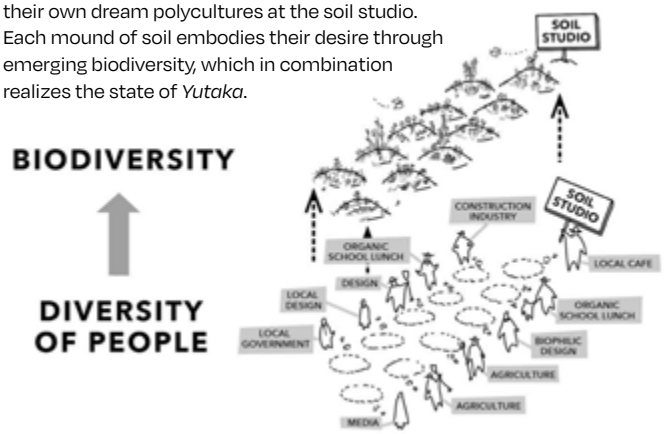
Yutaka is drawn from traditional Japanese thought and defined here as a holistic and regional conception of biodiverse wealth and abundance.



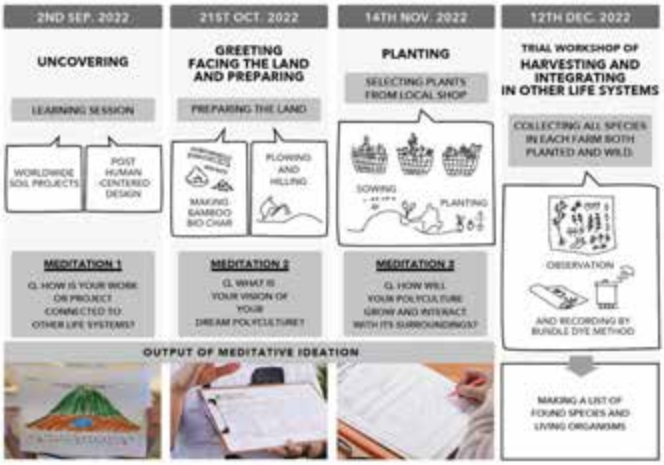


Typically Polyculture is used to denote agricultural species mixtures (Weißhuhn, 2017).

Pilot Soil Studio Overview
People from various backgrounds tried to realize their own dream polycultures at the soil studio. Each mound of soil embodies their desire through emerging biodiversity, which in combination realizes the state of *Yutaka*.



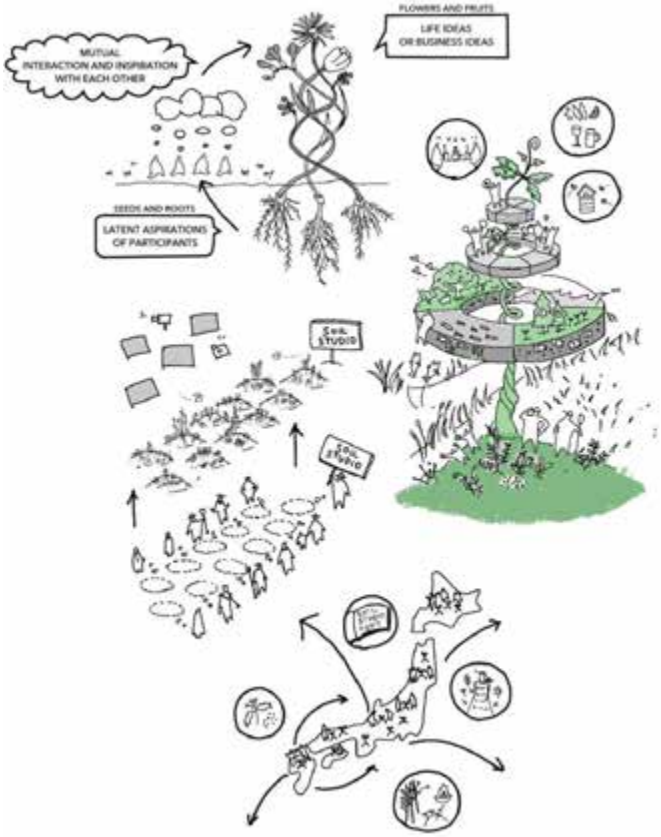
The meditative methods developed by Inamura (Ito, 2021) was combined with co-dreaming of Sanders and Stappers (2012, 2014). With recent shifts in design research toward more-than-human conceptions (Sznel, 2020; Inamura 2022), co-dreaming has been expanded.



Results

matches the research on feelings of connection to nature. (Mayer & Frantz, 2004).

What are te characteristics of the Soil Studio



1: Polycultural creativity
The key difference is to foster the individual human aspirations/desires/needs of the participants through polyculture.

2: Design Studio Concept
The Studio concept: 'what is Yutaka in relation to the soil?'. This is a provocation to learn and develop new ideas for how to connect biodiversity to value. Design approaches have shown many possibilities of innovative use of natural materials (Solanki & Corbin 2018).

3: *Yutaka* Concept
Invoking the concept of *Yutaka*, abundance and wealth based on ancient and holistic world views, is a unique point of the Studio.

4: Methods
Some key methods conducted during Studio praxis included, co-dreaming, meditative design methods, prototyping, and learning sessions.

5: Agroecological technique

Funabashi has presented a no tilling method (though hilling is allowed), minimum soil improvements and no external fertilization (2016). Here, Bamboo bio-char (a local monoculture issue) was used to improve soil conditions and be eligible for carbon credits. As for species of plants, commercial species were chosen, however the Studio format is open to local/heritage varieties and seeds.

6: SLOC scenario

Soil that is Small, Local, Open and Connected.
In line SLOC scenario proposed by Manzini (2011).

7: Societal Context

The soil studio is part of a joint research project between industry and academia and built on a memorandum of cooperation between the city municipal government and university faculty. The city's vision reflects citizen feedback, national policy, and intergovernmental goals. As such the studio pilot is interlinked with layers of regional societal systems, connecting policy to individual.

Conclusion

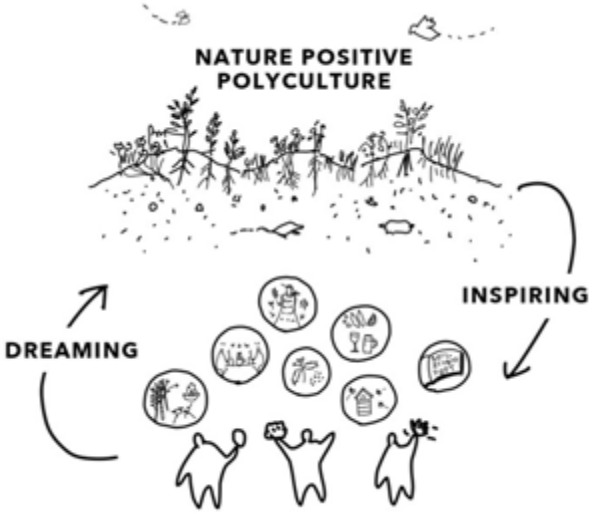
A studio model was established based on Funabashi's work on Augmented Ecosystems through desk research and a site visit. Agroecological methods were combined with the 'collective dreaming' of Sanders and Stappers, utilizing Meditative Design Methods developed by Inamura to explore latent aspirations of human participants to envision a thriving polyculture. The participants then engaged in prototyping and making based on the polyculture. The preliminary results and feedback were recorded. Participant feedback provided highly encouraging anecdotes on the success of the pilot. These results were shown in a public exhibition in the city. The documented interactions of the participants indicate a sense of connection to nature and drive a virtuous cycle of dreams and inspirational learning from the emerging nature positive polyculture. The studio empowers participants with a potent means to explore what is *Yutaka* in relation to soil.

Relevance to readers

The concept of *Yutaka* is relevant as an example of vernacular/local worldviews to drive design development in the nature positive space.

Readers in the Societal, or design for government space, can be informed about how individuals might be engaged in large scale societal transformations on the ground level, with alignment to layers of policy.

Those who are researching mindfulness, meditation and related concepts will find novel applications reported through the case to add to the overall literature of meditative design processes.



Future Research

Though the project is still early in its pilot stage, it has demonstrated potential as a transformative model towards agroecological states of *Yutaka*. Next steps will be to develop the existing Soil Studio, enabling participants, as well as quantitative and digital approaches. The Soil Studio presents aspects that more than the sum of their parts, though based in local worldviews and ecological contexts, have clear structural, methodological, and societal aspects that can be adapted to other localities, beyond Japan and the Asia-Pacific region. Testing the studio format to see how it applies to other sites are also an important trajectory, considering the global spread of circular, participatory and nature positive approaches, it can be hypothesized that the soil studio format will be relevant in many places, and the adaptations necessary also need to be clarified.

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Material experience: the future of material selection for product design

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Abstract

It has become more and more important to consider the future material selections in product design. The material choices influence on the user perception and hedonic experience qualities, but they affect also product qualities such as recyclability and durability. Understanding the user experience with materials can help us to design for more sustainable transformations. In this paper, we address the topic of material experiences through user research. In our research, we focus on four characteristics in the material experience: arctic, classic, expensive and cheap, and present two user studies investigating the user experience with materials in products. The first study utilized the material probes method, and included a user test in which the participants could explore and feel different materials: glass, metal, leather, plastic, concrete, and wood. The second study consisted of individual interviews of eight (8) people. As salient findings, we report that wood, glass, and leather were perceived to represent classic and arctic, whereas plastic provoked negative reactions. With plastics, an interesting contradiction was found when people still often used plastic products to describe an expensive product category.

Author keywords

Design materials; material probes; user experience; user studies.

Introduction

Designers' work can be said to focus around creating new products and solutions for people to use, and their work is visible in every sector of life with different consumer products. However, it is recognized that today we live in a world where the population grows and consumption is constantly increasing, creating problems with the over consumption of natural resources, pollution, and waste, and an urgent pressure to change this development. As a result, we are more focused on the environment and sustainability. According to Maleque & Salit (2013), the environment and factors affecting it are featured increasingly in design; this shows in how materials are chosen, manufacturing processes, life cycle thinking and in material development. Environmental values and sustainable growth are also significant factors in marketing of these products (Maleque & Salit, 2013, 70), and drive for design for transformation and nature friendly solutions.

Product designers and industrial designers work integrally with different physical materials. Materials are an essential part of the user experience with tangible products, and their selection influences on the product's outlook, durability, usability, price, and recyclability. Material choices are thus an important part to consider in the design phase, and understanding how people perceive the materials provides useful background information for these choices.

We investigated the user experience with product design materials with two different user study methods. The first study utilized the material probes method, and included a user test in which the participants could explore and feel different materials: glass, metal, leather, plastic, concrete, and wood. In the second study, interviews were conducted with eight (8) people, who also presented product examples of their choices. Our work contributes in understanding the user perceptions of material qualities and user experience, and can provide insight and inspiration for product designers and researchers who are interested in materiality as part of the user experience.

Material Experience

User Experience with Materials

User experience (UX) is a central concept when designs are assessed, and it goes beyond the definition of usability - efficiency, effectiveness and user satisfaction - which has traditionally been the key concept when user interface design goals are set (Law et al. 2008). User experience design does not consider only the instrumental value of the interactive artifact. It highlights also hedonic aspects, and that emotion and affect have important roles in the holistic perception. These include factors such as aesthetics, emotional engagement and stimulation (Hassenzahl & Tractinsky, 2006). User experience is studied with user-centered design methods, which can be applied in design and evaluation phases (Hassenzahl & Tractinsky, 2006; Häkkilä, J. 2020, p. 68).

Even though design education is changing, and the methods and tools in the field have generally moved to fast modeling methods such as 3D printing and laser cutting, design stu-

dents still need a good knowledge of materials and practical experiences (Johansson & Konttinen, 2021, 90). The skill of producing successful and insightful design requires knowledge of previous solutions from a contextual and historical level (Falin, 2011, p. 122). Only with sufficient understanding of the effects of material selection, can we have an impact on the future of product design.

Also, successful product development requires a deep understanding of users' preferences. Design is one way to concretize users' needs and make products easier to use, more functional and sustainable. Today, a designer is expected to have good empathy skills, so that they understand user needs and at the same time can push their own opinions aside (Huotari, Laitakari-Svärd, Laakko & Koskinen, 2003, pp. 9-25). Understanding user experiences with materials can be a tool for change and transformations.

According to Karana (2010), the material is a very essential part of the product and the material experience created through the product is multifactorial. When people interact with products, their senses are in contact with the product's materials, which mainly provide visual and tactile stimuli. The environment and previous experiences also have their own influence on how materials are perceived (Karana, 2010, p. 23.) Designers need to be aware of the overall picture affecting users' experience with physical products and materials. Materiality plays a central role also with tangible user interfaces, since materials can be experienced thru touching and haptic feedback. Nevertheless, according to Häkkilä & Johansson (2018) materials also affect the visual design and the style of the products. Therefore, the designer can promote values and create associations with material selections (Häkkilä & Johansson, 2018, p. 36).

Materials and Designing for Nature Positive Transformation

Design educators are creating a foundation for the future by teaching tomorrow's designers. Preparing design students with knowledge about the importance of material selections for product design can make a difference towards a nature positive transformation. Nature positive transformation is an essential requirement in the future design. This is simply because a turn towards more sustainable solutions must happen in order to give Earth as the living planet a chance to flourish also in the future. The future of the entire planet is greatly affected by the ongoing development trends, which are of great concern. These include the overuse of natural resources, global warming, increasing population, urbanization and the socio-economic challenges of consumer society. Different measures and campaigns have been developed to increase the awareness of the issues. As one illustrious example, Earth Overshoot Day has been announced as a measure to describe the overuse of natural resources and the planet's capability to recover from the toll the humans are putting on the biocapacity. It is calculated for each year by Global Footprint Network, and marks the day when Earth's biocapacity suffices to provide for the Ecological Footprint of humankind. In 2022, the Earth Overshoot Day was on the 28th of July. Sustainability needs to be addressed with a wide spectrum of solutions across the society, since it has been recognized as a key challenge. According to Ljungberg (2007), developing more sustainable products can be affected in part by the material selections. However, the material selection process today is complicated and challenging, since there are virtually countless options available. Designing products for a sustainable future gives the material selection and the designer even more significant role.

Study I – Material Probes

Method

In the first phase of our research, material probes were used as a qualitative data gathering method. Material probes method in the context of interaction design has been described by Jung and Stolterman (2010), who addressed the topic of materiality related to digital artifacts. The method was developed to provide understanding on how people perceive different material qualities, and to feed to the discussion on how these observations and desires could be incorporated into the design. Jung and Stolterman employed a three-step procedure, which included asking the study participants to tell stories of memories related to physical artifacts, playing with material samples while speculating on their preferences, and comparing the physical and digital artifact experiences (Jung & Stolterman, 2010). The material probes method was later adapted by Häkkilä et al. (Häkkilä, He & Colley, 2015), who studied the experience with natural materials by providing tangible samples and assessing them with product reaction cards based on the Microsoft PRC set (Benedek & Miner, 2002). Here, product reaction cards provided a set of predefined words, from which the participant could choose the terms best matching their experience with the physical material probe.

In our study, we adopted the material probes method by concentrating on the second step of the original procedure by Jung and Stolterman (2010). Here, we introduced study participants the material samples as tangible, physical bits they could touch.

Study Set-up

The material probe method used in our first study consisted of seven material probes and the questionnaire which had three questions for each material sample (probe). We chose seven hard materials, and decided to name and label the material samples (probes) in the test situation alphabetically (a, b, c, d, e, f, and g) to minimize pre-existing opinions related to different materials. The material probes are presented in Figure 1 and consisted of the following materials: glass, metal, leather, plastic, concrete, cardboard, and wood.

Figure 1. Material probes in the Study I:
A. glass, B. metal, C. leather, D. plastic, E. concrete, F. cardboard, and G. wood

Each study session lasted for approximately 40 min, and included the following steps:

- Completing a background questionnaire.
- Interacting with each material probe in turn.
- Following a Product Reaction Cards (PRC) based methodology (Benedek & Miner, 2002), for each material, selecting three (3) terms from a list of 14 that best described what the material 1) felt like and 2) looked like.

» Rating the materials on a 5-point Likert scale against the categories: arctic, classic, expensive, and cheap.

A total of 22 participants (15 female, 7 male; aged 20–41, with the average of 27 years) took part in the study. Participants were predominantly university design students and staff.

Results

The tactile and visual sensations evoked by the material samples are presented in Figure 2, which summarizes the answers for the questions posed with the material probes: "How does the material feel?", and "What does the material look like?". Figure 2 presents the three most common PRC terms selected for each material.

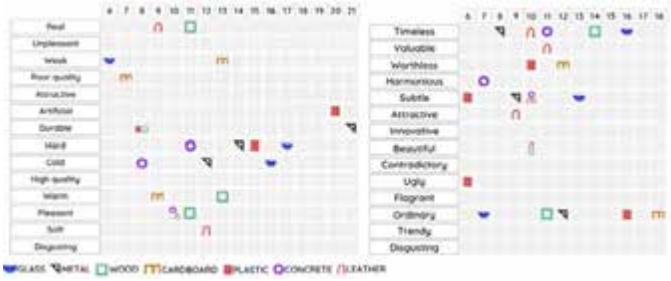

Figure 2. Three the most frequently chosen PRC terms for each material to describe 1) how the material felt like (left), and 2) how the material looked like (right).

The test participants' associations between the materials and categories arctic, classic, expensive, and cheap are present in Figure 3. Wood, glass, and leather were perceived to represent classic and arctic, while concrete, plastic, metal, and cardboard did not fit these categories so well. Wood, glass, and leather were perceived almost equally as classic and arctic materials. Leather was perceived as the most expensive material. Plastic and cardboard were perceived as the cheapest materials compared to the others used in the material probes.

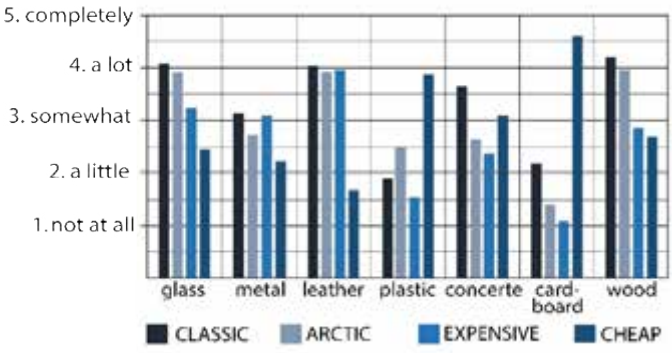

Figure 3. The average of the results of how participants combine materials with the categories arctic, classic, expensive, and cheap.

Study II – Interviews

Method

The second phase of the data collection consisted of interviews. The interviews were run as a separate study, with different participants as the first, material probes study. The interview method is suitable for situations where the answers are relatively unknown, and where the researchers are interested in bringing out comprehensively different viewpoints (Millar & Tracey, 2009, p. 80). Different kinds of probes can be used as an integral part of an interview in order to provoke memories and to stimulate the interviewee to speak more (De Leon & Cohen, 2005). De Leon and Cohen (2005) call non-verbal, tangible probes as object probes. Object probes are artifacts which are used explicitly to generate verbal responses, and they can be selected by the researcher or the study participant him/herself. Object probes can be for instance photographs, which can help participants to verbalize their memories and observations. For instance, Collier and Collier (1986) have pointed out how photography can support ethnographers in conducting interviews and thus in collecting richer data from field studies. Our interview study took inspiration from the material probes method by Jung and Stolterman (2010), who asked people to tell memories related to different materials. In our study procedure, we utilized objects and photos selected by the participants as part of the interview.

Study Set-up

The interviews were supplemented with product examples chosen by the participants, and the material experience was observed through the selected products. Prior to the interview, the participant had to choose one product from their home for each category: Classical, Cheep, Expensive, and Arctic. We also instructed that the examples should not be any clothing or anything eatable.

T study included the following steps: The pre-task, a background questionnaire, and nine ready-made questions, which the participants received before the interview situation. Each interview lasted 30–40 minutes and was conducted via video calls. Altogether eight participants (7 female, 1 male, 27-61 years, average 40 years) took part in the study. All persons interviewed had some kind of connection to the Finnish Lapland.

Figure 4. Pictures of the products which participants had chosen for the categories arctic, classic, expensive, and cheap.

Results

All the product examples are shown in the Figure 4. there found also the products main materials. In the "arctic" category, the products included many sports equipment that are used in the (sub)arctic region. The products chosen to fit the definition of "classic" consisted mainly of products related to home and living, excluding musical instruments. The products chosen to fit the definition "expensive" consisted mainly of electronics products. The product choices defined as "cheap" were justified by the affordability of the purchase price. Two products of this group were self-made.

Discussion

About the Findings

Material experience is a very wide and subjective matter, influenced by a large number of factors, such as the user's values, cultural background, previous experiences, age, gender and senses. Also, the user's financial situation affects how materials are experienced, especially when defining them as either expensive or cheap. Therefore, designers need to take the target group into account when choosing the product materials.

Based on the research regarding expensive materials, it can be concluded that people consider technical products expensive, because of their cost and for not being long-lasting in respect to their price. This is a well-known problem, and the principles of sustainable development are nowadays not implemented in all technical devices. It is especially interesting to discuss the "arctic" qualities of product design based on this study. The material and product choices of the arctic category showed a clear connection to natural materials. The functionality of the materials and the match with the use cases in the arctic region came to the fore. Of the categories used in the study, arctic was the only one that was a region-related category. It may be that the functionality of a material is easier to understand if it can be linked to a certain area or conditions. This would provide an interesting line for further research.

Plastic is a material that divides people's opinions, as noticed also in this study. Participants experienced plastics very negatively, both through physical experience and mental images. In interviews, however, a result contradicting this observation emerged, as many of the objects in the "expensive" category were, to our surprise, plastic.

The findings indicated that design has a rather large importance in how users experience the material and how they see and feel about it through the products. Plastics as a material is not perceived as expensive, rather the opposite, but it is used in many products that are expensive. The designer's choices affect how the user is experiencing different products and materials. The designer should take the target user group into account already when choosing the materials for the design, as the perceptions on different material qualities may differ between user groups. However, these factors are not fully controlled by the designer alone.

About the Theme Transformation for Nature Positive

The development of new materials has an important role in the future in replacing the existing harmful ones. Designers should be educated about new, more sustainable materials to be able to make better choices for product design, as they do have a role in transforming the physical artifacts to be more nature positive. Consideration of nature comes in quite seamlessly in arctic design, since the design is strongly influenced by the surrounding environment (Häkkilä & Johansson, 2018). Also the effects of climate change are specifically apparent in the arctic areas. For the nature positive transformations, it is promising to note that plastics, which have gained a lot of negative publicity for the waste problem it has created, also provoked negative results from the participants in this study.

Limitations and Future Work

We acknowledge that our study is limited by the sample the participants. The results might have differed somewhat if the same users would have selected to do both of the studies -material probes as well as interviews, or if the study had been conducted in different culture. However, as the research addressing the perception of design materials is at the core of product design, we believe our study provides some interesting insights to the topic. For future research, the observed contradictions e.g. with plastic as design material would be an interesting topic for future research.

Conclusions

In this paper, we have presented a two-phased qualitative research investigating the user experience with design materials. As salient findings, we report that wood, glass, and leather were perceived to represent classic and arctic, whereas plastic provoked negative reactions. With plastics, an interesting contradiction was found when people still often used plastic products to describe an expensive product category.

Based on the research results it can be concluded that some materials provoke a more nature positive user experience. Especially in the arctic category, natural materials such as leather and wood emerged. In the study, the product choices of the arctic category were combined with the conditions of the (sub)arctic region. In the selection of materials, wood, leather, and glass were chosen as arctic materials, which was also observed in the arctic product choices regarding leather and wood.

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Discerning modes of design in ecological restoration

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Abstract

Ecological restoration is an art and science that offers a practical approach to repairing and caring for relationships in living systems. Restorationists, a community of multiple epistemic cultures, most often frame their work as a practice of ecology. Ecology provides a systems-oriented approach to natural and life sciences that can be applied to restore and repair. Yet, the word design also frequently appears in the work of ecological restoration. What do restorationists mean when they refer to design?

In this paper, I introduce ecological restoration to a design audience and frame restoration as a repair practice that advances designed interventions in socio-ecological systems. Through three case studies from the United States context, I identify three different ways that design appears in the work of ecological restoration: planning, technology, and transitions. As these case studies show, approaching restoration as designing can make restoration processes more transformative, more inclusive of multiple worldviews, and more critical of environmental injustices. Yet, design approaches can also depoliticize ecological restoration by oversimplifying it, or by normalizing an overly technological approach that seeks quick fixes to complex problems. By bringing ecological restoration and design into deeper conversation, this piece highlights the impacts of various design postures that are brought to the work of restoring ecosystems.

Author keywords

ecological restoration; earth repair; socio-ecological systems; transition design

Introduction

Worldwide, communities and governments are responding to environmental degradation by taking up the work of ecological restoration. The term restoration describes the work done by people to return ecological structure and function to sites like wetlands, coastlines, forests, meadows, and rivers after they have been harmfully disturbed. Examples of large-scale anthropogenic disturbances that restoration responds to include some types of agriculture, aquatic eutrophication, hydrologic disruption, logging, mining and oil spills (Jones et al., 2018). Restoration may also be used to address disturbances that are not directly anthropogenic, like wildfire and flooding, or to re-introduce beneficial disturbances that promote ecosystem flourishing. Restoration is widely accepted and recognized as a useful tool for ecological repair, and features in two key United Nations frameworks. One, to restore 350 million hectares as part of the UN Decade of Restoration and the other, to preserve biodiversity through restoration of 15% of earth's degraded ecosystems by 2020, an Aichi Biodiversity target that has not yet been realized (Unit, 2020). While restoration activities receive billions in funding (USD) annually, success in ecological restoration work is a complex and elusive process of changemaking that often requires modifications in policy and human activities, in addition to ecological parameters (Christian-Smith & Merenlender, 2010). In this paper, I introduce restoration to a design audience by asserting that restoration is a design practice, illustrating the ways that design practices and postures appear in restoration, and suggesting how those ways of designing relate to the potential for a restoration initiative to effect systemic change.

The practice of restoration affirms that humans have necessary, active and beneficial roles to play in repairing and maintaining earth's ecological functions (Egan et al., 2011; Higgs, 2003; Jones et al., 2018). This stance distinguishes restoration from practices of rewilding, conservation and preservation, where people are intentionally kept out of or away from protected lands. The restoration community comprises a vast amalgam of people, institutions and local communities who practice restoration with distinct methods, motivations and visions of success (Higgs, 2003; Kimmerer, 2011; Tomblin, 2009). The practice is most broadly defined as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed." (2023). Early definitions of ecological restoration emphasize the replication of historic conditions (Higgs, 2003). However, most contemporary restoration approaches frame the work as a way to create desired ecological conditions that, while deviating from a historic baseline, are ecologically sound and culturally relevant (Coleman et al., 2020).

Restoration as Repair

Restoration can be understood as a practice of repair. In fact, it is often referred to colloquially as "earth repair" (M. Hall, 2005). Restoration has also been described as an act of "relational repair" between groups of people, as well as between people and various non-humans, for injustices past and present (Almassi, 2017). This framing reminds us that social injustice is often intertwined with ecosystem degradation, as is the case with the removal of many Indigenous people and groups from their lands in the North American context (M. M. Hall et al., 2021; Kimmerer, 2011). Holistic and durable repair of ecosystems

must also consider these social contexts. Writing about repair, scholars Markus Berger and Kate Irvin theorize that repair can be either "first-order" or "second-order". First-order repair is about "a continuation of what occurred before (i.e., a car mechanic replacing a standardized part)" (2022, p. 2), whereas second order repair requires "enacting thinking and practices that challenge the status quo" and leads to "a complete transformation of the thing, system, and relationship itself" (ibid). With this framing, repair can be evaluated by the extent to which it is a systemic intervention, or simply a symptomatic fix. Restoration reflects this tension, as many projects are limited to first-order repair, prioritizing cleaning up an environmental mess without addressing its systemic root causes. Both kinds of repair are necessary, yet scholar Laura Martin argues that restoration "will offer no more than a temporary repair" (2022, p. 230) if systemic causes of degradation remain unexamined. To conceive of restoration projects as systems interventions, we must conceptualize ecosystems as socio-ecological systems that include human social dynamics and concerns (Perring et al., 2015).

Restoration as Design

Restorationists create material interventions in living systems ranging from earth moving to plant propagation in order to bring about better future conditions. Restoration is thus a practice of not only repair, but also, designing. Ecologist Eric Higgs draws the connection, noting, "Restoration is fundamentally about design, and the challenge ahead is to enlarge our capacity for good ecological design." (2003, p. 95). Discussing restoration in relation to design is inherently important because of restoration's significant contributions to a thriving and living future for both humans and non-humans. Further, despite the recognition by restorationists that design is relevant to their work, a robust dialogue is mostly absent between the fields of design and restoration, to the detriment of both. Higgs observes that, "as restorationists, we are involved in the design of ecosystems and places whether we like it or not" (271). Noting some ecologists' hesitancy to engage with design, he further argues that, *"we need to acknowledge that restoration is fundamentally a design practice [emphasis original]"* (274).

Scholars Mang and Reed (2013) and Du Plessis (2012) connect the dots between design and living systems by advancing frameworks for what they call regenerative design and development. These frameworks and tools support "design and construction of mutually beneficial and life-supporting relationships between built and natural environments" (2012, p. 15). As these proposals originate from a design and architectural posture, they emphasize changes to how the built environment is designed to benefit and regenerate natural systems. Restoration, on the other hand, primarily originates from ecological sciences, a field which has historically omitted the built environment from its study and consideration. Thus, with the exception of scholarship from designers of the built environment, design and restoration ecology mostly lack theory and frameworks to explain how their work interacts. Here, I bridge this gap and respond to Higgs' call for explicit recognition of design in restoration. I do so by identifying and discussing three ways that design is currently used to create interventions in socio-ecological systems through restoration and earth repair activities in contemporary cases from the United States context. I additionally suggest that the way we design restoration and repair will determine if the repair will catalyze beneficial systems transformations toward more sustainable and ecologically sound futures.

Design and Restoration: Three Cases

Here, I present three cases to discern and critique the roles that designing plays in restoration, so that restoration activities may yield more durable and transformative outcomes. These examples come from the American context, with start dates ranging from 2010 to 2022. They were selected because they are contemporary, self-identify as restoration projects, and illustrate three distinct modes of how design appears in restoration. As they are all ongoing projects, their ecological and social outcomes are not fully realized or understood. Restoration projects are typically evaluated in terms of recovery completeness and recovery rate based on indicators from ecological sciences (Jones et al., 2018). Instead of grading or scoring these project outcomes, my review identifies and critiques how design appears in the processes used to plan or carry out the restoration projects. I also locate the interventions in terms of their positioning as systemic leverage points using the "Places to Intervene in a System" framework by Donella Meadows (1997). This framework ranks leverage points in order of their likelihood to produce meaningful systems change, which Meadows calls "effectiveness". In this framework, a leverage point in the 12th spot is the least effective, with effectiveness increasing as the ranking proceeds from 12 up to one.

Institutional Restoration: Upper Truckee River

Design frequently appears by name in what Tomblin (2009) calls institutional restoration projects. These are projects led by state and local government agencies, or other institutions who may own or manage land, such as land trusts. Design is often considered a distinct stage in these projects, taking place between the establishment of goals and reference conditions and project implementation. In these contexts, designing is the process of solving a specific, singular problem of spatial configuration of ecosystem features (Holl, 2020).

This use of design appears in the case of the Upper Truckee River, a restoration project in the works since 2010 in the Lake Valley State Recreation Area (LVSRA) in South Lake Tahoe, California. This project aims to reduce sediment flows into Lake Tahoe from the Upper Truckee river by slowing or stopping streambank erosion in a particular river section. Erosion control measures include bank stabilizing work and re-introduction of historic river meanders, which slow down the flow of water. In addition to the river, the other significant feature of the LVSRA is an 18-hole public golf course on the river's banks. Restoration goals, which are set and managed by the California State Parks, also include creating a larger buffer zone between the river and the golf course, so that the river is less affected by the golf course and vice versa.

Restorationists in the Upper Truckee currently face a daunting task. Their design must simultaneously re-establish river meanders, move the golf course holes further from the river bank, keep the golf course at 18 holes, and do all of the above within the current footprint of the LVSRA. Project backers have hired professional golf course designers to solve this restoration problem by producing a golf course design that checks all of these boxes. In the socio-ecological system of the Upper Truckee river, design is being used to change the "structure of

material stocks and flows (such as transport networks, population age structures)" which Meadows (1997) rates as the 10th most effective place to intervene in a system, out of 12.

Work on this restoration project has not moved beyond the design phase in almost 10 years of deliberation due to a lack of public support and conflict amongst stakeholder groups. Despite the seemingly impossible constraints to satisfy, project backers continue to believe that a design solution exists for the LVSRA that will check all of the boxes. In a case like this, considering design as a distinct phase with pre-prescribed activities may be preventing restorationists from fully engaging with all that design has to offer to their work, as well as limiting how much learning and emergence can influence their processes.

In this case and in many other institutional projects, design serves an additional purpose of being the means for communicating and recording a plan of action for regulatory purposes. Regulators and the public may need to give approval to a specific restoration design, often communicated through 2-D schematic drawings as seen in Figure 1. In this way, design serves as a unifying vision of restoration success, yet restorationists must avoid framing ecological degradation as a purely logistical problem that a restoration design plan alone can solve. In the LVSRA case, project leaders maintain their emphasis on golf course design as the way forward, with a new course design and environmental impact statement expected in early 2023.

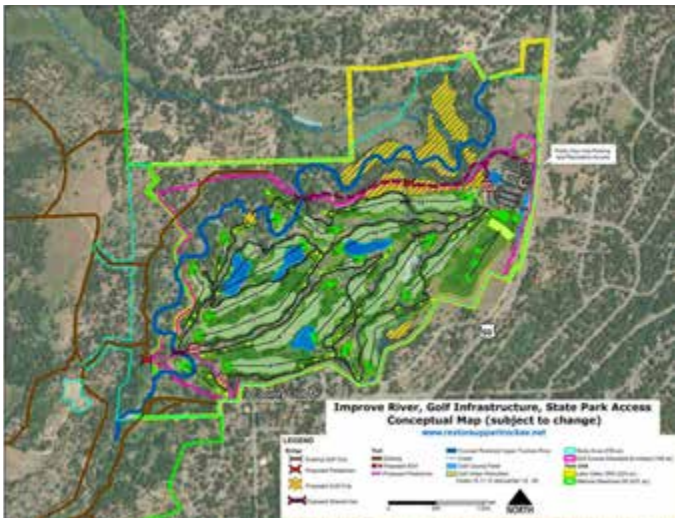

Figure 1. A proposed restoration design for the LVSRA (Source: CA State Parks)

Designing Technology for Restoration: RIBITs Interface Redesign

Design has long been associated with planning in institutional settings. Increasingly, design also interacts with restoration through technology. A 2022 collaboration between the non-profit Environmental Policy Innovation Center (EPIC) and the US Digital Service (USDS) illustrates this dynamic. In this project, an interdisciplinary team of designers and programmers worked to re-design the website interface (Figure 2) of a restoration tracking database managed by the US Army Corps of Engineers, called the Regulatory In lieu fee and Bank Information Tracking System (RIBITs). RIBITs is used to organize and track mitigation banking, a form of ecological offsetting for wetlands that shares some similarities with the practice of carbon offset trading.

The USDS and EPIC project is an example of "designing for restoration", which differs from the "designing restoration" example on the Upper Truckee River. In this case, a design process was used to update the human interface for a technological system that organizes restoration efforts. In a blog post about the effort, design project members explained that the current RIBITs system (Figure 2) was known to be difficult to use, and that a human-centered design approach was selected as a methodology for improving usability (Mahr, 2022). Over the course of several months, the project used tools like affinity diagrams, user journey maps and digital prototypes to design proposed changes to the system interface.

These redesign efforts for RIBITs will likely make a positive contribution to the system interface and perhaps make the system easier to use for those who engage with it. Yet, this project, in designing technology for restoration, exemplifies a common pattern in the way that design engages with wicked problems. This pattern appears when designers acknowledge wicked problems in designing, even citing them as a primary motivation, but focus their efforts on updating or creating technologies to mitigate the effects of the wicked problem, rather than interrogating the root causes of the problem itself.

Project briefs that make a call to, for example, "design for mental health" or "design for sustainability" show this same pattern. The problem with this way of working is that a website or technology design can be made highly usable and reflect the results of a human-centered process while doing little to address or change the dynamics of broken systems that produce these wicked problems. This kind of designing produces only first-order repair. In this case, the broken system is the market-based wetlands offset governance system that RIBITs reports on. Mitigation banking is meant to ensure "no net loss" of wetlands. Yet, in practice, the system incentivizes novel wetland construction or wetland consolidation in exchange for the destruction of healthy, functioning wetlands. What's more, the wetlands that mitigation banking produces are often less ecologically functional and offer fewer ecosystem services than the ones they replace (Steinhoff, 2008).

Figure 2. The RIBITs interface before the redesign effort (Source: US Army Corps of Engineers)

Design's engagements with wicked problems like wetlands protection and river restoration must produce more than first-order repair. Eric Higgs notes that "Design offers the prospect of reorienting our typical relations in a technological culture" (2003, p. 280). From a systems perspective, the proposed website redesign of RIBITs for greater usability aims to change the structure of information flows in the socio-ecological system of United States wetlands mitigation banking. This type of intervention ranks as leverage point number six of 12 in the Meadows framework. This leverage point is com-

monly engaged through digital technology design projects. While this particular design intervention may make the work of wetlands mitigation banking more transparent and efficient through RIBITs, this approach also normalizes a technological restoration culture. Here, rather than being used to "attune us to critical responsibilities" (ibid), such as stopping wetlands destruction in the first place, or finding creative ways to preserve them, design has been used to make the RIBITs system more navigable. These two examples show that design can be used for restoration in ways that ignore or even normalize the root causes of degradation. Instead, design must be used for more substantive change to catalyze the transformations that true earth repair requires.

Designing Transitions by Restoring: Fire Mimicry in California Oak Woodlands

In this final example, design appears in a restoration project without being explicitly named. This example illustrates the ways that restoration, as a design practice, creates meaning and culture while also solving a problem. In this case, restoration is a designed transition emerging from a community group. In contrast to the previous examples, in which design was used as a way of conceptualizing ideal spatial plans in restoration, or in advancing technological approaches, this final example shows how a designed intervention for restoration can create transformative learning and relationships to catalyze broader change.

Oak woodlands are ecologically and culturally significant features of the landscape in coastal California. Prior to Euro-American colonization, Native Californians managed oak woodlands with fire as well as hand tending (Klinger, 2006). Today, these beneficial disturbance regimes (Anderson, 2013) have largely disappeared, due to ongoing Native land dispossession. As a result, forest health has declined and these woodlands are more susceptible to disease, drought and catastrophic wildfire. Oak forests need regular episodes of low-intensity "good fire" to restore health, but many forest sites are too unhealthy or too close to human settlements for this kind of burning to be possible.

Fire Mimicry is a transitional restoration process that bridges this divide between current conditions of unhealthy, fire-prone oak forests, and a future where healthy oak trees can be tended with fire (Klinger, 2008). Fire serves many purposes in an ecosystem such as making soils more alkaline, killing pathogens, hardening oak tree bark and lowering overall fuel loads. Fire mimicry offers these benefits without direct application of fire. Phases of fire mimicry are sequenced, beginning with a stage of clearing and thinning of unhealthy or overgrown woody materials. Then, mosses and lichens are removed from the tree trunks with a mineral wash applied. Finally, the tree soil is treated with alkaline minerals, and any infection sites are surgically removed and covered with more mineral wash. The trees can be treated multiple times over several years, and observation over time is a key part of the process. Fire mimicry is generally quite safe and, with the exception of tree felling, can be easily practiced by non-experts. The method is primarily disseminated through community workshops and work weekends to non-expert and aspiring land stewards, and is not explicitly named as a design practice.

How is fire mimicry designing, and what might it teach about other ways of designing? Fire mimicry relates to design in several ways. One, it is an important example of a transitional design practice taking place at the household and community scale, what Manzini calls "diffuse and competent designing" (2015). Through gradually redesigning a landscape, fire mimicry interventions restore forests such that good fire can be returned to the landscape, transitioning forests and human communities away from the legacy of fire suppression. If those who practice fire mimicry are successful, the practice will become largely obsolete. This characteristic indicates an effective transitional practice. Those who practice fire mimicry do not explicitly self-identify as practicing design or Transition Design. Yet, the way that this practice simultaneously makes change across material and immaterial dimensions exemplifies the approach to changemaking that Transition Design proposes (Irwin, 2019; Sides et al., 2022).

Through landscape and designed transition, fire mimicry may produce second-order repair. The processes of learning and practicing fire mimicry produce what might be called "relational encounters" (Manzini, 2015) within groups of people, as well as between people and trees. These kinds of relational encounters support the kinds of transformative, systems-level change that comprise second-order repair (Dorn & Dickman, 2022). Locating these interventions in the Meadows framework, Fire Mimicry appears to act at two different levels. One, the landscape design activities change the size of buffers and stabilizing stocks (leverage point 11 of 12), such as the soil pH and the local fuel loads. At a higher level, by empowering community members to see nature as a socio-ecological system in which humans can positively contribute, fire mimicry also engages leverage point four, "the power to add, change, evolve, or self-organize system structure" (Meadows, 1997, p. 14). Fire mimicry work and the relational encounters it produces can effect change by fostering cultures of land stewardship and tree care, educating the public about the links between fire suppression and cultural suppression of native people, and ultimately, facilitating the return of indigenous land to indigenous stewardship along with the associated practices of cultural burning.

Table 1. Summary of restoration cases reviewed

Case	Location	What interventions are being designed?	Leverage Points Engaged	Design mode case exemplifies
Upper Truckee River	Lake Tahoe, USA	River and golf course layout	The structure of material stocks and flows (10)	• Designing as Planning • Professional Design
RIBITs Interface Design	Cloud Data-base, USA	Wetlands data-base interface	The structure of information flows (6)	• Designing Technology • Human-Centered Design
Fire Mimicry	Coastal California, USA	Oak forest composition over time	• The power to change system structure (4) • The size of buffers and stocks (11)	• Diffuse designing • Designing Transitions

Conclusion

The previous three examples illustrate three different ways that design appears in the work of ecological restoration: through planning, technology, and transitions. In the exam-

ple of the Upper Truckee River restoration project, design is employed in an expert-driven, problem-oriented way to serve as an official plan of record for a restoration project. This example shows how restoration is designed in institutional settings and its tendency to produce first-order repair only. The RIBITs interface design example shows how design interacts with restoration through technology, illustrating the pattern of designing "for" wicked problems through technological means. In this case, human-centered design was used to redesign the interface of a system for governing wetlands mitigation banking. While the project likely met system usability goals, it did not show evidence of deep engagement with or attempt to change the dynamics of mitigation banking. Finally, the example of fire mimicry shows how, through producing meaning and culture while also solving a problem, restoration practices can serve as designed transitional interventions. While all of these cases come from the United States context, their lessons may be relevant to other geographies. In particular, the planning and technological modes of designing identified here are likely to appear in other landscapes of ongoing settler colonialism, as these modes reflect a way of relating to land based on abstraction and control.

Together, these examples paint a picture of how design already appears in restoration. By analyzing them together, we can begin to imagine additional or modified design postures that will more consistently produce durable and holistic ecological repair. Restorationists, acting as or collaborating with designers, must bring the best version of their craft as well as critical attunement to the meaning of "nature-positive" to this challenge. In the context of restoration, designers should aim to: acknowledge and address the root causes of environmental harms, recognize that a particular design is just a snapshot in an ever-chanting system, remain open and transparent in their processes, seek out ways to engage non-experts in the design process of restoration, and center the wishes and needs of Indigenous people, local communities and the beings whose lives are most affected by environmental harms. Design postures that reflect the above suggestions have a great deal to contribute to the challenges of restoring living systems. The way that ecological repair work is done matters deeply. Through engagement in this work, design and those who practice it may also be positively transformed.

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From visual to multisensory: how does intangible cultural heritage of traditional costume self-remodel in digital interactive environment?

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Abstract

With the rapid development of digital technologies such as artificial intelligence, virtual reality, augmented reality, and 3D imaging, digitalization has become one of the primary cultural heritage protection and dissemination methods. Compared with other cultural relics, traditional costumes are vulnerable to environmental factors in storage. Therefore, protecting them in the digital environment and stimulating visitors' senses effectively is still an important project. Especially under the upsurge of the "digital future", avant-garde and artistic virtual products and technological innovations such as virtual fashion, 3D simulation displays, and virtual exhibition halls have brought new cognition and provided abundant means for the digital protection of traditional costumes. However, researchers have not paid enough attention to summarizing their narratives and expressions in the context of digital technology from a methodological perspective.

First, this paper analyses the concept of intangible cultural heritage and its digitalization from a documentation perspective, investigating research themes, technical means, and display modes in the digital production of traditional costume heritages. This part is a review and summary of the early stage of the research. Second, this study combined 5 typical practical cases in China, from the aspects of multimedia interactive participation, mobile interactive applications, digital museum display(virtual tour), gamification(skins) and digital costume collection to explore how organizations, museums and professionals can use digital technology to map information transmission with the audience's multi-senses, which will better authentic experience of traditional costumes. Finally, taking the life etiquette costume of the Ming and Qing Dynasties as the research object, this study discusses the technical path and development strategy of digital protection and constructs the overall framework of the database.

The results show that as a cross-disciplinary field, emerging digital technologies have broad application potential in protecting traditional costume cultural heritages, conducive to reproducing the new form of these finite objects and delivering rich intrinsic value. Meanwhile, in the interaction process, visitors have more opportunities to perceive the more profound charm of cultural heritages. The conclusion in theoretical and practical value can be used as a reference for other related cultural heritage fields in the digital background.

Author keywords

digitalization of intangible cultural heritage; traditional costume; digital technology; multi-dimensional construction; innovative application; case studies

Introduction

With the rapid innovation and application of digital technology, it has become an obvious trend to use computer graphics, virtual reality (VR), augmented reality (AR), computer animation and other technological means to present national intangible culture through digital storage, retrieval and display (Ch'ng, Cai, Leow, & Zhang, 2019; Yu & Cui, 2021). The protection and effective development of intangible cultural heritage, realizing all-round and three-dimensional digital information transmission, as well as multi-sensory interactive experiences such as sight, hearing, and touch, effectively broadens the path for inheritance and enhances social influence (Zhuang, 2021).

Costumes are an intuitive expression of national self-cultivation and spiritual outlook. Their unique beauty is also essential to sharing pleasure and artistic inspiration for creativity(Kang, Cassidy, Cassidy, & Li, 2015). Visitors can only view the restricted and protected collection of valuable old costumes and textiles through the windows using the old exhibition methods. With the popularity of human-computer interaction technology, three-dimensional virtual presentation, and the new mode of clothing culture propagation through mobile clients, more comprehensive sensory experiences are provided to the public (Jiang, Guo, & Ma, 2017; Martin & Mauriello, 2013). This has become an effective way to inherit and recreate costume culture. Scholars pay attention to the technical aspects of digital costumes and explore the possibility of virtual simulation in reproducing historical costumes(Jiang et al., 2017; Villarreal, 2020). Some studies have applied two-dimensional and three-dimensional software to create digital replicas of costumes from historical sources and to assess the similarity between historical prototypes and their replicas(Kang et al., 2015; Moskvin, Kuzmichev, & Moskvina, 2019). Liu's latest research results, with the help of CLO3D software to complete

the costume archaeology and digital restoration of the figures in the Tang Dynasty's paintings(Liu, Lu, et al., 2022; Liu, Wu, et al., 2022; C. Zhu et al., 2022). In conclusion, digitalizing historical costumes is a contemporary multidisciplinary research field combining cultural studies, science-based reconstruction methods, and virtual reality(Moskvin et al., 2019).

A unisensory interface stimulates only one sense, while a multi-sensory interface involves multiple senses (e.g., sight, hearing, touch) (Mishra, Shukla, Rana, & Dwivedi, 2021). Immersive technologies such as VR and AR are cutting-edge in providing users with unique multi-sensory digital experiences(Spence, Puccinelli, Grewal, & Roggeveen, 2014). China has carried out the digital transformation of cultural products based on the digitalization of museums but there is still a gap between the practice and exploration of digital fashion for traditional costumes and other collections (such as porcelain and bronze ware). The content of this paper is organized as follows. First, this study reviewed relevant concepts through literature reviews, such as the realization process and technical means of intangible cultural heritage digitization, and the contents and methods of digital protection for traditional costumes. Secondly, combined with five typical cases in China, we summarized the specific methods of reshaping traditional costume cultural heritage with digital means to improve users' sensory cognition. The third part introduced one of our ongoing research and its digital protection ideas and development strategies. Finally, the academic and practical implications are discussed.

Intangible cultural heritage, traditional costume and digital protection

The digitization of intangible cultural heritage (ICH)

UNESCO's 2003 Convention defines the concept of Intangible Cultural Heritage (ICH) and divides it into five categories (UNESCO, 2003). China has further divided ICH into ten categories(Chinese Cultural Studies Center, 2008). Some scholars have integrated and concluded according to the research needs. For example, Lv *et al.* proposed that ICH can be divided into three major modules: traditional performance, traditional skills and culture(Lv & Zhang, 2016). It is unreasonable to use the dualism of tangible and intangible as the criterion for dividing the material and intangible cultural heritage(Carboni & De Luca, 2016). Because ICH contains both tangible and intangible material and behavioral meanings.

Digitalization has become one of the main ways to protect and spread ICH. The digitalization of ICH is to transform, reproduce and restore the contents of ICH into a shareable and renewable form by using digital collection, storage, processing, display and dissemination technologies (Ma, Tu, & Xu, 2019; Wang, 2009). The ICH's digitalization in China has experienced three historical stages of " in database " (2005-2012), " being online " (2013-2016), and " in presence " (2017-present), and has formed digital feature forms, communication and user experiences(Quan, 2022; Wen & Zhao, 2022). According to the characteristic of dynamic and static, the digitalization of ICH can divide into three categories: dynamic art (oral tradition and performing art), static art (craft skill), and space-time art (festival ceremony)(Ma et al., 2019). An analytical framework should account for the range of visible and invisible objects under the constraint of a context-dependent action in a universe of symbolical and collective representations and enable the digital processing of physical and immaterial levels (Fig. 1)(Carboni & De Luca, 2016; Ma et al., 2019; Staab & Studer, 2010).

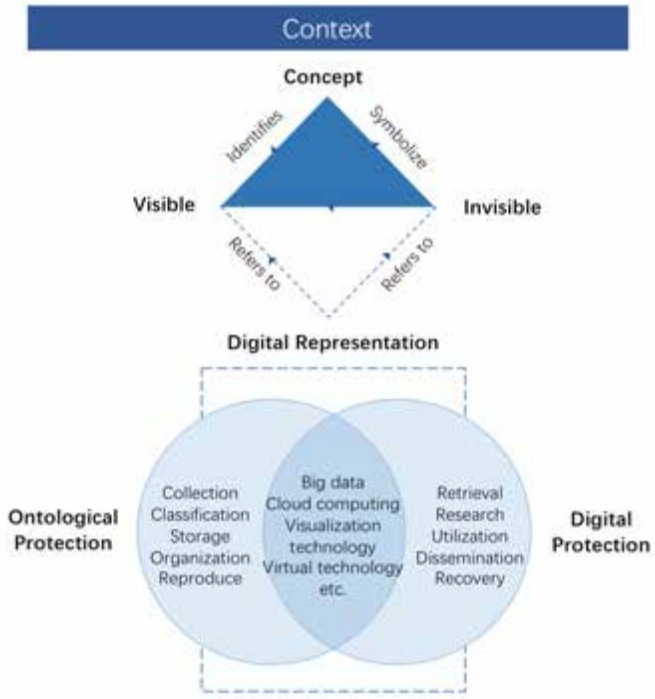

Figure 1. The process analysis and coding system construction of the digitization of ICH.

The technical means and presentation methods of digital protection of ICH

Integrating cultural heritage and digital technologies has produced many concepts. Ma *et al.* (Ma *et al.*, 2019) differentiated ICH digital technologies between basic e.g., pictures, text, video, and audio, and emerging e.g., the application of 3D scanning, VR, AR, and motion capture technology, the latter providing more technical means to digitalizing ICH. Both technologies utilize various new media carriers to digitally display ICH. Some researchers have summarized and classified the exhibition types of ICH. For example, Huang *et al.*(Y. Huang & Tan, 2012) believed there are five presentations: traditional information type, mechanically controlled type, interactive touchscreen type, sensor-based interactive type and virtual-reality-based experiential type. In terms of the digital communication mode of ICH, mass media, digital collection, and Internet-based are the main modes of communication at present, with immersion communication as a supplement to the previous three(Tan & He, 2021). ICH encompasses a variety of types, cultural connotations, and categories. Therefore, digital displays need to adopt appropriate and varied media technologies in order to accurately display information about cultural relics and convey their intangible elements such as value and spiritual connotation (Ma *et al.*, 2019).

The contents and presentation of digital protection of traditional costumes

Traditional costume collections found in handicraft and folk art are an important ICH and reflect a culture's social life. Cui et al. (Cui, Niu, & Wang, 2019) pointed out that traditional costume as a cultural expression can be seen in three contexts: material, social, and spiritual. Based on these contexts, our research constructed an overall framework of digital display

design of traditional costumes (Fig. 2). The flexible use of digital technology improves the effectiveness of the transmission of information about traditional costumes and enhances the audience's knowledge, viewing experience, and sensory perception of that interaction.

The traditional costume should focus on the organic combination of ontological and digital protection. To date, the ontological protection has been quite adequate. The digital protection of traditional costumes should focus on the dynamic presentation of invisible factors, such as traditional skills, the production process, and various attributes of cultural value and spiritual connotation. The display media for digital protection of traditional costumes are based mainly on public culture platforms, PC network platforms, mobile intelligent devices, and social networks (X. Zhang, 2015). For example, digital museums and digital databases, as necessary digital operating forms, are also introduced into the clothing field. Research has been conducted on making and restoring traditional Chinese clothing with 3D virtual technology, such as CLO3D, Style 3D and Style Fabric (Liu, Lu, et al., 2022; Tong & Li, 2021; W. Zhang & Ma, 2021). VR technology is essential for both revitalizing intangible values of ICH and comprehending those intangible values. It also allows for the understanding and reproduction of the relationship between tangible and intangible values in each context (Karakul, 2022).

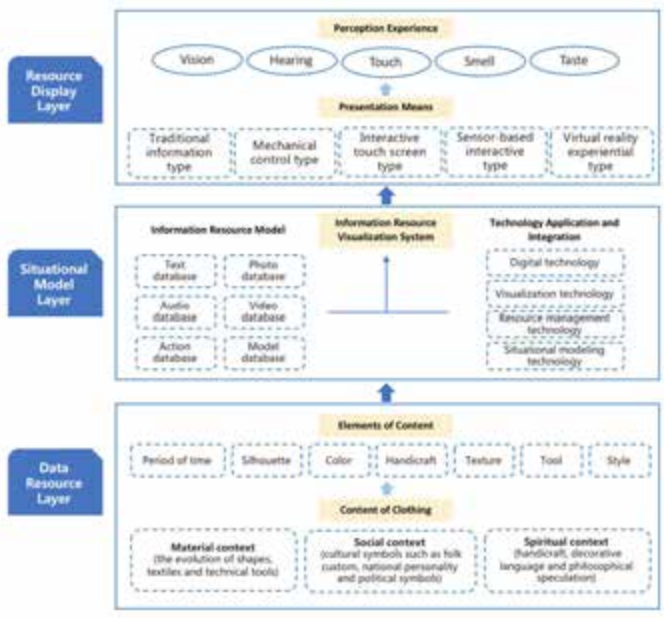

Figure 2. The model of digital display design of traditional costumes.

Innovative application of digital protection of traditional costumes: Methods and case studies

Case 1: "Palace Embroidery and Costume" project in the Palace Museum

In addition to using traditional media to display intangible cultural heritage, museums, art galleries, and other public cultural platforms integrate digital means for display(X. Zhang, 2015). The Duanmen Digital Pavilion is composed of the virtual digital form of the Palace Museum's cultural relics, including paintings, interior furnishings, costumes, embroideries, ancient architecture and so forth(M. Huang, 2016). Using the interactive display of "Digital Court Costumes" with human posture recognition technology and Kinect motion-sensing control technology, visitors can virtually try on Qing Dynasty court costumes through interactive equipment (Fig. 3). This interactive feature allows users to appreciate and understand their artistic features and institutional norms, thus deepening their knowledge of traditional costume culture. In the "Digital Palace Embroidery Paintings" project, visitors can use touch screen linkage Ventuz technology to gain an understanding of the imperial embroidery painting process and to observe traditional skills such as embroidery. In conclusion, interactive multimedia, with its sensory participation experience, is the platform whereby visitors more easily understand the historical aspects of cultural relics collections.

Case 2: Ethnic Costumes Museum of Beijing Institute of Fashion Technology

Major comprehensive museums or museums focusing on costume collections have realized the importance of building a web-based digital museum with the Internet and digital technology for online communication, dissemination and protection of intangible cultural heritage(Wu, Jiang, Liang, & Ni, 2022). The Ethnic Costumes Museum of the Beijing Institute of Fashion Technology holds more than 10,000 pieces of traditional cultural relics, such as national costumes, fabrics, embroideries and silver ornaments(Beijing Institute of Fashion Technology). The Museum has a digital database of ethnic costumes based on design and application, thus providing an opportunity for researchers and lovers of costume culture to gain a greater understanding of the subject. The Museum's Ethnic Costume database displays the clothing of 36 ethnic groups in China. Among these, the Han costume section includes 291 pieces of short jackets, long gowns, single trousers, horse-face skirts (Fig. 4), and cloud shoulders. Each collection piece has detailed descriptions (basic properties, collection information, material technology) and pictures (overall silhouettes, details, cutting drawings). Using short videos and animations, the Museum's three other databases display 32 pieces from ancient collections, introduce 91 typical costume materials and techniques, and show the

Figure 3. The digital project of the Palace Costumes.

Figure 4. The display online of digital database for ethnic costumes.

production details and wearing process. The digitalization of the Ethnic Costume Museum has broadened online access to valuable resources, thus enabling historical costume lovers and researchers to further their learning and stimulate their positive attitude toward cultural heritage.

Case 3: The art visualization network platform of Guizhou ethnic minorities

Taking the excellent traditional culture and art of 17 ethnic minorities in Guizhou who have lived for generations as the research object, this project classified and displayed them in digital ways by integrating internet information technology and big data(Guizhou Minzu University). Four mobile apps have been built with AR interactive displays and interactive wearable experiences to allow users to view ethnic costumes, silver jewellery, architecture and opera. When opening the "Guizhou costume" program (Fig. 5), users can select the representative costume through the left and right arrows and understand its basic shape and patterns by rotating the 3D model. In addition, app users can learn the cultural connotation of the traditional costume by reading the accompanying text description when they click the model. Interestingly, AR technology can be used to create a virtual scene with interactive characteristics by first scanning the ground and then combining costumes, characters, and scenes in a self-selected background. This, too, is available just with a click, on the circular icon in the upper left corner of the home page. This process helps users obtain a more comprehensive sensory experience of traditional costumes (Fig. 5). This project also built a virtual simulation platform of Miao embroidery, where visitors can learn Miao embroidery skills at any time by following an on-screen step-by-step animation simulation. Therefore, the interactive experience of the AR interface can help users better imagine what these historical costumes may have looked like, thus increasing their enthusiasm for learning traditional costumes.

Figure 5. 3D model and AR experience of the Miao nationality's costume for the festival.

Figure 6. The design of the traditional costume game skin in The Magic Blade.

Case 4: The series of digital costume design in Liangyuan Hanfu and Huaxia Nishang

Digital costumes are commonly known as skins in the game industry. Skins are one of the tools used by players to decorate their avatar to achieve a unique and personalized aesthetic expression of the player, rather than just a simple graphic symbol(Makryniotis, 2018). Louis Vuitton, Burberry, and other luxury brands have cooperated with game companies to design costumes for game characters and produce gamified digital marketing. Currently, historical costume elements are also introduced into digital fashion to promote the sustainable development of traditional costume culture. In 2021, the TV program "Dress China" cooperated with the designer, Guo Pei, and the game "The Magic Blade", leading to the design of a series of Chinese-style costumes in the theme, "Floral Scrolls with Mandarin Duck". This pattern represents the beauty of good marriage (Fig. 6). These costumes are reproduced by digital art, so young people can enhance their perception of the beauty of Chinese-style costumes when playing games. Gamification is a design strategy that improves users' experience. Fu *et.al*(Fu & Liang, 2022) said traditional costume skins could build emotional bonds between game users and game characters, stimulating players' curiosity, imagination and exploration and enhancing their cultural identity in the real world and well-being in the virtual world. Museums and costume-oriented cultural organizations have also formed a new creative mode that can be shared(Wen & Zhao, 2022). In 2022, the magazine, Chinese fashion, and the digital collection platform, Changong, launched a series of digital traditional costume collections of "HuaXia Nishang" from the Tang, Song, Ming, and Qing Dynasties in which users can virtually try on costumes(Qing, 2022). Overall, the combination of online games and traditional costumes can be seen as an attempt to lead modern fashion consumption and the sustainable development of traditional Chinese costumes in a digital way.

Figure 7. Costume interactive program through a visitor touch screen.

Figure 8. The virtual exhibition hall of the "Yiguan Dacheng: The Costume Culture Exhibition of Ming Dynasty" and 3D virtual costume models.

Case 5: Digital preservation and utilization project of relics collected by Shandong Museum

Clothing from the Confucius Mansion is the symbol of the Ming Dynasty costume culture and, as a result, is rich in information about the Dynasty's intangible elements and hierarchy regulations. In 2022, one important part of the "Digital preservation and utilization project of relics collected by Shandong Museum" was "Yiguan Dacheng: The Costume Culture Exhibition of Ming Dynasty". This undertaking digitally protected more than 40 pieces or sets of historical costumes which have been collected by Shandong Museum, spanning a range of silhouettes, details, and textiles. This project consists of three steps: high-definition photo shooting; three-dimensional data acquisition and processing; and, pattern extraction(Z. Zhu & Zhou, 2020). Information mapping, the most crucial aspect of digital protection, maps the detailed structure and color texture collected by the HD camera in the first step to the modeling results from the second step. The result is a three-dimensional model with complete information. This project differs from the other project's noted above because its displays are comprehensive and use a variety of technical means and display media for representation and communication. For example, the large-screen interactive program set up in the physical museum (Fig. 7) can present costume information through a visitor touch screen. The exhibition also designed a touch screen version of silk fabric to enhance tactile perception(An & Chen, 2022). Additionally, there is an animated display showing when and how traditional costumes were worn by those living in the Confucius Family Mansion. The animation enhances the audience's visual and auditory senses, leading to a deeper understanding of the meaning of each traditional costume. Elsewhere, visitors can experience a virtual tour of the virtual exhibition hall(Fig. 8). More interestingly, visitors can click the costume picture to watch the high-definition 3D virtual costume model and learn about the costume's pattern, wearing rules, and meaning. In summary, this project uses digital deduction and engaging interactive experiences to entertain visitors and advance their aesthetic perception and knowledge.

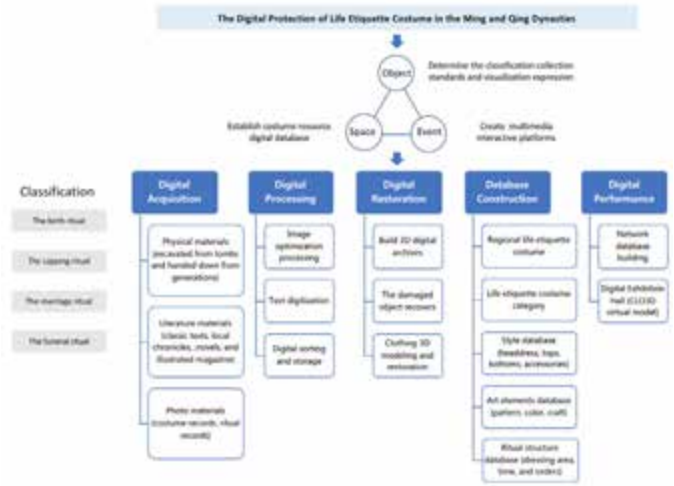

Figure 9. Digital protection countermeasures of life etiquette costume in the Ming and Qing dynasties

Exploration on the path of the digital protection of traditional costumes: Taking the Life Etiquette Costume in Ming and Qing Dynasties as an example

Life etiquette is a vital yet intangible part of folk culture heritage, constituting a symbolic cultural space created from folk costumes, rites, rituals, and beliefs. It is generally believed that the four transitional rites held at the critical point of life stage of birth, adulthood, marriage and death are called "life etiquette", which is an important "rites of passage"(from Arnold van Gennep(Gennep, Vizedon, & Caffee, 1961), French ethnographer and folklorist). A person's life etiquette costume is the clothes they wear during the four critical stages of life (birth, adulthood, marriage and death). As carriers of ritual activities, life etiquette costumes play an important cultural intermediary role. They contain rich artistic aesthetics, folk connotations and cultural characteristics. Changes in social environments, norms, and rituals, have led to the disappearance of the rituals and costumes that represent traditional life etiquette. In the complex and multiple modern context, especially the era background when the government emphasizes the importance of strengthening national etiquette education in China, the contemporary inheritance and practical transformation of traditional life etiquette costumes have attracted the attention of many aspects. The use of digital technology in the information age may give life etiquette costume "new life" and provide strong support for the dissemination, protection and development of traditional clothing cultural resources. Therefore, this study proposes a path for the digital protection of life etiquette and costume culture in the Ming and Qing Dynasties through the use of "object (costume)", "event (narration)", and "space (experience)" (Fig. 9). Before building the database, digital acquisition (e.g., literature and images), digital processing (e.g., image optimization) and digital restoration (virtual restoration and multidimensional display) are necessary for life etiquette costumes. The overall framework of the database classifies and sorts the corresponding life etiquette costumes according to the life etiquette categories and ritual structure and then summarizes the primary sorts, typical styles and collocation ways in the dressing lines. Hopefully, this approach of presenting the results of both the literature review and research on life etiquette costumes will provide a model for contemporary dress codes and design guidelines.

Discussion and conclusion

A field of research is currently exploring how best to effectively combine intangible cultural heritage with emerging digital technologies so that user interactions are optimized. A summary of the results are as follows:

1 This study contributes to the literature on the application of digital technology in the digital conservation of ICH and traditional costume relics and the role of providing a multisensory user experience. This study summarized the basic concepts, primary technical means, and presentation media of intangible cultural heritage digitization through literature reviews. Compared with unisensory interfaces, multisensory interfaces provide vividness and interactivity for users in a sensory-rich environment(Flavián, Ibáñez-Sánchez, & Orús, 2019). Based on this, from the perspective of costume culture communication, this study built an overall framework for the digital display design of traditional costumes. The application of digital technologies (such as AR, VR and 3D virtual) expands traditional displays. It visualizes the projection of the real world and the physical environment, promoting information search and reducing the cognitive burden of users.

Table 1. Overview of innovative application cases of digital protection of traditional costumes.

NO.	Title of the case	Display media	Display mode
Case 1	"Palace Embroidery and Costume" pro-ject in the Palace Museum	Public culture platforms	Multimedia interactive application
Case 2	Ethnic Costumes Museum of Beijing Institute of Fashion Technology	PC network platforms	Digital image presentation
Case 3	The art visualization network platform of Guizhou ethnic minorities	Mobile intelligent de-vices	AR interaction scene construction
Case 4	The series of digital costume design in Liangyuan Hanfu and Huaxia Nishang	Social networks	Gamification design and development, network media display
Case 5	Digital preservation and utilization project of relics collected by Shandong Museum	Public culture plat-forms, PC network platforms, mobile intelligent devices and social networks	Network media display, 3D virtual simulation, multimedia interactive application, digital animation innovation

2 This study selects 5 typical cases to explore methods of traditional costume relics' digital protection and their adapted digital media and modes (Table 1). The research shows that the digital communication mode based on public culture and PC network platforms is the most common way to promote knowledge learning and sensory attraction. Creating AR interactive scenes changed the costume display for users, effectively improving users' interest and visual perception. Integrating traditional costume elements into gamification design and digital collections will become new tools for museums and cultural institutions to expand the spread of costume culture. Case 5 shows a relatively comprehensive digital communication system for the intangible cultural heritage of a costume. Dynamic forms of multiple senses can create higher visual and emotional attraction to enhance the interactive experience and improve users' cognition and understanding of costume culture.

3 Taking the life etiquette costume of the Ming and Qing Dynasties as the research object, this study discusses the technical path and development strategy of digital protection and constructs the overall framework of the database from the direction of "object-event-space". The communication of traditional costumes needs to include the activity field matching them. Computer graphics technology and 3D clothing software provide the opportunity to realize the image, product and space virtualization of traditional costumes and improve users' perceived visual and emotional attraction to a greater extent. More importantly, digital practice is beneficial to the protection and promotion of life etiquette costume, such as promoting understanding and acceptance of traditional culture or fostering national pride in younger generations and providing inspiration for relevant designers or enterprises in product design.

Digital design content is regarded as the expression of technology, but it is worth paying attention to how to use technology to design and establish effective information dissemination channels. Through the analysis of typical cases, the results of this study aim to help museum managers, organizers and designers better understand the application status of intangible cultural heritage digitization and provide valuable strategic insights into the development, application and promotion of the multisensory interface experience of traditional costumes extended by digital technology. Further studies should adopt quantitative research to compare users' responses to the digitalization of costumes between haptic and multisensory interfaces. Additionally, the role of different levels of users' attitudes and behavioral intentions in a multisensory environment should be explored.

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Designing sustainable furniture: guidelines to promote furniture life cycle design

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Abstract

Given the serious environmental impact of the furniture system, the role of design in innovating furniture products toward sustainability is increasingly recognized as a key leverage, as acknowledged by the European Union's Circular Economy Action Plan in 2020. The need for sustainable design knowledge to address environmental issues caused by the life cycle of furniture products – a fundamental part of the furniture system – has now been prioritized. Despite the fact that Life Cycle Design (LCD) is widely studied as a systematic approach that considers all life cycle stages and engages the objectives of reducing environmental impacts, its application within the furniture system is still very limited. Within this framework, the paper presents furniture-specific LCD guidelines to guide sustainable furniture design. These guidelines were developed through an established methodology involving scholars and specialists on both Design for Sustainability and Furniture Design, and were the results of a research project funded by the Italian Ministry of Education (MIUR), aimed at developing and disseminating innovative design strategies and guidelines to foster a sustainable and circular economy within the furniture industry. In this sense, these guidelines will promote long-term open innovation and technological transformation of furniture products, allowing designers and organizations to support the implementation of sustainable options from the beginning of the design process.

Author keywords

furniture design; Life Cycle Design; design guidelines; sustainable design.

Introduction

Furniture has recently been identified as one of the key sectors that should be addressed and improved to achieve more sustainable development (European Commission, 2020). Estimated by the Centre for Industrial Study (CSIL), total global furniture production in 2019 was US$490 billion, exportation was US$160 billion, and consumption was US$477 billion (CSIL & CNFA, 2020), resulting in huge resource consumption, harmful emissions and waste generation. Each year, 10.5 million tons of furniture are produced in the European Union, with 10 million tons of furniture waste generated, accounting for more than 4% of municipal solid waste in the European Union (EU) (Forrest et al., 2017). These impacts could also be seen throughout the life cycle of furniture, including pre-production, production, distribution, use and disposal (González-García et al., 2019).

The role of design

The importance of design in innovating furniture products for sustainability is becoming more widely recognized. Up to 80% of a product's environmental impacts are determined during the design phase (European Commission, 2020), emphasizing the importance of sustainable design knowledge in addressing major environmental issues associated with the furniture life cycle. Indeed, addressing environmental concerns early in the design process is more efficient than retroactive actions, as it avoids costly and dangerous operations to reverse or limit the damage. Looking at the overall design scene, although disciplines like environmentally sustainable product design or LCD are widely studied, their application within the furniture sector is still quite limited. Furniture LCD is the design of the furniture life cycle stages that aims to minimize the overall environmental impact of all life cycle processes concerning the functional unit (Vezzoli, 2018). Two major approaches, in particular, must be introduced. The first is the life cycle thinking approach, which means shifting from furniture design to the design of furniture life cycle stages, i.e. considering all processes required to produce, distribute, use and dispose of materials and furniture. The second approach is the functional unit approach, i.e., considering the function of the furniture rather than the physical furniture itself during design and impact evaluation.

The development of furniture-specific LCD guidelines

In this scenario, the paper presents innovative furniture-specific LCD guidelines. The development of furniture-specific guidelines was carried out as part of more than two decades of research of LeNSlab Polimi, a research group within the Design Department of Politecnico di Milano, working on Design and system Innovation for Sustainability (DIS).

In particular, the current contribution is based on the results of the research project_The Circular Economy for the competitiveness of Made in Italy industry - GIOTTO, which was funded by the Italian Ministry of Education and Research (MIUR) in collaboration with eleven national organizations. The project aimed at developing and disseminating innovative design

guidelines and tools to promote and implement a sustainable and circular economy within competitive value chains of Made in Italy, i.e. furniture, food and fashion. Through a multidisciplinary and complementary research consortium, GIOTTO contributed to empowering small and medium enterprises with innovative approaches to minimizing the environmental impact of their products throughout their entire life cycle. Within this context, , LeNSlab Polimi led research activities aimed at defining specific Life Cycle Design strategies and guidelines to guide the development of environmentally sustainable furniture products.

Method: from general to furniture-specific LCD guidelines

The approaches and processes for developing specific LCD guidelines from general ones have well-established roots. Over two decades of research and consultancy activities carried out by LeNS lab Polimi gradually led to the definition of a structured and validated methodology (Vezzoli & Sciama, 2006). This study was carried out with the method as illustrated in figure 1.

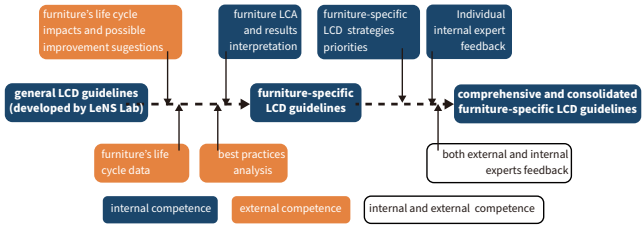

Figure 1. Prior knowledge and steps to develop furniture-specific LCD strategies/ sub-strategies/guidelines, adapted from (Vezzoli & Sciama, 2006).

The project started with a preliminary phase of desk research to uncover the most updated knowledge about the environmental impact of the furniture life cycle. On one side, a critical review of available literature was conducted to analyze previous evaluations of furniture's environmental impact, i.e. Life Cycle Assessment.

On the other hand, a detailed analysis of best practices from an environmental standpoint was conducted to provide inspiration for subsequent collaborative sessions when elaborating on furniture-specific LCD guidelines. The first stage produced an overview of the environmental impact of furniture's life cycle stages and best practices representing promising designs. Results from these research actions represented the framework to facilitate the successive step within the GIOTTO project, aimed at moving from general LCD strategies and guidelines toward the definition of furniture-specific version to reduce the overall environmental impact along furniture's life cycle.

The specification process was carried out through a collaborative workshop that involved scholars and experts on Design for Sustainability and Furniture Design, with the goal of generating a preliminary draft of furniture-specific LCD guidelines. The findings of the literature review and case study were presented as a context introduction. The workshop's main activity, the guidelines specification, was then completed. During this phase, a structured process was implemented for each general guideline, allowing participants to perform a variety of specification actions such as: integrating a general guideline related to particular furniture products or typology; adding a new guideline that deals with a certain environmental impact related to particular furniture products or typology; adding notes related to particular furniture product or typology; and erasing a guideline if irrelevant. The outcome of the workshop was a draft of furniture-specific guidelines, which was further reviewed and refined to integrate final improvements. Please see table 1 for a more specific example of the shift from general to furniture-specific Life Cycle Design guidelines.

Table 1. An example of generating furniture-specific strategy, sub-strategy and guideline from general ones

General strategy, sub-strategy and guideline	Furniture-specific strategy, sub-strategy and guide-line
Strategy: Product lifespan optimization	**Specific strategy:** Furniture use extension and intensification
Sub-strategy: Facilitate repairs	**Specific sub-strategy:** Facilitate/enable furniture re-use and remanufacturing
Guideline: Arrange and facili-tate disassembly and re-attachment of easily damageable components.	**Specific guideline:** Facilitate disassembly, especial-ly for parts that are easy to wear out, such as task chair wheels and back, up-holstery and desk surfac-es, using reversible connections or a two-way snap-fits system.

Furthermore, proper identification of LCD strategy priorities (the degree of relevance of various strategies) that take function into account is crucial for guiding design efforts. It is assumed that some strategies have greater priorities than others for each product, whether a car, a piece of furniture or something else. For furniture, for example, extending the lifespan is more important than reducing resource consumption, whereas reducing the resource consumption is more important for a car which consumes energy while in use. As a next step, a priority indicator was defined for each of the 6 design strategies based on their potential for environmental improvement (compared to the other strategies), based on the life cycle environmental impact of furniture defined in the first stage.

Results

Furniture's environmental impact along the life cycle

The **Pre-production** stage incorporates the impact associated with the acquisition of resources, delivery to the production area and raw materials preparation. If take wooden furniture, which has a significant proportion of total furniture consumption (Forrest et al., 2017), as an example, an average production of 1 m3 particle board consumes a total of 759 kg of materials and 507 MJ energy (González-García et al. 2019). The overuse of resources may cause resource depletion or deforestation. Chemical use is a critical source of hazardous emissions. For example, formaldehyde is a sensory irritant that, depending on the concentration in the environment and exposure time, can cause health problems for workers and users, such as eye, skin and respiratory allergic reactions (Liu et al., 2012). The **Production** stage includes all activities such as raw materials processing, components and package production, furniture assembly and other finishing processes, like polishing and painting of solid wood-made furniture. The cutting, punching and sanding processes generate solid waste such as sawdust, metal and plastic residues. The assembly, finishing and coating processes use adhesives and coatings which consist of resins, pigments, sol-

vents, additives and diluents, may emit Volatile Organic Compounds (VOCs) such as alcohols, olefins, ethers, alkanes and aldehydes, as well as wastewater containing sulfide, chlorine, alcohols, olefins, alkane (Cheung et al., 2017). VOCs will harm the environment and human health (Berrios et al., 2005). The **distribution** stage is concerned with furniture packaging and transportation to a warehouse or end users' location via truck, train, ship or even plane. These activities necessitate not only the use of energy for transportation but also the use of resources to manufacture and store the means of transportation. The **use** phase, which may consume water, detergent and electricity, has low environmental impacts (Donatello et al., 2017). However, it is still an important stage that must be considered because it has the potential to extend the lifespan, reducing the environmental impacts per functional unit in the long term. The **Disposal** stage includes different scenarios. In the EU, 80-90% of furniture waste is incinerated or disposed of in landfills, with 10% recycled (Donatello et al., 2014). Many furniture products become obsolete before the actual end of their functional lifetime. This is due to various factors such as relocation, furniture inadequacy after renovation, expansion of premises or new staff, and changes in the interior or corporate design – the latter resulting in perfectly functional furniture being disposed of for aesthetic reasons. Frequent office furniture replacement contributes to increased solid waste production, requiring more landfill space (Besch, 2005). Landfill disposal may generate methane and groundwater pollutants, while incineration generates toxic ash and causes air pollution (Ulrich & Eppinger, 2012).

Last but not least, consumption of non-renewable fossil fuels such as coal, natural gas and diesel oil occurs throughout furniture's life cycle for raw materials production, transportation or electricity generation releases CO2, CH4, CF4, C2F6, SO2, HF, NOx, CO, particulate matter, etc., may contribute to Global Warming (CO2, CH4, CF4, C2F6), Acidification (SO2, HF, NOx), Photochemical Ozone Creation (SO2, CO, NOx), human toxicity (NOx).

Many furniture LCAs (scientific papers and company Environmental Product Declarations) compares the environmental impact of furniture's life cycle stages (Wenker et al., 2018; Babarenda Gamage et al., 2008; Plaschke, 2019). Results indicate that the highest environmental impacts occur during the pre-production stage; The production stage is the second one, followed by the distribution, disposal and use stages; the pre-production stage has more significant impacts than all the other stages.

Furniture best practice analysis

Sustainable furniture best practices were investigated to discover innovative design interventions and long-term sustainable benefits and characteristics. 41 case cards (from 32 brands) were created. These case cards were used directly for brainstorming or as examples of design guidelines developed in the following stages. See an example in figure 2.

Furniture-specific LCD strategies (with priority), sub-strategies and guidelines

As a result of the research, furniture-specific LCD guidelines were developed, which include 6 strategies, 21 sub-strategies and 141 guidelines to stimulate and guide the generation of environmentally sustainable ideas. Table 2 shows an example of the hierarchical structure of each strategy, which contains several sub-strategies and additional specific guidelines.

Each of these 6 strategies was assigned a priority indicator – very high, high, medium, low and very low – which refers to the potential environmental burden reduction associated with each LCD strategy. ***Furniture use extension/intensification*** (very high priority) is to reduce the environmental impact of furniture and components by extending or intensifying the lifespan. ***Reduce material consumption of furniture*** (high priority) aims to reduce material use throughout the life cycle by avoiding extraction, processing, transportation and disposal. ***Furniture materials life extension*** (middle priority) seeks to extend the lifespan of furniture materials through recycling or composting. ***Resources conservation/bio-compatibility*** (low priority) aims to use renewable or inexhaustible resources (energy and materials). ***Reduce toxicity of the furniture system*** (very low priority) aims to choose materials or processes that minimize harmful substances emissions throughout the life cycle. ***Reduce energy consumption of the furniture system*** (very low priority) means reducing energy use throughout the life cycle.

Table 2. A furniture-specific strategy with sub-strategies and guidelines.

Strategy: 1. furniture use extension/intensification

Figure 2. A case card of sustainable furniture product (own elaboration)

Sub-strategies
1.1 Facilitate furniture maintenance;
1.2 Facilitate furniture upgrading and adaptation;
1.3 Design furniture for reliability;
1.4 Facilitate/enable furniture re-use and remanufacturing
1.5 Intensify furniture use

Guidelines: 1.2 Facilitate furniture upgrading and adaptation
1.2.1 Design reconfigurable furniture that is able to adapt to different spaces/situations, such as modular desks and storage structures that can be used for both the transformation of a given space or for a new function.
1.2.2 Design a family of products instead of single ones, with different properties and functions that enable adaptation.
1.2.3 Include add-on parts to transform and/or upgrade functions and properties.
1.2.4 Avoid premature aesthetic obsolescence by designing furniture that can be customized (e.g. exchangeable seat covers).
1.2.5 Consider designing multi-functional products that can adapt to the user's development (physical and cultural).
1.2.6 Design modular and on-site upgradable furniture, allowing the user to substitute with standard tools, for example, fixed feet with wheels or fixed components to adjustable ones.
1.2.7 Include multiple connection possibilities on tables and storages, e.g. electricity cables, joints to combine table surfaces, etc.
... a total of 13 sub-guidelines...

All furniture-specific LCD guidelines were eventually integrated into one of the main outcomes of the GIOTTO project - the MIUR manual "Handbook for sustainable furniture system design", which was conceived as an operative tool to enhance the application of the furniture Life Cycle Design, specifically aimed at guiding designers and companies toward environmentally sustainable furniture design and innovation. The handbook is available and open access on LeNS International's 'tools' section (http://www.lens-international.org/).

Conclusion: furniture-specific LCD strategies and open innovation

The primary contribution of this research is a set of furniture-specific product LCD strategies, sub-strategies and guidelines with best practices. The main innovation are the development of 21 furniture-specific sub-strategies and 141 guidelines that will significantly contribute to reducing environmental impact along the furniture's life cycle.

A second innovation lies in the priority assigned to each strategy, i.e. i.e. the level of environmental impact reduction achieved by implementing the strategy, which is crucial to improve the efficiency during the design process.

A handbook that integrates all these outcomes is currently being distributed worldwide through the Learning Network on Sustainability (LeNS), an international network that connects over 150 higher education institutions and organizations, with the goal of developing and disseminating the Design for Sustainability (DfS) discipline in worldwide curricula with a multipolar, open and copyleft ethos. Moreover, the handbook is being used in international master courses, as well as subjected to implementations and improvements to foster a collaborative and open innovation logic in the furniture sector. Indeed, even though the phenomenon of open innovation is now well-established and widespread in several disciplines (Gassmann, Enkel, & Chesbrough, 2010), the same cannot be said for the majority of sustainable furniture knowledge innovation. The handbook can represent a key resource for designers and organizations to support the implementation of sustainable choices at the early stages of the design process.

Reflection

These strategies, sub-strategies and guidelines have been developed for general furniture, but specific guidelines tailored to each type of furniture may be necessary for optimal effectiveness in real design practice. Since the outcomes of this research are open access, other groups of researchers and companies can develop more specific guidelines for individual furniture types.

The research contributes to 'Design for transformation' in the scope of the furniture sector. The design guidelines facilitate 'systemic & strategic problem solving' by supporting the furniture LCD at early stages to reduce the environmental impact throughout the life cycle.

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Biophilic design for remote studying environments: analysis of case studies involving a collaboration between ergonomics and environmental psychology

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Abstract

In our post-industrial society, although the remarkable technological advancement allows us endless possibilities, the maturity of the debate on environmental sustainability requires new design, production and consumption strategies, and a radical revision of the concept of development. Our lifestyles increasingly lead us to spend much of our time indoors, and this condition, exacerbated by conflicts and pandemic, has turned the spotlight on the importance of accessibility to the natural environment, put in risk by growing urbanization and global urban population, the upscaling of environmental degradation and the challenges posed by climate change. In this context, Designers are challenged to question new ways of establishing connections with nature that will contribute to mitigate, cope, and adapt to environmental and societal challenges while at the same time helping people to develop new capabilities in their given contexts. Biophilic Design emphasizes the need to maintain, enhance and restore the beneficial experience of nature in the built environment. Even if it's based on scientific evidence from several studies in the fields of psychology, medicine and social sciences, which demonstrate that exposure to natural environments or related elements has a positive impact on human health, further reflections are needed on how these inputs can be embodied in environments and artifacts by the Design disciplines. Based on these assumptions, the theme of the Psychology and Cognitive Ergonomics course within the bachelor's degree program in Industrial Design at Sapienza University of Rome was developed. Through an interdisciplinary approach Human-Centred Design and Environmental Psychology were combined to enquire about the use of biophilic elements within remote studying environments, a widely used practice following the closures of schools and universities caused by the Covid-19 pandemic. A combination of methods and tools from both disciplines were used to test Biophilic Design hypotheses that, on the one hand, ensure optimal ergonomic usability and, on the other hand, through their regenerative qualities, promote psychological well-being and reduce stress symptoms related to remote study activities and social isolation. The analysis of these case studies allowed us to reflect on Biophilic Product Design and their role in remote studying environments. We conclude by advocating the use of interdisciplinary practices in which Design, combined with Environmental Psychology becomes a promoter of more desirable domestic environments and of a future in which a symbiotic relationship with nature is established.

Author keywords

Biophilic Design, Human-Centred Design, Remote Studying, Environmental Psychology

Introduction

The growing urbanization and the continuous increase of the world's urban population have led to a direct and indirect (McDonald et al., 2020) impact on biodiversity (Turner et al., 2004). Environmental degradation and the challenges of climate change make access to greenery and nature a restricted privilege. In today's 'indoor generation,' most human activities occur within an enclosed space (Kelly & Fussel, 2019). This condition has been further exacerbated by the conflicts our society is experiencing and the global pandemic. Following the drastic incidence of Covid-19 since March 2020, the Italian government has implemented strict measures to stem the pandemic spread through rigid lockdowns. Since the pandemic, the world of work has radically changed, with a massive reliance on remote working for all those activities that did not require an unavoidable work presence. However, one of the areas most affected by the implementation of restrictive measures was the educational sector. All Italian schools and universities were forced to implement distance learning (e-learning or remote learning) throughout the most acute phase of the emergency. This forced transition has entailed not only a restructuring of teaching methods, now characterized by the unavoidable use of digital technologies

and means of communication (such as Zoom, Teams, Meet, etc.) but to a complete restructuring of home environments, now dedicated to the activity of studying or working remotely. In addition to this, of course, one of the main consequences of lockdowns has been the inability to leave except for stringent reasons (Corley et al., 2021; Dzhambov et al., 2021), thus limiting people's ability to have contact with natural environments (e.g., Garrido-Cumbrera et al., 2022; Mintz et al., 2021). Therefore, finding strategies to implement natural elements within the home environment became necessary.

The biophilia theory and biophilic design

The term "biophilia" can be summarized as "the innately emotional affiliation of human beings to other living organisms" (Wilson, 1993, p. 31). The concept was introduced by Erich Fromm (1964/1976) and has been popularised in the work of Kellert & Wilson (1993), who affirm that human evolutionary history has produced "the innate tendency to focus on life and lifelike processes" and the need to "affiliate with other forms of life". Biophilia has been conceptualized as a sign of mental and physical health, with supporting evidence showing that natural settings (compared to built settings) are preferred and lead to positive health outcomes, such as restoration from mental fatigue and stress. Building on the theory of biophilia, the biophilic design seeks to use nature in the design of indoor and outdoor environments (as well as in the design of artifacts) to promote people's health and well-being. Biophilic Design stresses the need to maintain, improve and restore the beneficial experience of nature in the built environment. It represents a sustainable approach with financial advantages across healthcare, education, retail, workplace, and community environments (Browning et al., 2012). Kellert & Calabrese (2015) have proposed design strategies for successfully applying biophilic design in diverse contexts, such as educational settings (Alves, Betrabet Gulwadi & Nilsson, 2022). The basic components of the biophilic design framework are: direct (e.g., having indoor plants), indirect experience of nature (e.g., watching nature), and the experience of space and place (e.g., prospect and refuge). Drawing from empirical evidence, biophilic design patterns are not formulas; they are hypotheses to be tested and should be thought of as another tool in the designer's toolkit - meant to inform, guide, and assist in the design process (Ryan et al., 2014).

The psychological impact of biophilic design

Biophilia is one of the aspects most touched upon in the study of this predisposition concerns the natural elements directly or indirectly experienced by the individual. The positive effect of exposure to natural environments and stimuli in promoting psychological well-being has been widely studied (Bratman et al., 2019). The term restoration refers to the recovery or regeneration of mental resources used in daily activities (Harting, 2004). The two main theories concerning restorativeness are the attention restoration theory (ART; Kaplan & Kaplan, 1989), according to which natural environments do not require direct attentional effort, thus allowing for a reduction in the use of cognitive resources (Jiang et al., 2020), and the stress recovery theory (SRT; Urlich, 1983), which draws on a psycho-evolutionary perspective, and postulates that the natural environment allows for a reduction in arousal and stress levels (Chang et al., 2021). Direct experience in natural environments is not the only strategy to activate the regenerative process. Implementing natural elements (real or reproduced) in indoor environments through biophilic design can allow one to experience effects similar to those activated by immersion in natural environments. Natural or artificial light with similar characteristics, implementation of natural materials such as wood or stone, natural sounds, and implementation of indoor plants or other reproductions of natural environments are just some of the elements most frequently found in the literature (Bolten & Barbiero, 2020; Browing et al., 2014; Kellert, 2008; 2018; Sturgeon, 2017). Research based on the implementation of biophilic design has reported results consistent with the literature on restorativeness in natural environments (Aristizabal et al., 2021; Cole et al., 2021; Determan et al., 2019; Jiang et al., 2021; Yin et al., 2020), thus confirming the possibility of being able to effectively integrate these types of elements into built and indoor environments as well, with positive effects on psychological well-being.

Aim of the study

Based on these assumptions, this paper intends to report an empirical study promoted during the Psychology and Cognitive Ergonomics course within the bachelor's degree program in Industrial Design at Sapienza University of Rome. Through an interdisciplinary approach, Human-Centred Design and Environmental Psychology set out to promote the use of Biophilic Design to improve remote studying environments, a widely used practice following the closures of schools and universities caused by the pandemic by Covid-19. The aim is to illustrate a possible methodology within Design education and to bring to greater maturity the reflections on Biophilic Product Design to extend our scientific community's knowledge and promote interdisciplinary practices.

Method

Participants

The research sample comprised 521 college students from different Italian universities who voluntarily completed the questionnaire. They were aged 18 to 38 (M = 20.93; SD = 2.20); 232 were men (44.5%), 282 were women (54.1%), and 7 preferred not to answer (1.4%). 466 students were enrolled in a bachelor's or single-cycle degree program (89.4%) and 55 in a master's degree program (10.6%).

Tools and procedure

The research was conducted in full compliance with the Ethical Principles of Psychologists and Code of Conduct of the American Psychological Association (APA) and was authorized by the Ethics Committee of the Sapienza University of Rome. The study was conducted in April 2022, when Italian universities, due to the Covid-19 pandemic, continued implementing a hybrid teaching mode with in-person and remote lectures. During an initial administration, participants were asked to think about the home environment where they performed their remote study activities (didactic or self-study) and to complete a self-report questionnaire. The first instrument was the Perceived biophilic qualities in remote studying (ad hoc): the measure includes 19 items referred to the main sources of Biophilia found in the literature (e.g., Bolten & Barbiero, 2020; Browning et al. 2014; Kellert, 2008; Kellert 2018; Sturgeon, 2017) divided into the 3 categories identified by Kellert and Calabrese (2015), namely direct experience with na-

Table 1. escriptive statistics, bivariate correlations and Alpha in diagonal.

Variable	N	M	SD	S	K	1	2	3	4	5	6	7
1. General Perceived Biophilia	521	3.20	.61	-.03	-.01	.81						
2. Direct Experience	521	3.65	.69	-.36	-.01	.89***	.81					
3. Indirect Experience	521	2.39	.81	.43	.02	.58***	.22***	.88				
4. Prospect and Refuge	521	3.19	1.23	-.02	-.86	.73***	.60***	.15***	.72			
5.Restorativeness	521	3.27	.72	-.18	.12	.41***	.36***	.25***	.25***	.72		
6. Engagement	521	4.43	.95	-.39	.17	.18***	.15***	.12**	.12**	.26***	.88	
7. Stress	521	2.35	.41	.16	.36	-.08*	-.10*	-.04	-.02	-.18***	-.08	.75

Note: * = p < .05; ** = p < .01; *** = p < .001; M = Mean; SD = Standard deviation; S = Skewness; K = Kurtosis.

ture (10 items; Alpha = .81), indirect experience (6 items; Alpha = .68), and the experience of space and place (3 items; Alpha = .88). Also, an overall perceived Biophilia score was calculated (Alpha: .82). The psychological variables concernedPerceived restorativeness (5 items; Alpha: .72; Korpela et al. 2008),Student Engagement (UWES-9; 9 items; Alpha: .88; Schaufeli & Bakker, 2003; 2004),and Student Stress - Effort-Reward Imbalance student questionnaire (12 items; Alpha: .75; Wege et al., 2017) For all these measures, the response scales consist of a 5-step Likert scale (from 1 = "Completely disagree" to 7 = "Fully agree"), except for the Engagement rating scale, for which a 7-step Likert from "never" to "always" was used. Socio-demographic data (gender, age, and degree course level) were also collected. The same participants were asked to fill out a second questionnaire containing an ergonomic checklist for objectively assessing all the biophilic elements with which they relate, directly or indirectly, during remote studying activity and that, therefore, could contribute to their satisfaction and requirements needs related to certain needs classes such as Safety, Well-being, Usability, Appearance, Management (UNI 8289:1981). For each requirements class, the requirements classes have been identified (UNI 8290-2:1983) to which the items of the Checklist refer by proposing questions for the verification of the qualitative and quantitative characteristics of the elements observed, starting from minimum inclusive safety performance (Villani et al., 2021) thresholds defined by regulatory references related to health and safety at work agile (L. n. 81/2017, art. 18-23), to the usability (D.M. 236/89) and from "good technique" criteria correlated with people anthropometric data.

Results

Relationship between perceived biophilic qualities and psychological variables

Jamovi v.2.2.5 statistical software was used to analyze frequencies, descriptive statistics, and correlations among psychological variables. The mean scores, univariate normality, and bivariate correlations between the variables under research are shown in Table 1. According to the skewness and kurtosis values, which are all between -1 and +1, the normality assumption was not violated. From the correlation analysis, the overall indicator of perceived Biophilia was found to be correlated with perceived restorativeness (r = 0.41; p < .001), engagement (r = 0.18; p < .001), and stress (r = -0.08; p < .05), demonstrating how the perception of natural elements can help regenerate students' cognitive resources, promoting their engagement in the educational activity, by reducing stress-related symptoms. Regarding the specific sources of Biophilia, direct experience of natural elements, whether internal or external to the study environment, reported the highest correlation indices, correlating positively with restorativeness (r = 0.36; p < .001) and engagement (r = 0.15; p < .001) and negatively with stress (r = -0.10 < .05). Indirect experience with nature, prospect, and refuge reported same correlation indices with restorativeness (r = 0.25; p < .001) and engagement (r = 0.12; p < .01). Unexpectedly these two sources of perceived biophilia did not correlate with perceived stress (r = -0.04; p = n.s.) (r = -0.02; p = n.s.).

Objective perception of biophilic-related elements

The ergonomic checklist results about biophilic elements have been analyzed on three levels: biophilic elements in general (one general index), level of individual needs classes (6 indices), and level of individual requirement classes (15 indices). Each of these three refers to the individual elements of the checklist that, aggregated, return these summary indices. Generally, it has emerged that inside the remote study sites/

Table 2. Ergonomic checklist results about the biophilic element

Class	Yes	No	NR
Needs class - Security	32%	57%	11%
Requirement class – Fire safety	30%	58%	12%
Requirement class - Safety of use	34%	56%	10%
Needs class - Well-being	35%	36%	29%
Requirements class – Thermal comfort	41%	21%	37%
Requirements class - Acoustic well-being	28%	55%	17%
Requirements class - Visual well-being	51%	38%	11%
Requirements class - Olfactory well-being	46%	47%	7%
Needs class – Usability	45%	37%	18%
Requirements class - Accessibility	14%	56%	30%
Requirements class - Furnishability	58%	23%	19%
Requirements class - Furnishability	58%	23%	19%
Requirements class - Flexibility	41%	50%	9%
Requirements class - Usability	45%	40%	15%
Requirements class - Communicativeness	84%	9%	7%
Needs class – Appearance	41%	47%	12%
Needs class – Privacy	38%	49%	13%
Requirements Class - Spatial Privacy	55%	31%	14%
Requirements Class - Functional Privacy	20%	66%	14%
Needs class – Management	77%	16%	12%
Requirements Class - Maintainability	65%	22%	13%
Requirements Class - Cleanability	79%	10%	11%

workstations, there are no biophilic elements in 40% of cases inside the remote study sites/workstations. The results of the other two levels are shown in Table 2.

Examples of biophilic design

The psychological and ergonomic results were subsequently considered as a basis for developing the design proposals. The ergonomic approach to the project, with its ability to evaluate the multiplicity of variables that define the interaction between people and what they relate to (Tosi, 2018), has been combined with the philosophy of Human Centered Design. The biophilic design solutions presented by students vary in the use of materials, shapes, and textures in their aim to stimulate sensory perception, improve well-being and meet ergonomic requirements. Moreover, to prevent the solutions of these new designers from being replaced by superficial imitations, a more holistic and sustainable approach has been stimulated (Stevens et al., 2020), promoting the use of solutions respectful of Nature and also from the point of view of materials and production processes.

The data collected by the Ame group showed that as the appearance variable increases, the level of perceived stress decreases while the person's interest increases. On the other hand, an increase in olfactory well-being, linked to air quality, leads to a psychological reduction in stress. Finally, good usability within the smart studying workplace positively influences the subject's performance, increases well-being and engagement, and reduces stress and burnout. They proposed a cactus-shaped desk module that performs several functions, including tidying up cables, pen holders, and air freshener. This product is intended to improve classes of needs such as Safety, Wellness, Usability, and Management, stimulating the perception of natural elements on different sensory levels. The material they use for production is Ecoallene, derived from the processing and recycling of poly-bonded waste, which is colorable, versatile, infinitely recyclable, and suitable for various types of molding.

Instead, the Palma group, in order to improve their situation, worked on the correlation of ergonomic well-being on mental and physical health and on how colors and materials reminiscent of nature increase the sense of belonging to a place and, consequently, the desire to spend more time there. So they designed Ceppo, a footrest whose materials and shapes recall a tree trunk. In particular, it improves the ergonomics of the study station and stimulates sight and touch during the remote study activity through natural materials such as wood and stabilized lawns.

The Cinquis group started from the point of view of implementing acoustic well-being, usability, appearance, and safety, which were found to be lacking in the questionnaire, and from the psychological point of view, improved direct experience with nature, in particular through sound, because of the direct effects they have on restorativeness and engagement. They worked on evoking nature at a sound level, designing a speaker that recalls the organic shapes of a shell, also associating on a semantic level the act of bringing the shell to the ear to listen to the sea. In addition to reminding marine environments, the speaker emits white noises that stimulate concentration during one's study time.

In the last case, however, the ergonomics checklist showed that visual comfort, usability, accessibility, and flexibility were lacking, so they implemented them in their remote studying station. From a psychological point of view, they instead worked on enhancing the indirect experience with nature through shapes and colors, as it increases the organizational potential of the user, the positive relationship between the user and the room, and a general sense of security. So, with the *Jungle-IT* (Figure 1), Marmotas group brings the jungle into the remote study station. The system, consisting of simple elements such as wooden profiles, rope, cork leaves, and S-shaped steel hooks, offers the possibility of a support/shelf where to place books and also serves as a bulletin board, allowing to reorder sheets and notes.

Figure 1. Jungle-IT by Marmotas, rendering

Conclusion

In conclusion, this study shows the positive impact of using natural elements in promoting ergonomic and psychological well-being in remote studying settings. Design, with its ability to act both on a micro- and macro-scale, can encourage the implementation of biophilic elements, particularly in those contexts where direct contact with green spaces has been diminished, such as in large cities or metropolises, but also extreme context like the Fourth Environment. It can help to cope with traumatic and unpredictable events, such as the Covid-19 pandemic and conflicts, that makes immersion in green spaces difficult. The collaboration between two different perspectives, such as Psychology and Design, shows how Biophilic Design can be put into practice: it allows both the analysis of objective requirements for design and the consideration of students' subjective needs and perceptions. The benefit of this interaction is that it allows the construction of more desirable remote studying environments centered on humans and their real needs and a symbiotic relationship with nature. Biophilia alone is not enough to generate automatically sustainable solutions in this context. It is therefore important to provide constant input to students on how to make this reconnection with nature not only aesthetic but the result of a conscious practice at every level. To face today's challenges, using the green "as a sole legitimization of an otherwise unsustainable project is not enough," as Celine Baumann states (Block, 2019). There is, therefore, a need to find more holistic and enlightening solutions by broadening the scope and examining the challenge in a wider context and at different scales (Scalisi & Ness, 2022). Developing a new unity with nature is necessary, a paradigm shift from "human on nature" to "human and nature".

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Bioreceptive interfaces for biophilic urban resilience

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Abstract

The emerging field of Biodesign sees living organisms as embedded in the design process to create bio-generated materials and artefacts. To support the growth and maintenance of these organisms, designers can adopt a Bioreceptive Design (BD) approach, recently defined as a design approach occurring every time materials or artefacts are intentionally designed to be colonized by life forms. Through this approach, the inert counterpart undergoes specific studies to reach the best bioreceptive potential for the designated life form, also considering the environment in which the artifact will be placed. In urban environments, BD examples tackle vegetation to create greener spaces and provide phytoremediation for better air quality and biodiversity in the built environment, in the wider view of nature-based solutions and climatic transitions of cities.

This study addresses the possibility of developing bioreceptive interfaces for mosses and lichens to respond to biophilic and regenerative sustainability needs in urban contexts. These organisms have contributed as pioneers, during the evolution of life on our Planet, in the formation and regulation of soil and atmosphere; moreover, they are currently used in biomonitoring actions, also contributing to the environmental awareness of the built environment. The paper proposes BD as a design approach of mutual interest, aiming at responding to the host needs and preferable environmental conditions, serving multiple species that act as co-authors of an open-ended design, increasing urban biodiversity, and providing resilient, restorative, and regenerative environments.

In particular, we present some of the results of an interdisciplinary research through design, born from the collaboration between design and biology, aiming both to bring sustainable and innovative solutions for the Biodesign and architecture sectors, but also to positively affect biological activities of biomonitoring and citizen awareness. From the design perspective, BD is applied for the selection of those material features that match the needs of the selected organism (e.g., porosity, color). Moreover, the use of Computational Design has played a crucial role in designing and prototyping bioinspired, organic shapes and textures. From a biological perspective, the research compares different methodologies for the bio-colonization of artefacts to obtain the best results for the timing and survival of the organisms. The prototypes were therefore exposed open-air with no protection or superficial treatments in a highly colonized area (from mosses and lichens), favoring the attachment of spores and propagules on the surfaces. On the other hand, some prototypes were used to test the transplant of the organisms as an alternative and faster possibility, also suitable for interior design.

This study points out how BD can be applicable when designing for the living, making clear the designer's possibilities for adopting this approach: ranging from material design to biomimicry, designing for not-only-human users, considering the host's needs and preferable growth conditions, adopting a multispecies design approach while suggesting new relationships among biotic and abiotic agents. The paper highlights how BD can provide sustainable, low-maintenance, and regenerative nature-based solutions to foster resilient urban environments.

Author keywords

Biodesign, biophilia, bioreceptive design, biomonitoring, urban resilience, green infrastructure

Introduction

The design field is increasingly aware of the limits of the current models of production and consumption, therefore looking to contribute to the transitions by proposing sustainable solutions. In particular, designers are rediscovering the material side of the projects, hybridizing their practice with materials science, chemistry, and biology, opening up a new era of interdisciplinarity driven by the research for radically sustainable materiality (Oxman, 2016). In this regard, Biodesign arises from an entanglement of design and biology as a new approach based on the involvement of living organisms in the design process (Myers, 2012). The biological origin of biodesigned materials and artefacts can lead to an organic aesthetic and a more significant presence of living organisms in the built environment. Livingness has already been recognized as a material quality in design (Elvin Karana et al., 2020). This feature leads to design systems relying on organisms' abilities to create bio-augment-

ed products and multispecies environments. From the low to the high level of biological organization, the quality and quantity of interactions between humans and other natural agents can positively affect human wellbeing (MacKerron and Mourato, 2009). On a "microscale", recent studies recognize the importance of microbiota in the built environment for human health (Flandroy et al., 2018; Mills et al., 2019). To restore urban microbial biodiversity, Watkins and colleagues (2020) propose a framework for microbiome-inspired green infrastructures, by explicitly recognizing the microbiota's role in the functionality of an urban ecosystem (Watkins et al., 2020). Also on a "macroscale", the presence and abundance of natural/green areas is demonstrated to positively affect human health, habits, and work (Wargocki et al., 2000). Many organisms can have bioremediation effect, they can contribute in microclimate improvement, carbon storage and sequestration, noise reduction, and phytoremediation; these are just some of the benefits of plants and vegetation in urban areas (Dadea et al., 2017). Cryptogamic covers (which include cyanobacteria, algae, fungi, lichens, and bryophytes) have a significant role in the fixation of carbon dioxide and nitrogen from the atmosphere (Elbert et al., 2012), as well as reducing the runoff during the increasingly frequent phenomena of heavy rains, and providing food and shelter for other organisms, thus enhancing urban biodiversity. Many of these species, especially lichens and mosses, can also be used for environmental biomonitoring, defined as "the use of biological systems (organisms and organism communities) to monitor environmental change over space and/or time" (UNE EN 16413:2014). Lichens and mosses are currently used as bio-indicators of air quality changes in urban and non-urban environments (Contardo et al., 2020): being sensitive to air pollution, the physiological alterations occurring in polluted environments are manifested at individual and community levels. Furthermore, many species are able to bio-accumulate a large number of contaminants, providing a reliable estimate of the presence and the biological effects of those substances on the biota (Bargagli & Mikhailova, 2002). Still, natural elements also have a psychologically positive effect, addressing "biophilia", a concept introduced by the psychoanalyst Erich Fromm and, to date, highly appreciated in design and architecture (Söderlund, 2019; Soderlund & Newman, 2015). E.O. Wilson defined biophilia as "the innate tendency to focus on life and lifelike processes" (Wilson, 1984). Wilson argues that exploring life, and understanding how we are part of it, can be a profound and complex process in human mental evolution. Humans' benefits in response to a natural environment are based on our co-evolution with the natural World, and today biophilic urban design is claimed for its beneficial effects on humans' mental health and life quality (Andreucci et al., 2021). However, our current cities are far from a biophilic approach: they embed the modern aesthetic of sanitation as a value system (Pasquero & Poletto, 2020), and are planned for the confinement more than the proliferation of other species. To foster biodiversity and biophilia, urban environments should be designed to support the spontaneous growth and regeneration of living organisms, improving multispecies relationships and self-regulating and regenerative environments. Such coexistence with other organisms should be accommodated through proper design, addressing materials, surfaces, textures, spaces, and habitats. Here, the role of the inert counterpart as life-supporting material is fundamental and can be designed to better meet the organisms' requirements. In this respect, Bioreceptive Design (BD) is an approach that occurs *every time a material or artefact is intentionally designed to be colonized by one or several groups of living organisms* (Pollini & Rognoli, 2021), aimed at supporting self-regulating biotic and abiotic assemblages, designed to foster biodiversity and green spaces. This study aims to enhance the presence of lichens and mosses in urban environments through BD, by testing both material features and biological treatments suitable for an effective bio-colonization of the built environment. The selection of the organisms for this project was based on their tolerance to highly urbanized environments. The cryptogamic cover, in general, can positively affect air quality, augmenting green spaces and fastening cities' rewilding and biophilia exposure. Moreover, a significant objective of the study is the possibility of using bioreceptive materials and objects for biomonitoring activities to foster human awareness of the environmental quality of urban spaces intended as multispecies environments.

In the last years, the emphasis on improving the resilience of cities in the face of urbanization and climate change has led to the adoption of the (not still clearly defined) expression of "urban resilience" (Meerow et al., 2016). Many scholars have already related this concept to the importance of biodiversity and ecological networks (Ahern, 2013; Jansson & Polasky, 2010; Schewenius et al., 2014). Although these actions are primarily human-oriented, the dimensions of urban resilience need to tackle cities ecosystems as a whole, designing for restorative and regenerative nature-based solutions (Mang et al., 2016; Seddon et al., 2021).

Methods

This study relies on a transdisciplinary, mixed-method research approach, including design and biological methods. From a design perspective, the project relies on three main approaches: (i) Bioreceptive Design for the selection of those material features that match the organism's needs (e.g. texture, composition, porosity, color); (ii) Computational Design for the creation of special textures and shapes, followed by additive manufacturing for prototyping; (iii) Biomimicry for gathering inspiration from the natural shapes and textures increasing water absorption and spatial distribution on the surface to increase the self-regulatory ability of the system. Once the prototypes were created, the second part of the study focused on the observation of changes, by exposing the prototypes open air to evaluate the colonization status of biofilm, lichens and mosses over time.

Bioreceptive Design: bioreceptivity has been defined as "the aptitude of a material (or any other inanimate object) to be colonized by one or several groups of living organisms without necessarily undergoing any biodeterioration" (Guillitte, 1995). Pollini & Rognoli (2021) proposed to broaden the original definition, for design purposes, outlining a methodology for the design of bioreceptive materials and artefacts. This study mainly relies on this methodology, with the aim of identifying those bioreceptive material features that can facilitate the colonization by lichens and mosses. The Bioreceptive Design traditionally follows 3 steps: (i) the design of the material composition, (ii) the design of the physical characteristics of the surface, and (iii) the design of the shape of the material or artefact (Pollini&Rognoli, 2021).

Computational Design: The shift from imitation of natural forms to the imitation of the constitutive logic through which

nature creates its forms appears today as one of the emerging patterns in the relationship between computational design and additive manufacturing. Layering production allows objects with material systems of extreme formal complexity. In this direction, generative design and additive manufacturing integrated with a bioinspired approach can contribute to the development of new types of products with high form, function and performance in relation to the context (Pollini et al., 2020). The computational approach plays a leading role in this context, directing the formal as well as the material conception process (Romero, 2014). Computational Design was crucial for prototyping during the 3D modelling phase, assisting the conceptual phase. Generative modelling software (Rhino and Grasshopper) was used to develop and test different textures and shapes, while additive manufacturing was employed to create the prototypes and moulds.

Biomimicry: among the biological informed disciplines, biomimicry works at the interface between physical and biological sciences (Iouguina et al., 2014). In this research, we looked for natural models for water management, from the ability of a texture to capture nocturnal humidity, to dendritic shapes to avoid excessive water stagnation. Moreover, we took inspiration from some natural patterns that distributed empty and full spaces for greater bioreceptivity.

Bio-colonization evaluation: materials' bio-colonization is a complex mechanism that occurs since the moment an object is exposed open air. The weathering, creates micro-fractures and deposit a large amount of water and nutrients other than spores and microorganisms in general on the surfaces (de los Rios et al., 2004). Biocolonization has traditionally been seen as a threaten for materials, (de la Fuente et al., 2013); however, the biofilm cover can actually play a protective role in some cases, thus the debate about the removal or not of biofilm is case-specific (Pinna, 2014). To evaluate the biocolonization stages, prototypes were exposed open air in a highly colonized location by mosses and lichens. Some tiles were previously treated by transplanting in the grooves parts or the entire body of the selected organisms, others were exposed with no treatments.

Project description

As outlined in the BD procedural thinking (Pollini & Rognoli, 2021), at first it is necessary to acknowledge the life cycle and preferred living conditions of the organisms, to create suitable bioreceptive materials and artefacts. To do so, we selected two cosmopolitan species, widespread in heavily urbanized environments: the lichen *Xanthoria parietina* and the moss *Bryum argenteum*, and we created an ID cards for both of them (Figure 1).

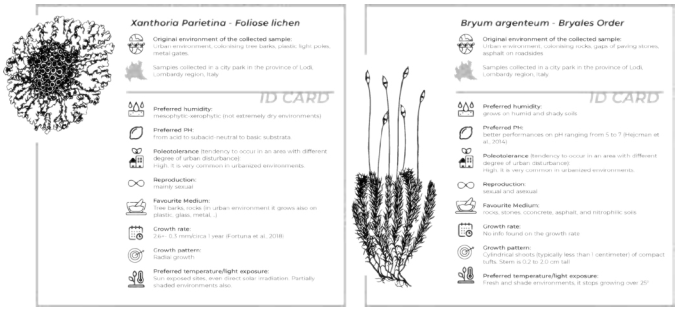

Figure 1. ID cards of the lichen Xanthoria parietina and the moss Bryum argenteum

In BD there are three levels of intervention: the material composition, the surface texture and the whole system, including the overall shape of the artifact (Pollini&Rognoli, 2021). All these variables are being tested, however the slow growth rate of the organisms is a limiting factor (Fortuna & Tretiach, 2018). Besides, we carried few other experiments as possible proof of concept for a further hypothesis of bio-colonization pattern.

To date, we have had two prototypes exposure cycles, the first since April 2022 and the second since December 2022; The project is following a reiterative investigation workflow which can therefore be subdivided in three main phases: (i) the creation of support prototypes with different bioreceptive features; (ii) the prototypes' exposure in an open environment (rooftops and similar), characterized by high lichen and mosses colonization or transplant actions (iii) the comparison between tiles with different analysis tools (e.g. microscopy) to address the degree (and success) of colonization based on the characteristics of the material and texture.

The phase of design and prototyping carried several research questions. Some emerged from the early literature in the field, which already reported about 3D printing techniques for biological colonization observing the role of microgrooves (derived by the layer-by-layer printing texture) and planned geometries (Huang et al., 2018; Mustafa et al., 2021). Other questions addressed the best integration model between biology and design, mainly focusing on creating physical samples idoneous for lichen and mosses colonization. Willing to test the bioreceptive material properties we developed different sets of tiles on which to study the bioreceptivity of the different design options by avoiding other variables; here, the tile can be considered the minimum unit of measurement to study the influence of a texture or material in terms of bioreceptivity. The design of textures was drawn through 3D modeling and parametric design (Figure 2). Parametric 3D modeling has been performed using the software Rhino and Grasshopper, particularly Grasshopper's plugin Parakeet, which provides a collection of components focusing on bioinspired and geometric algorithmic pattern generation (Parakeet, 2018).

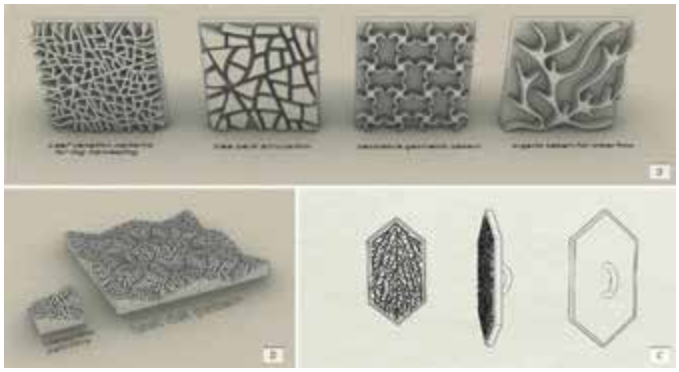

Figure 2. Computational modeling of different patterns (a. Stamps with different patterns - computational modeling; b. Tile pattern virtual testing - computational modeling; c. Stamp with pattern - computational modeling)

In the concept phase, planning the water flow has been fundamental, in fact, both lichens and mosses require high humidity but no water stagnation, meaning that the ideal substrate needs to drain water and possibly harvest air humidity without having parts of the surface where water can stagnate for a long time. Textures have been mainly bioinspired; in particular, four of them took inspiration from dendritic patterns,

an archetype for growth patterns in nature (Miguel, 2014), which characterizes many natural surfaces (e.g., leaf patterns), and they can easily aid in water channeling. To better test the hypothesis that bioinspired forms could more easily be bioreceptive, two textures with purely decorative motifs have also been tested, which, however, could still channel the water without excessive stagnation. Biomimicry has been considered for the realization of textures simulating the unevenness of tree barks and leaf venation patterns, in fact, leaf venation has been tested successfully as a model for bioinspired fog harvesting (Qasemi et al., 2020), which might be ideal given the high humidity requirement that bot lichen and mosses have. Another type of tile was conceived with a dendritic pattern, but this time designed also taking into consideration a minimum hint of shape, thus approaching the third level of BD which also considers the shape. Assembling side by side several tiles, a wavy surface is obtained, with more internal movement where, in addition to the grooves that inscribe the pattern, there is a concave and convex movement of the entire surface (Figure 2 a, b, f). We choose to limit the movement of the objects in order to avoid strong differences of exposure and shading, which could influence the effectiveness of bio-colonization. The physical creation of the tiles followed using advanced machinery for 3D printing. Here, a series of prototypes in self-hardening clay, PLA, and resin were made. The PLA and resin prototypes served as models to create moulds, which were subsequently used to make clay and concrete tiles (e.g., Figure 3, c, d). Moreover, a few other samples were 3D printed in clay and suddenly fired.

Among the planned variables we had, we decided to analyze traditional building materials first, indicating further DIY-Material experimentation (Rognoli et al., 2015) for subsequent and future steps. Among the materials analyzed we have terracotta, white and red clay, mortar and concrete. Testing different materials also allows us to test the effect of different colors, material porosity and composition. Surface color is a neglected aspect in the study of cyanobacterial biofilm formation, however, color appears to influence the growth of cyanobacteria, which few study shows prefer red and white (Gambino et al., 2019; Sanmartín et al., 2020). Porosity and roughness instead are very well known and important parameters for this field of study (D'Orazio et al., 2014; Manso, 2014;

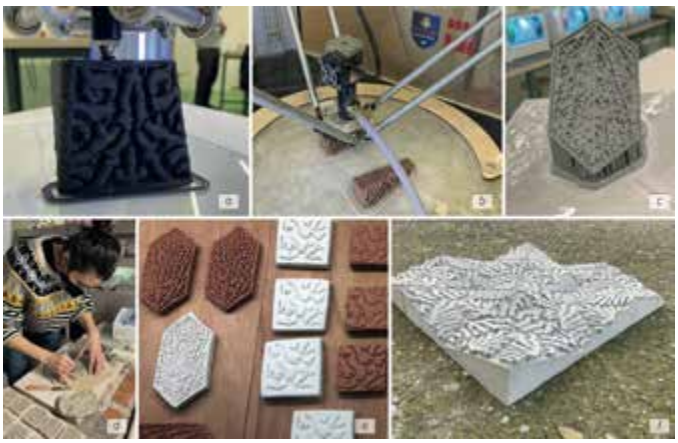

Figure 3. Prototyping process (a. 3D printed dark grey clay; b. 3D printing red clay; c. 3D printed stamp; d. Usage of 3D printed tiles as stamps; e. Clay tiles; f. Concrete tiles)

Miller et al., 2012), as well as pH levels (Manso et al., 2014). The selected set of prototypes differing in colors, shape, material and superficial pattern are described in Table 1.

Table 1. Prototypes description

Material	Shape and size	Shape and size	Color
Hand molded clay	5x5 cm., flat	6 patterns – 6 tiles each	Red and white
3D print-ed clay	10x10cm., concave	1 pattern	Red
3D print-ed clay	10x10cm., concave	1 pattern	Dark grey
Concrete	10x10cm., concave	1 pattern	Pale grey
Mortar	10x10cm., concave	1 pattern	Light grey to white

From a biological perspective, the study compares the performance of different treatments of the materials for the bio-colonization, with the aim to obtain the best timing and treatments for our final goals. The artefacts were exposed to open air in a highly colonized environment by mosses and lichens with three different treatments. The first one is "no treatment" to see the effective bioreceptivity of the artefact per se and the textures both for lichens and mosses (and biofilm in general). The second is the "transplant" treatment, for which entire organisms (the moss Bryum argenteum and the lichen Xanthoria parietina) were transplanted on the artefacts, by exploiting their grooves to put a part of the soil and the moss, or natural glue on the prominences for the attachment of the lichen thallus. The third treatment is a different kind of transplant, since using the same technique of the method above, just the reproductive parts of the lichens and the mosses were transplanted on the artefacts. Except for the "no treatment" samples, the other two treatments were carried out separately for mosses and lichens to avoid the substratum competition between the two organisms. To test the influence of the material per se without the textures, some samples with no texture were exposed in the same environment. The different treatments aim to test the timing of bio-colonization in different "scenarios"; i.e., the absence of nutrients, the presence of adult individuals and the presence of young or potential individuals (experiments still in progress). The 5x5cm. tiles, instead, were sorted by pattern, glued to wooden supports and exposed with no treatment in natural environment (Figure 4).

First investigation from April 22: the first cycle of exposure took place a little late in the winter season due to the restrictions on access to the facilities caused by the pandemic. In any case, since April 2022, the first ceramic prototypes have been on display (and still are). Regular checks are performed to avoid excessive coverage from extraneous material (e.g., leaves) and assess the tiles' integrity. Currently, no evidence of colonization is visible to the naked eye. As time progress, we will study effective colonization and to which extent it occurs, comparing the degree of colonization between colors, patterns, materials, and shapes.

During the same period, parallel material experiments were made: (i) lichens were transplanted onto self-hardening ceramic tiles using a DIY bioplastic as glue, and (ii) silicone molds were created for making tiles testing different combinations of

Figure 4. Tile exposure (a. b. d. Siena Botanical Garden; c. e. mosses and lichen transplant; f. Tiles exposure and first colonization by green algae)

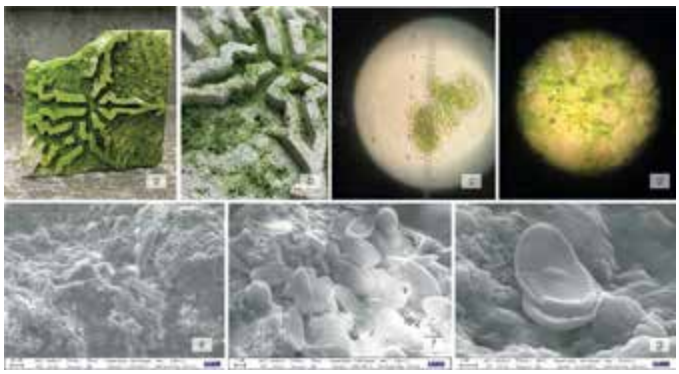

Figure 5. Analysis of green algae colonization of concrete tile (a. b. Colonized concrete tile; c. d. 40x visualization of green algae species; e. f. g. SEM observation of the green alga species "Cocconeis placentula")

cement and mortar; the latter were used for moss transplant and spontaneous colonization tests.

Second investigation from December 22: the second cycle of exposure made use of cement tiles for a more inclusive experimentation with the moss component as well. A set of 16 tiles were exposed of which 3 without treatment, 6 treated with transplants (3 for lichens and 3 for mosses), 6 with transplant of reproductive portions (as before), 1 flat tile as a control sample. Other side experiments in this second cycle were a moss colonization test by rubbing and the testing of materials with different cement and mortar gradients aimed at moss transplantation.

Early findings

Given the slow growth of these organisms, at the moment, no visible results were obtained, as expected. However, some early findings emerged from the parallel and DIY-oriented experiments: the first exposed concrete and mortar tiles in 2022 were colonized by green algae and mosses protonemata (early stages of development of mosses), considered a good sign as a pioneer species. Through SEM observation it was possible to identify the species of the green algae, that could be *Cocconeis placentula*, pioneer species of inorganic substrata (Figure 5). Such colonization corroborates the importance of the porous substrate and microgrooves pattern, typical of 3D printing, for the bio-colonization.

Moreover, the moss transplanted in January 2022 onto a cement tile is still alive, exposed outdoors. On this basis the authors decided to set up the second cycle of experiments in 2023. Also, the lichen transplant that took place in January 2022 was successful, maintaining its vitality even after a year of indoor exposure. This also paves the way for the possibility of using these bioreceptive solutions indoors, with applications for biophilic design and bioremediation (and biomonitoring) of indoor air. Our findings regarding the bio-colonization are in line with those reported by Rely et al. (2019), who tested the installation of plants on concrete mixtures for green walls, observing the persistent vitality and development of the organisms. Moreover, regarding the effectiveness of the pattern and the material's features, our findings confirm what hypothesized by Manso et al. (2014) and Mustafa et al. (2021), by working with concrete features. With this study, we aim also at highlight how BD can provide materials experiences (Karana et al., 2015), that might become significant for more-than-human users too. Living organisms cannot report considerations on the sensory, emotional, significant and performative aspects, but these levels could be evaluated based on their living response and the quality of their growth. Considering the human perspective, the material experience arises also from the relationship between the material and the organism grown on it. In this case, the significant aspect compared to traditional materials is the change over time and the perception of the living material. The proposal is to insert a transversal temporal level in the materials experience framework, which can report information on how sensoriality, emotion, performance and meaning can change over time.

Next steps – Conclusion

Thanks to this multidisciplinary collaboration, the possible outcomes of the project can be broad, contributing to biophilic urban resilience, and positively affecting design, architecture, lichenology, bryology and citizen science. The first goal of the project was the design of multiple bioreceptive surfaces to serve as support within the biomonitoring activities with lichens and mosses. The project foresees reiterative research cycles, and it is currently still in progress, oriented to understand which materials and textures are more pleasant for lichens and mosses to proliferate on. On the basis of the obtained results, we will investigate (i) a more suitable design of the tiles (ii) Different treatments before exposure, focusing on using natural medium to favor transplant (especially for lichens), (iii) material design experimentations, that can still lead to new insight, also adopting a DIY approach, offering the possibility to play with materials properties such as pH or porosity. (iv) Following the first results, new prototypes will be made for further tests, and different measurements and analyses will be possible over time concerning both lichenology, bryology, and material design (e.g., thermal insulation, oxygen production, air bioremediation, and expressive-sensorial qualities of the artefacts in terms of design opportunities).

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Artificial nature: possibilities for mycelial composite material design

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Abstract

Although the trend of interdisciplinary and non-disciplinary boundaries is becoming increasingly vigorous, due to the lack of knowledge related to biomaterials, in the process of using them for design practice, designers have developed a knowledge gap between design and material disciplines. Thus, they cannot integrate biological materials into product innovation to form artificial natural objects that are more ecological and life-like. This paper experimentally explores the way mycelium composites are used in product design in an attempt to incorporate the unique growth and rich sensory experience of mycelium materials into the design process. A design method oriented to biomaterial innovation is proposed, and a prosthetic protective cover is designed using this method. By developing agricultural waste into biological mycelium materials, products are re-endowed with a time-sense compound experience and a rich sensory experience, thereby creating artificial natural objects with the ability to repair nature.

Author keywords

Mycelial materials; Material experience; Biomaterial design; Artificial nature.

Introduction

Materials, as an important innovative element in design activities, unsustainable materials, and their product applications are constantly pressing the limits of Earth's ecosystem. Biomaterial design, as a typical interdisciplinary discipline, presents strong potential for innovation, mainly in that biomaterials provide a variety of alternative production methods, such as biomanufacturing and natural growth, for current production activities. For example, the representative mycelium composite material in biomaterials, with the help of the automatic force of fungal growth, helps designers change the traditional role of passive application of material properties; however, forward thinking utilizes the properties of biomaterials and introduces them into design activities throughout the entire process.

This paper will use mycelium composite material as an example of a prosthetic protective cover material and employ methods such as material experiments and the innovative design of biological materials to study the objective and subjective characteristics of mycelium materials. Through the new design method and experiment, this research has preliminarily obtained a new experience quality for the material. Due to its non-toxic and harmless natural growth method, it can not only replace the traditional industrial production method but also reduce its incidental pollution problems. The above results will provide theoretical and practical references for the design of emerging materials and their application areas in the future. A design approach based on material innovation will simultaneously change the designer's role of passively selecting materials to one of actively and experimentally creating new materials and promoting the rapid application of new materials in design activities.

Research on the Characteristics of Mycelium Composite Materials

Mycelium is the vegetative part of fungi, such as Ganoderma and mushrooms, and it is also called "the root of mushrooms." Mycelium is composed of many microscopic mycelial long-line fiber structures that use the enzymes secreted by themselves to decompose the polymers in the matrix and produce the nutrients needed for growth (Appels et al., 2019). In addition, mycelium functions as a "natural glue" that penetrates the gaps of the matrix material by the growth of mycelium and eventually forms interlocking structures to produce biocomposites (Elsacker et al., 2020). Combining the objectives and experimental materials of this research, the author will focus on the design method and application research of mycelial composites to reveal the potential future application and development value of the material through an experimental exploration of the subjective and objective design characteristics of mycelial composites.

Subjective properties of mycelium composite materials

Humans carry the environmental influences of society and culture to perceive the unique qualities of materials through the five sensory organs of the body. The subjective properties of materials are the characteristics with which humans form perceptions with the help of multiple senses, such as touch, which contains emotions, a sense of experience, etc. (Sun, 2016). It is often more akin to a sensory interaction between

materials and people that occurs through the human sensory organs to perceive and stimulate psychological and physiological response attributes (Zuo, 2010). This research will focus on mycelium composites, which have a flowing "time" quality and material texture due to their unique biological properties. To obtain people's subjective characteristic evaluations of new biomaterials, the author used a focus group method to collect qualitative data on the subjective characteristics of mycelium materials and summarized them in a table. A table of the subjective characteristics of the mycelium composite material was established (Table 1).

Table 1. Sensory properties of mycelium composite materials.

Sensory	Properties
Tactility	Sometimes delicate and sometimes rough; the delicate part is like soft skin
Texture	Bumpy natural fiber texture with some irregular signs of use
Color	Scattered pale yellow small spots among large areas of white
Form	Non-fixed organic looking form, twisted and squeezed into a shape at will
Odor	Has a special natural odor; the smell is reminiscent of a haystack after rain

By experiencing the quality of materials first-hand, designers and users avoid being limited to capturing the objective characteristics of materials, thereby ignoring the relationship between new materials and external factors (Yin, 2017). According to the table of the subjective properties of the material, this biomaterial, characterized by growth and dynamics, develops an imperfect experience of the passage of time.

Objective properties of mycelium composite materials

Through queries and combing literature related to the properties of mycelium materials, the three dimensions of material composition, physical properties, and chemical properties were explained in detail.

1. Composition of mycelial composites. Mycelium grows by sticking to the substrate matrix to form biocomposites. Different types of fungus seeds and substrates ultimately affect the properties and growth conditions of the material. At present, it is common to inoculate substrates with species of Basidiomycota, which have two important characteristics: septum and anastomosis (Alemu et al., 2022). In the selection of substrate materials, agricultural waste, such as straw, sawdust, wheat bran, corn cobs, straw, fallen leaves, etc., can be used, as well as tea leaves, fruit and vegetable peels, coffee grounds, nut shells, etc. that are discarded in daily life, giving the material the ability to degrade quickly and naturally.
2. Physical properties of mycelial composite materials. After the mycelium material has finished growing, it presents an open porous structure similar to sponges and bones. The combination of the three-dimensional structure and chitin in fungal cells makes the material extremely light yet strong (Haneef et al., 2017). This unique porous structure enables it to absorb sound waves in the frequency range of 350 Hz to 4 kHz (Pelletier et al., 2019). It is a potential sound-absorbing and sound-insulating material. A related study tested the physical and mechanical properties of two groups of mycelial materials with different substrates made of wood, sawdust, and a combination of sugarcane and cassava roots. The final results of the tests showed that the density of the first group of materials reached 420 (kg/m^3), while the density of the second group of materials was 440 (kg/m^3); the average modulus of elasticity was 3.97 (MPa) for the first group of materials and 22.7 (MPa) for the second group; and the average compressive stress at 5% deformation was 0.17 (MPa) for the first group of materials and 0.61 (MPa) for the second group of materials (Heisel et al., 2017). Clearly, different combinations of substrates and their processing methods affect the density and tensile and compressive strength of mycelial materials.
3. Chemical characterization of mycelial composite materials. Fire resistance and non-allergenicity are two chemical properties that mycelium materials possess. In terms of fire resistance, chitin produced by fungi is a natural polymer whose combustion requires high heat (Silverman et al., 2020). The substrate covered by the growth of chitin in the hyphae has high fire resistance properties; thus, this material is also called a natural fire retardant. Its non-allergenic nature is due to the substrate it uses being a natural and environmentally friendly material. The mycelium forms a soft white covering after it finishes growing on the substrate. Finally, the material is sterilized at high temperatures for up to several hours to effectively remove bacteria and other microorganisms.

Application of Mycelium Composite Material in the Design of a Prosthetic Protective Cover

Creating product goals

This paper takes the material-driven design method (MDD) proposed by Karana as the basic process (Karana et al., 2015) and fine-tunes it with the application scope of mycelial composites and prosthetic protectors cover. Eight steps of the biomaterial design approach are proposed. Design a protective cover product for the disabled that provides calf prosthetic protection and decoration functions and constructs an innovative design process for mycelium composite materials. The prosthetic protective cover can provide a collision protection function for prosthetic parts and realize beautification and waterproof functions by covering the prosthetic parts. Studies on users with physical disabilities have shown that people with disabilities not only need tools to assist them physiologically but also have a strong sense of inferiority and rejection psychologically. The addition of mycelium materials can reconstruct the visual, tactile, and other multisensory interaction modes of rehabilitation aids (Zhao et al., 2020), bringing more emotional care to the disabled.

Material property matchingj

Based on the analysis of objective and subjective characteristics of mycelium material above, match the material characteristics with the product objectives. Query whether the material characteristics can meet the user requirements and product development objectives. This design successfully

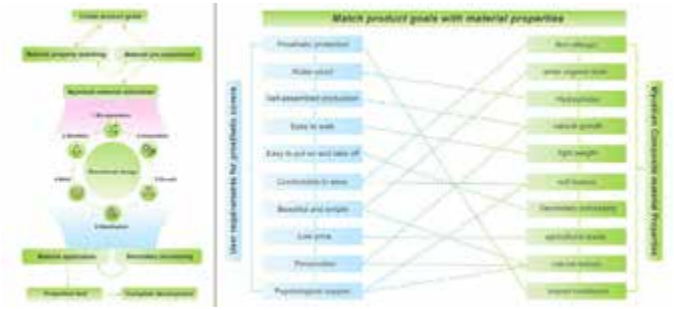

Figure 1. Left: Mycelium composite material design flow chart ; right: Matching of product requirements and material properties.

Figure 2. Left: Mycelium protective cover cultivation process: (a) substrate disinfecting; (b) inoculation; (c) adding material into the mold; (d) mycelium grows naturally; (e) drying material ; right: mycelium prosthesis protection cover wearing effects.

matches the user requirements and material properties (Figure 1), the prosthetic cover will be designed in depth.

Mycelium material pre-experiment and cultivation

After comparing the color, odor, form, touch, and texture between the six mycelium material samples and the impact resistance test, the sample with the material formulation of Ganoderma, wood chips, wheat bran, and glucose was selected because the subjective and objective characteristics of this sample met the product development needs.

To begin, the chopped sawdust and wheat bran were mixed according to 70% and 30% of the total mass of the material, respectively, placed into a sealed bag, and sterilized in a high-temperature environment of 100 °C for 2 hours to prevent the substrate from being contaminated by bacteria. After the inoculation was completed, the substrate was placed in a sealed bag with a breathing valve, and the mycelium was left to colonize and grow in the substrate for one week. The colonized mycelium composite material was then placed into the mold, and pressure was applied to limit the growth space of the material and to generate the shape to be molded. After eight days of growth in the mold, the shaped mycelium composite was removed. It was placed into a sealed bag and grown again for seven days, allowing the mycelium to completely cover the substrate and increasing the strength and density of the material. During the cultivation process, the mycelium growth environment temperature should be controlled at 25°C–30°C, and the relative humidity should be 80%–90%. Finally, after growth, the mycelium composite material was placed into an oven and baked under convection at 100 °C for 2 hours to remove the fungal activity and moisture in the mycelium. The mycelium protective cover cultivation process is shown in.

Secondary processing and material application

To realize the convenience of wearing the prosthetic protective cover, secondary processing is required. To date, a calf prosthetic cover based on mycelium biomaterial has been fabricated. The steps for wearing the mycelium prosthetic cover are shown in, and the effects are shown in (Figure 2).

Material properties test

A material testing machine was used to test the mechanical properties of the prosthetic material The mechanical properties of the complete mycelium prosthetic cover were tested. The test was divided into a vertical cross-section and a transverse cross-section of the protective cover, test process, and results (Figures 3). A series of material performance tests proved that the performance of mycelium material is between that of rigid polymer foam and polyethylene, and the prosthetic protective cover made of mycelium material can provide corresponding protection functions and meet its basic performance requirements.

As an emerging biological material, mycelium's biophilic properties can help designers create a more ecological and natural artificial nature and integrate it with nature to form a "living" artificial natural object. Designers also have the opportunity to be the subject of life-shaping, blurring the boundaries between living and non-living, and presenting a cooperative model of mutual integration and symbiosis between human and non-human species. Based on the exploration of the implicit and explicit characteristics of mycelium materials, this study provides designers with a biomaterial-driven innovative design approach through the experimental application of biomaterials in the design of rehabilitation assistive devices. It is worth noting that the physical properties of the material will be affected by product function, manufacturing technology, and the use environment. Therefore, designers need to further investigate the application of the material in diverse products, in addition to testing the mycelial prosthetic cover through international standards to verify the usability of the product. The innovative application of biomaterials expands designers' imaginations and gives products a new sensory experience. In addition, mycelium materials use new biomanufacturing models to naturally "grow" carbon-negative products with low energy consumption, and they can be combined with different agricultural wastes to produce unique material textures to meet the individual needs of users. The experimental application research of mycelium material also builds many possibilities for the future application development of biomaterials in design and can even rebuild the artificial new order of nature with the help of its biological elements.

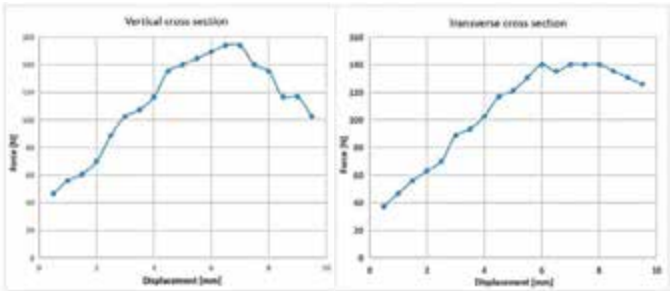

Figure 3. Left: maximum compressive force of vertical cross-section; right: maximum compressive force of transverse cross-section.

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Botanical design: exploring the application of parametric plants in furniture

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Abstract

Although far away, the pandemic of 2019 has given rise to many thoughts towards people's lifestyles and attitudes. More and more people are getting used to working and studying at home, which has given rise to many inspirations for the development of technology related to the lifestyle. Studies have previously demonstrated that incorporating botanical decorations into living scenes can benefit people's mental and physical health. There are also many artists and scientists on this basis to explore the integration of plants and machinery development, trying to use the characteristics of plants to achieve the purpose of convenient people's life. "Biophilia" advocates the human instinct to be close to the natural world and defines the innate emotional connection between humans and other living things as 'pro-life'.

By parametrically controlling the growth of plants to create furniture forms for people to use, this article tries to push the boundaries between living and non-living, natural and artificial, and computational and biological intelligence. The experimental method is adopted to precisely control the exposure of experimental plants to indoor environmental qualities such as water, sunlight, air movement, gravity, touch and media to produce tolerant porous shapes in their growth forms and then shape into furniture form. This has also been verified by previous studies that show the effectiveness and possibility of creating self-standing 3D structures by integrating computational design tools in designing with plant roots.

In addition, this case also combines knowledge from disciplines such as biology and materials science to parametrically predict trends in the survival of plants as intelligent organisms and to explore the use of plant ecosystems in the construction of man-made landscapes by presenting the possibility of plant roots as sustainable materials and transport carriers. Products created so far include chairs and tables using plant roots. The paper details the process of designing parametric plant furniture and the product's effect pictures. The second half of the paper highlights the potential implications of this design technique. At the end of the article, the research explores the future direction of parametric plant design, i.e. the use as furniture while preserving the natural properties of plant growth, thus creating a new ecological cycle in future use. Overall, this study has been carried out with important implications for biological, sustainable, and environmental design. In addition to the current research, which is mainly concerned with the simple planting of space, this study goes further and explores the plasticity of plants themselves as controllable biomorphs. With the current trend of sustainable design, it is also worth looking at how ecologically sustainable and circular living spaces can be constructed. Finally, this research will also enrich the diversity of human living spaces with tactile sensory and interactive properties that can be further developed and applied to the health and education sectors in the future, aiming to improve the well-being of the inhabitants.

Author keywords

Plant arts; biophilic design; parametrical design; sustainability; furniture design.

Introduction

Design practice is affected by a growing understanding of the ecological footprints caused by humans. In design practice, there is a growing understanding of the ecological footprint caused by humans (Sahoo & Sethi, 2021). With the increasing awareness of environmental pollution, searching for new materials and solutions has become a major trend in recent years. As a result, eco-design, or "sustainable product development", has come to the fore. Wimmer et al. (2010) define eco-design as an approach that takes into consideration the environmental impacts of products during their whole lifecycle. Design practices also vary in terms of their CO2 emission (Kim et al., 2013), energy efficiency (Favi et al., 2012), recycling (Gallagher et al., 2019) etc. In addition to the aspects listed above, other studies explore design from the perspective of the whole, with great attention now focusing on the "cradle to cradle" design framework, initially proposed in 2002 by architect William McDonough and chemist Michael Braungart. Representing a continuation of a sustainable approach that takes into consideration multiple forms of life and future generations, "cradle to cradle" design is a biomimetic way of designing products and systems that models human industry on nature's processes, where materials are viewed as nutrients circulating in healthy, safe metabolisms (McDonough & Braungart, 2017).

This research explores an awareness of sustainability that aims to push the research for new materials and solutions as a branch of botanical design. It is also an approach of "sustainable product development" (Wimmer, Lee, Kun-Mo & Po-

lak, 2010) designed to improve the environmental impacts and the quality of human life.

Even though some research exists, it is a new area and is still in its infancy. Especially research on parameterisation in plant design (Song et al., 2019). Thus, this research takes the approach—Growing Design (Camere & Karana, 2017; Ciuffi, 2013; Montalti, 2010) as the main concept, trying to take the growing materials from living organisms (plant roots) to achieve unique material functions, expressions and sustainable design solutions. In Growing Design, designers collaborate with biological organisms, guiding their growth and forging the conditions in which a material/product is created. Such a creative process may generate novel materials, exploring the range of properties by controlling the growth of the organism or by experimenting with different shape possibilities by directly growing materials into a desired product idea (Camere & Karana, 2017).

In early 2020, during the COVID pandemic lockdowns in many countries, the idea for this practice arose. Limited access to outdoor activities prompted a reevaluation of the relationship between humans and nature, and the potential for incorporating plants in furniture design. Given that plants have existed on Earth much longer than humans, this research explores the intersection of the two. Despite the pandemic's waning impact, mobility issues still prevent some, such as the elderly and disabled, from experiencing nature still common. Thus, this research results in the cultivation and design of furniture utilising the Bougainvillea glabra's roots as the primary focus for conducting furniture design. The current collection includes a chair and table. The research aims to contribute to a sustainable environmental design by offering unique insights into parametric design and plant growth control.

Theoretical basis

Sustainability and parametric approaches can be used together to create innovative and sustainable solutions. Inspired by the natural forms of plant roots and a desire to maintain organic shapes and patterns, this research seeks to create more intuitive and user-friendly products that feel more connected to the natural world. This offers a means of keeping the most original feel and inspiring the use of more sustainable materials and manufacturing processes, as natural systems often use minimal resources and generate little waste. Such considerations provided the initial inspiration for this research and its ultimate objectives.

Sustainable design focuses on reducing the environmental impact of products and spaces, considering the entire lifecycle of a product from its design to its disposal. This approach can include using sustainable materials, minimising waste and energy consumption during manufacturing and transportation, and designing products for disassembly and recycling. Sustainable design can also incorporate the principles of biomorphic and parametric design by optimising the use of materials and reducing the environmental impact of the design process. In this research, there are clear sustainable advantages to harnessing the environmentally friendly nature of plant roots, the low level of industrial intervention in the creation process, the natural form of the finished product, and the subsequent recycling, treatment, and reclamation.

The parametric design uses algorithms and digital tools to create complex, non-linear shapes that respond to specific design parameters, such as structural integrity, environmental conditions, or user preferences. This approach can help to create more efficient and optimised designs that use materials and resources more effectively. Parametric design can also be combined with biomorphic and sustainable design to optimise the use of materials and reduce the environmental impact of the design process. In this research, the main objectives are (1) to explore the reason of adopting parametric tech in design practice, (2) to achieve tailored plants, and (3) to explore their adoption in furniture design.

Together, these two design approaches can create sustainable, innovative, and beautiful designs that respond to the natural environment (Eren, Düzenli & Akyol, 2018; Yoo et al., 2020).

Table 1. Two primary materials horizontal comparison.

Plant types	Length of stem	Technical support/advantages	Weakness for furniture design
Bougainvillea glabra	Single stem up to 6m; Example: In the sixth lane of Liantang Village, Luohu District, Shenzhen City, bougainvillea glabra climbed along the building from the underground to the 8th floor, occupying most of the wall surface and forming a "flower waterfall" with a height of about 20 meters.	There are many research bases in China and other areas; Many cities in China regard it as the city flower, like Shenzhen, where also has a plant-research center; In Chaoshan region of China, craftsmen specializing in the cultivation of bougainvillea species for root carving; life time is long; Evergreen woody large vine, water, fertilizer, adequate sunlight; When it has enough water and fertilizer, it grows as fast as it can; Non-perishable and durable, it can still be used for sculpture after being transformed into a dead body.	Slow growth, need to optimise cultivation approaches; There are many kinds of species and more experiments need.
Fungi	After the operation of crushing, various shapes can be generated; There is no diverse manipulation of features.	There have been successful cases, and the products can be smooth, waterproof, sustainable cycle; There are related research centres in Netherlands, Germany, the United Kingdom, China etc.	Cell polarity and growth rate affect mycelium morphogenesis; As furniture material is easily affected by room temperature, humidity and other environmental factors; Different fungus need to be selected for experiments; Most experimenters still need to mix it with wood, waste or other materials.

Drawing inspiration from natural systems and using advanced digital tools, designers can create products and spaces that are both functional and aesthetic while minimising their environmental impact. Integrating these design approaches can lead to more efficient and sustainable designs, benefiting both people and the planet.

Methods

The research is based on taking advantage of computer vision and sensing improvements. The key is determining which rhizomes can be controlled by effective parameterisation. The transverse comparison was conducted on three raw materials of bougainvillea glabra and fungi as the primary analysis objects. The focus is mainly on the physical characteristics of the two materials, the advantages of application, and the weakness of furniture design. There are two reasons for the materials chosen: firstly, the accessibility of the material was a key consideration. Bougainvillea glabra is widely grown in the southern regions of China and fungi are well-researched for cultivation. Secondly, the team included sustainability and low carbon as core objectives in the initial design planning. In other words, we wanted to eliminate unnecessary industrial processes throughout the design. Ensuring the original growth of the plants was another key factor considered. Therefore, combining these two considerations led to the selection of trillium and fungi as the two alternative raw materials.

It is clear from Table 1 that the biological characteristics of bougainvillea glabra - its ability to survive for long periods, the width and length of the plant's roots, and the fact that it is grown over a large area in southern China - make it very suitable as a raw material for plant furniture. Although fungi are also extremely plastic. The use of fungi as a raw material for furniture may require the production of appropriate abrasives for the targeted cultivation of colonies and a series of tests on the load-bearing capacity of the furniture once it has been shaped. Thus, bougainvillea glabra was chosen as the main object of study. However, it is not the perfect raw material in its original form. The biggest problem is its slow growth rate. Therefore, various nutrient solutions (to promote growth) were used for testing during the design process. In the end, coconut water and tetracycline-based growth hormone were used in this study as the main nutrient solution to stimulate the growth of bougainvillea glabra.

Results

The study is currently in its experimental phase and is set in a factory located in Wuhan, China, where the root of the bougainvillea plant is being extensively researched. It should be noted that this is a conceptual investigation. The entire process can be divided into two parts: cultivating the roots to produce raw material for furniture design and using a parametric model to control the plant's secondary growth and shape it into plant furniture.

Cultivating process

The project is still in the experimental stage and should be considered an investigation on a conceptual level. Thus, a bougainvillea glabra design is taken as an example to explain in detail. First, selecting a container with a large basin mouth and mixing a large amount of river sand with culture soil is necessary to maintain bonsai. It is important to note that when planting the stump into the mixed culture soil, the bonsai stump should be raised above the mouth of the basin. River sand curing bonsai has good drainage permeability and is a better choice. Another point worth noting is that after adding a large amount of river sand, the soil's fertiliser protection performance is weakened, and water and fertiliser management should be paid attention to in the later maintenance to ensure the normal growth of plants. Let the roots sink deep into the soil. Then consider whether to transplant. The detailed steps include six, from root extraction to gravel cultivating root.

Table 3. Six steps of cultivating the root.

1 Root extraction	Coil up most of the root system and curl it into a certain shape. During transplanting, the root system of the plant should be lifted upward, preferably beyond the height of the pelvic mouth, and most of the coiled roots should be fixed with tools and wrapped in sand. In the normal maintenance process, under the influence of external factors such as wind, sun, rain, etc., most of the coiled roots will be slowly exposed, and the improved roots will be slightly shaped and processed. Expose the root system in a regular time and remove the soil from the roots of the plant, leaving some of the roots bare.
2 Developing root	Fill a deep cylinder pot with a layer of soil (nutrients added with growth hormones) at the bottom and sand at the top. Plant the prepared plants in the pot. In order for a plant to grow, its roots will keep spreading down to absorb nutrients. What we need to do is, every once in a while, remove some of the sand from the top of the pot, so that the root system will slowly come out. Finally, the roots of the plant have sunk deep into the nutrient soil at the pelvic floor. After the upper layer of sand is removed, the plants are replanted in the pot together with the nutrient soil, and the exposed roots can be artificially fixed with tools after shaping. After a period of time, it can be set, and this time can be exposed to the natural wind and sun, which can naturally promote the aging of the exposed roots.
3 Revealing the roots	Plant the plants in shallow POTS. Due to the limited height of the pot, the root system of the root part of the plant will definitely be exposed to the soil of the pot. The root system can be gradually fixed, and finally shaped.
4 Desoiling	If breeder want to create the effect of hanging roots and exposing claws, you need to expose the roots on the surface of the soil. You need to spray water, and you need to flush the soil away from the surface and expose the roots.
5 Choking	Plant into the pot, pile soil at the roots so that the base of the plant is above the pot but not completely exposed. Wait until the plants are alive in the pot, slowly from high to low remove the backsoil, after a long time of maintenance and shaping, can be replanted on the pot.
6 Gravel cultivating	Use plastic to roll up and make a cylindrical drum without a bottom, or use a wooden bucket or bamboo basket without a bottom to surround the plant and fill it with sand, a few pebbles, water and fertilizer. Once the plant is alive and the roots have penetrated into the soil beneath the sand, remove the sand from the top several times, preferably at different intervals with the help of growth hormones. Finally, remove the roll and reserve the finished product.

Parametric growth

The main branches were intentionally bundled and different environmental stimuli, including water, gravity, touch, and media, can guide plant roots. With artificial manipulation, plant roots can be shaped to grow in various directions and either stay on the surface or penetrate obstacles they encounter. In

materials science and engineering, the porous structure of parameterization allows plant roots to form a network structure with bearing capacity. By placing obstacles in the direction of growth, the roots can be shaped, and the hierarchical drive of botanical roots can be combined with parametric porous structures. After experimenting with AGAR medium and 3D porous barriers, small and large porous pla structures were 3D printed to design appropriate barriers for the roots and complete the "parameter porous bead experiment." The "bonding ability" of the roots associated with the porous structure enables them to combine into 3D blocky patterns with high compressive strength, verifying that the porous structure of the 3D printed plant can produce a certain tolerance in root formation.

The process of parameterizing plants can be divided into eight steps. Firstly, record the growth of the plant roots, including growth rate and time. Next, an algorithm is generated, which may be integrated within the GH modelling software. Thirdly, the initial furniture design model is set to roam freely. Fourthly, record the user's body data in detail. Fifth, determine the rhizome (starting point), which involves combining personal data with the user's usage habits, distribution of force points, and common postures. Sixthly, using this data, deepen the model and set the "obstacles" and "collisions" in the GH parametric modelling software. Seventh, use a Boolean Toggle to control the reset operator. Eighth, the rootstock grows gradually according to the obstacle position, creating a stable path network. Extract the trajectory lines and use the Weaverbird plug-in to smooth the surface (which can be set to subdivide the structure). Finally, a furniture model with a support structure is created.

There are several recommendations for this whole process. The main branches should be kept bundled and guided. Plant roots can be shaped gradually in different environments by water, gravity, touch, and other media. Plant roots can be artificially guided to grow in all directions and can stay on the surface of obstacles or penetrate them when encountered. In the porous structure of parameterisation, the plant roots can form a network structure and develop bearing capacity, because the porous structure allows the plant roots to grow into a denser network structure with a higher degree of fit that ensures a stronger network structure.

Figure 1. The grinding picture of the production process.

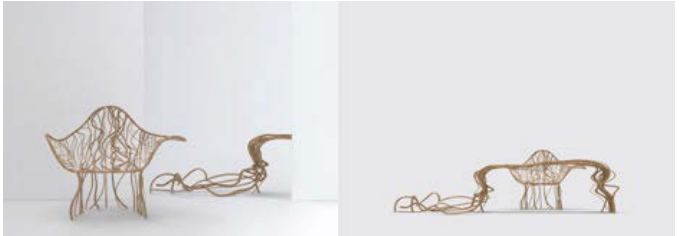

Figure 2. Effect pictures of the two items.

The project initially planned to include a wide range of furniture products, such as tables, baskets, chairs, lamps, etc..However, there was a shortage of funds during the project. The final products therefore consisted of a chair and a table (see Figures 1&2).

Conclusion

Sustainable design is the global challenge and goal of humankind. Sustainable product design and production driven by technology can reconstruct human and environmental relationships. As the embodiment of this concept, plant furniture design is important. Taking the tree house as an example, it can effectively withstand nature's storms. After an earthquake or tsunami, the only structure that can guarantee human survival is a treehouse. This design is also significant for improving the urban environment and solving the housing problems of low-income and homeless people.

In addition, plant furniture is of great significance for establishing a biological regenerative life support system. Bioregenerative life support system is the core technology of long-term manned space activities in the future. It has the advantage of continuously regenerating oxygen, water and food, the necessities of life for human beings, in a closed system. Plant is an important part of the biological regenerative life support system. Plant furniture can complete its metabolism and regulate indoor and outdoor temperature and air quality, significantly benefiting disease patients, medical places, urban planning, etc.

There are drawbacks to such studies. The first is the high cost of input. Suppose the related techniques are to be promoted on a large scale. In that case, further experimental studies on the rhizosphere growth of Bougainvillea are needed, such as experiments on guided growth in different environments. Later user testing, as well as the cost of promotion, are significant expenses. Secondly, the maintenance of the product also needs a series of experiments to test its usability, such as whether it will grow mouldy in the supermarket environment, how to maintain it and so on.

Creating a meaningful product application concept, i.e., designing for material experiences, takes much work. It requires a critical understanding of what the material offers in terms of function/utility and overall experience: *how it gratifies or disturbs our senses, what meanings, associations, and emotions it evokes, and what it makes us do* (Giaccardi & Karana, While a material with endless combinations of its ingredients, would excite and inspire designers in exploring its possibilities for design, this may also give a sense of uncertainty (Daalhuizen, Badke-Schaub, & Batill, 2009; Krishnan & Bhattacharya, 2002), as the *boundaries of the material* would not be known in an early stage of a material-driven design project (Barati, Karana, & Hekkert, 2015).

In a word, this research uses this case to analyse the characteristics of the growing design process, which aligns with the notion of WHO 2022 sustainable development goals. The creative thinking and design of material and product concurrently expand the boundaries of design toward new territories asking for new tools and methods, which also is one of our future research endeavours.

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Systemic Design Oriented Leadership (SDOL) – a co-created play for eco-social leadership development with the methods of systems thinking

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Abstract

The global economy is at a turning point, having reached its limit long ago after many decades of fossil fuel economy and growth thinking. Moreover, the world is becoming increasingly complex, accompanied by social, political, climate and technological challenges. The global COVID-19 pandemic has highlighted the interdependence and interconnectedness of different systems. Organizations that have to constantly adapt and reinvent themselves to changing situations require leaders who have learned to think in a connected way, to experiment, to endure uncertainty and, above all, to change their mental models.

In recent years, organizations invested considerable effort and resources to developing and enhancing the leadership skills of managers through various forms of Design Thinking tools and Design methods. Nevertheless the complexity for human and ecological problems asks for a further education of leadership actors, towards a new leadership mindset – beyond Design Thinking methods. Current leadership training programs aim to develop individual skills and growth of leadership without considering this in a systemic context and promoting the systemic perspective. How can a Systemic Design Oriented Leadership (SDOL) play kit - developed in co-creation - enable tomorrow's leaders to see the whole picture and to make systemic decisions that are sustainable and social?

In order to train leaders in an eco-social thinking and behavior a Systemic Design Oriented Leadership (SDOL) play kit was developed. The method framework was set to Grounded Theory (Glaser, 1967) and Systemic Action Research (Burns, 2014), where playful, experimental interventions were designed, methodically recorded and evaluated together with the managers in regular co-creative workshops.

Through SDOL play kit, leaders are able to understand complexity and at the same time the play kit can serve as a compass, that influences the strategic competence of leaders to make eco-social decisions. SDOL as a play and co-creation trains the new skills for eco-social management in organizations. It allows leaders as players to experiment, speculate and react to behavior in play by the infinite game of synthesis, critique and redesign.

Author keywords

Leadership, Systemic Design, Systems Thinking, Play, Co-Creation

Introduction

In the context of digitalization, climate change and overlapping crisis, many companies are facing a huge complexity in the world. More than ever, companies and their leaders are challenged to think and act in a systemic way. In recent years, organizations invested considerable effort and resources to developing and enhancing the leadership skills of managers through various forms of Design Thinking tools and methods. Managers in middle and higher management positions have clearly realized the business values of design methods, especially Design Thinking (Badjoko, 2018) and User Experience, that have have been at the forefront of supporting digital transformation in companies (Magistretti et al., 2021). The leadership of tomorrow might has to experiment and needs new design strategies beyond Design Thinking. Authors such as Beehner (2019) argue that leadership has to enter into new relationships with nature, society and individuals in order to be able to make a sustainable, trust-based impact on solving problems. The new approach for leadership develops towards an ethical approach as Beerel (2020) formulated in her book "Ethical Leadership and Global Capitalism: A Guide to Good Practice". She argues that "(...) ethically sensitive managers need to engage in self-examination and developing their own self-awareness. They need to reflect on the kinds of people they are, their value system and the types of decisions they make. They need to be open to self-development and change and should seek out for opportunities for personal growth and challenge". Also Mugadza et al. (2019) explain how leadership has changed since the Pre-Industrial Age - from the born leader in industrial times towards innovative leadership with a Systemic Design perspective.

It seems that traditional innovation methods such as Design Thinking or UX Management might not be sufficient anymore for an eco-social leadership development. Habicher et al. (2021) conclude in their research on transformation of leadership in SMEs, that Design Thinking plays only a marginal role in the firms, if it comes to socio-ecological transformation. Current leadership training programs aim to develop individual skills and growth of leadership without considering this in a systemic context and promoting the systemic perspective. If organizations are looking for new leadership or eco-social leadership development, managers might first be trained in Systems Thinking, in analyzing relationships between stakeholders and finding patterns in behavior. How a ludic Systems Thinking in

leadership development can change a mindset from growth to a more sensitive one into the direction of social and ecological decision making, has not been extensively researched. There are almost no tools in leadership development that focus on a change management by Systems Thinking play and game dynamics beyond design thinking methods.

The central objective of the ongoing research project is the question to which extent Systems Thinking as a ludic intervention embodied in a serious play kit can influence the personality development of managers to act in a socially sustainable way in order to transform corporate structures.

How can a Systemic Design Oriented Leadership (SDOL) play kit, developed in co-creation, enable tomorrow's leaders to understand complexity and to influence the strategic competence of leaders to make systemic decisions that are sustainable and social?

This paper shows the first results of the author's ongoing research project SDOL and the co-created ludic intervention.

Theoretical concept of play

Play seems to be a serious opportunity to make the reality of work more motivating and meaningful - not only for leaders. Because play seems to enable people to reflect themselves, to question behavioral patterns, to test and explore interactions in a group. Also play might enable people taking over risks and bearing uncertainty, which is often the case in design processes. Brown et. al for example claim, that play is a catalyst, like design methods, for being productive and creative (Brown et al., 2019).

There seem to be various definitions in literature of what play is and it might depend on its nature, purpose and manifestation. Three famous examples might be the definitions of authors such as Huizinga, Vygotsky and Rubin. According to Huizinga (1955), play is a free activity standing quite consciously outside 'ordinary' life as being 'not serious', but at the same time absorbing the player intensely and utterly. In psychology Vygotsky (1978) for example characterized children's play as an activity that is "desired" by the child, "always involves an imaginary situation" and "always involves rules" (which are in the minds of the players and may or may not be laid down in advance). Rubin et al. (1983) characterized play as a behavior that is intrinsically motivated, focused on means rather than ends, distinct from exploratory behavior, nonliteral, free from externally imposed rules and actively engaged in by the players.

As Gray (2013) e.g. concluded that essentially all of the descriptions of human play can be boiled down to the five characteristics: Play is an activity that is self-chosen and self-directed, intrinsically motivated, guided by mental rules, imaginative and conducted in an active, alert, but relatively non-stressed frame of mind. Gray's conclusion seems to describe the qualities of creative thinking in design processes and seems to have similar arguments to Mainemelis et al. (2006), who proposed that play facilitates five creativity-relevant cognitive processes: problem framing, divergent thinking, mental transformations, practice with alternative solutions and evaluative ability.

Figure 1. Shows the comparable framework of the author and Mainemelis.

The SDOL research project follows the definition of play according to Mainemelis, because of the comparable System Design teaching process that was developed by the author at the HTW Berlin: Synthesis, Critique and Redesign (fig. 1, see below).

Table 1. Shows the comparable framework of the author and Mainemelis.

System Design teaching process	Mainemelis et al. play process
1. Synthesis – exploring the system	Problem framing and divergent thinking
2. Critique – identify the leverage points	Mental transformation
3. Redesign – create the system interven-tion	Practice with alternative solutions and evaluative ability.

Methodology

The methodology is inspired by Grounded Theory and Systemic Action Research where playful, experimental interventions were designed, methodically recorded and evaluated together with the managers in the co-creative workshops. The process in the ongoing research project SDOL took place both horizontally in the leadership teams and vertically in the individual areas.

Organization of the workshops

Together with the participating leaders (finance and consumer goods industry) three consecutive workshops, based on the Systemic Design process mentioned before, were organized. Each workshop duration was up to four hours, twelve leaders from different departments participated. For the first workshop on *"Synthesis – Explore the System"* the leaders got information by forehand in form of articles on Systems Thinking, Systemic Design process and the goal of the workshops. Each of the three workshops started with a playful warm-up. The task in the first workshop was to define the personal definition of leadership. The guiding questions in the first workshop were:

What personal competences distinguish you as a leader? What is your eco-social perspective in your context (team, company, organization, etc.)? How would you describe your leadership style? What challenges do you face in your leadership position? After this, each group had to present and discuss their personal challenges and definition on leadership in their current status in the whole group.

The aim of the second workshop *"Critique – Identify the Leverage Points"* was to reflect on the re-enactment of leadership and the causality in order to identify leverage points for transformation. The task was to replay recruiting moments within an re-enactment. The challenge was to set up a role play, where three persons took over the part of the company's perspective and preparing questions on economic, social and

ecological positions. At the end they had to discuss the behaviors and feelings in the re-enactment.

In the third and the last workshop *"Redesign - create the system intervention"* the leaders had to prototype with LEGO® Serious Play® the ideal leadership play. The first task was to answer reflective questions on the own purpose of leadership. The guiding model derived from the original IKIGAI model (Kamiya, 1966) that was presented to the participants before starting the challenge. The questions for the own reflection were adapted to the eco-social focus: What are you really good at? What do you love in nature? What does our society need? What do you need for your organization or team? Answering these questions and having had a deep inner personal reflection in the first two workshops, the participants had to redesign their mental model of leadership as a play.

After each of the three workshops the participants got a questionnaire via E-mail for evaluating the overall experience and describing transformational moments in their organizations.

Figure 2. SDOL Workshop, Celik P. (2022)

Results

The group discussions, observations, individual interviews and retrospective questionnaires produced the following results: 85% of the workshop participants had no former knowledge about Systemic Design and Systems Thinking processes and 41% would like to have even more information about the presented model "Synthesis, Critique and Redesign".

In addition to the transformations of the directly used tools, 82% of the leaders report that the playful exercises moved them to a changed self-perception and new behaviors. The exploration of the play inspired all leaders to use ludic interventions in daily business. Overall, 79% of the leaders report having better understood systemic leadership through the play workshops. Five leaders stated that playful moments made them think how to overcome the routines in their organizations and to be more sensitive for eco-social decisions in their teams. 92% of the participants were "very satisfied" with the task in the first workshop and the inner reflection. Three participant described the challenge in the first workshop "as a very emotional moment, becoming aware of mental role-models and their implications". One participant suggested to have a predefined selection of leadership motives, which they could have selected making a postcard story for leadership. 57% of the participants said that the role play in the second workshop was very challenging in terms of presenting in front of the group and 23% described "an overcoming moment of shame". Seven participants state that the role plays provide important projection areas for what they believe is inconsistent in application processes in large companies. Reflecting on the recruiting process in the company 87% have seen this as an enlightening moment to change something. For two workshop attendees play artefacts, f.e. rolling the dice on salaries, was an ethically critical moment that should be discussed further. Overall, 90% of the participants were inspired by the re-enactment challenge to further develop their own recruiting processes. In the third workshop 95% of the participants observed that the personal information shared between leaders in the "IKIGAI - challenge" was much closer to the "own heart" than it would be in a business context, where it is nearly always about "pretended roles" and rarely about self-reflective motivations. One participant commented that something like self-awareness does not usually happen in the business world, but that the playful workshops had managed to do this. Overall, 70% of the participants reported that the play workshops inspired them to change something about their leadership style. Across all workshops, 71% of the leaders reported that the activities gave them an inspiration for eco-social leadership development. 90% of the participating leaders would recommend a Systemic Design Oriented Leadership (SDOL) perspective through play and two leaders recommended more challenging play situations that could even take place in nature to reflect on eco-social decision making.

As a result of the three workshops, that is based on the feedback and the Systemic Design process of the author, a Systemic Design Oriented Leadership play kit was prototyped.

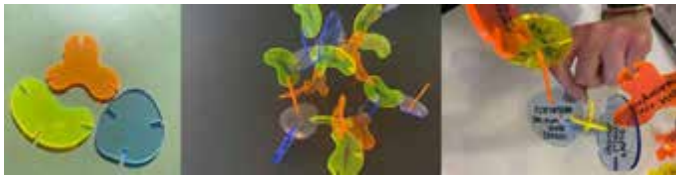

Figure 3. SDOL play kit, Celik, P. (2022)

The first idea of a SDOL play kit consists of three differently shaped elements of colored acrylic material. Each color or element refers to one of the systemic levels such as Synthesis, Critique and Redesign. These shapes can be connected and related to each other. The aim of the play is to answer questions on each level and to connect them. The questions on each shape are based on the questions from the third workshop, but also derived from the inner leadership reflections of the first and the second workshop:

- Orange (Synthesis level) = *What do you love in nature?*
- Yellow (Critique level) = *What does our society need?*
- Blue (Redesign level) = *What does your organization or team need for eco-social decision making?*

The play is prototyped for 12 participants and has three levels, where each participant has to create his/her artefact by answering the questions. The play takes 100 minutes in total. It starts with a short introductory presentation on Systemic Design and Systems Thinking (10 minutes). After the introduction the participants get the first question for the orange coded level of "Synthesis" *(What do you love in nature?)* presented and have to write down their answers (15 minutes). They are allowed to write one term on one acrylic shape and can use as much as needed. After this they have to answer the second question on the yellow level "Critique" *(What does our society need?)* by writing on the yellow parts (15 minutes) and after this they step over to the third blue level "Redesign" *(What does your organization or team need for eco-social decision making?)* (15minutes). After writing

down the answers for all three levels the participants have time to stick the single acrylic parts together. They have to decide on their own how to connect and relate the individual terms or answers on the color-coded levels to each other (15 minutes). With the elements of the play kit the participants create a structure or artefact that helps to understand complexity and reflects the personal leadership ecosystem. At the end, the participants are asked to present, discuss and reflect their artifact in groups of two (30 minutes).

Conclusion

A systemic orientation of the economy is needed, and this requires leaders who are trained to think in systems and create impact (Barge et al., 2008). Particularly young employees (Millennials and generation Z) might be questioning classic leadership roles and are orienting themselves towards companies that represent social and ecological values (Titko et al., 2020). There is a potential in serious play to evolve the role of leaders from "mitigators" and innovators to systems thinkers, interested in shaping ecological and social change.

The three workshops are related to the process of the authors Systemic Design Model (Synthesis, Critique and Redesign). The methods of Grounded Theory and Action Research took place in every step and allowed to reflect and develop the co-created SDOL play kit.

In the SDOL workshops there were plenty of playful moments and discussions about leadership values and the systemic perspective. A shared trust was quickly established in the play, which enabled honest feedback and made independent collaborations between the partners. Through the co-created plays in the workshops the leaders were empowered to experiment corporate cultures and to use ludic interventions to further develop the innovative power of their organizations. Set into the business context, systemic play suggestions, like the re-enactment and in particular the "salary dice", raised ethical questions. Leadership might have the inner conflict of acting fairly, both with new recruits and the annual salary negotiations. But fairness might be a question of perspective. This example shows clearly that the systemic perspective of the manager might be missing in order to be able to make a socially fair decision. Therefore the focus in SDOL is on a constant reflection with the participants on the effects and adequacy of the methods that were developed in a co-creative process. Especially in the third workshop, the participating leaders revealed a lot about themselves as they went to an inner journey to find their "IKIGAI". Inspired by the third workshop a first SDOL play kit was prototyped.

At present, this co-created play is still in work and evaluated. It is being tested with a bigger group of managers and there is a need to explore the play kit with a higher relation to nature as well as to specify socio-ecological questions regarding the particular fields of action in daily leadership.

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Design for transformation. Unlock competencies for coping complexity

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Abstract

After almost three years since the Covid outbreak, the structural damages the pandemic wreaked are finally becoming more evident than the death toll. A growing crisis that affects the public sector, families, and companies is anticipated by failed businesses and routines that have been disturbed by the fear of the invisible. The university enters this situation as a strategic place for research and a training ground for experts who will steer the transformation.

Grounded on a vision of design as a force of change, the Imagis Lab research group has investigated the different meanings of "design and transformation" since 2015, probing the transformative skills of distant professional worlds. The focus has been on understanding design's role in promoting change processes. So to know how to be a human and professional anchor capable of activating contemporary, sustainable and long-lasting organisational change.

The first part of the paper will provide a description of the main actions and insights from the Research Through Design approach. The research, started in 2018 and still ongoing, begins with an insight: digital transformation is human-driven. This a statement that prompted us to investigate the role that design, marketing and communication can play in organisational change processes. The second part of the paper is devoted to presenting the reflections on the transformative competencies inherent to the design practice, among which are: emotional agility (listening for self and others); leadership (motivation for self and others); creativity (breaking from automatism and identifying an actual solution); storytelling (insight and creation of new meanings).

As a result, we propose to look at the design(er) as a figure able to challenge contemporary complexity (strategy) through active listening and empathy (human-driven approach) for identifying contemporary solutions (marketing, product, and service) developed by sequencing seemingly distant dots (design) and conveyed through new meanings (storytelling).

Author keywords

Design for transformation; Design attitudes; Soft competencies; Emotional Agility; Leadership; Creativity; Storytelling.

Introduction

Almost three years have passed since the Covid outbreak, and the structural damage caused by the pandemic is now emerging clearly beyond the death toll. Failed businesses and routines disrupted by the fear of the invisible anticipate a progressive crisis that strains public administration, families and businesses. Into this scenario comes the university, which, on the one hand, stands as a privileged place for research; on the other hand, it prepares professional figures to lead the transformation (Stolze et al., 2018; World Economic Forum, 2020). In this technological, economic and social evolution context, digital transformation emerges as an increasingly relevant and unavoidable phenomenon in the business landscape (Kane et al., 2015). Suppose we understand Digital Transformation (henceforth DT) as a process enabling a major cultural transformation (Kraus et al., 2022). In that case, there emerges the need to understand how design, marketing and communication become crucial areas of a process that involves people first and foremost.

Our work aims to define how the practice of design emerges as an indispensable asset for developing cultural transformation within companies and what are the competencies of this new type of consultant: the designer for transformation.

Design (Manzini, 2015), marketing (Kotler & Keller, 2009) and communication (Jenkins et al., 2013) have historically been levers for reaching and engaging audiences. The difference from the past is that today, with the implementation of digital technology, they acquire a renewed ability to respond to audience needs. They become natural enablers in organisations' transformation processes because of their ability to collect and interpret data by understanding the target audience's needs and intervening directly in the relationship between supply and demand (Ronchi et al., 2020).

Main actions and insights coming from the Research Through Design

Grounded on a vision of design as a force of change (Design Council, 2021), the Imagis Lab research group has investigated the different meanings of "design and transformation" since 2015, probing the transformative competencies of distant professional worlds. The focus has been to understand the role of design in fields where the "know-how" connected

to a specific aim gives way to "knowing how to orient" in the unknown. So to know how to be a human and professional anchor capable of activating contemporary, sustainable and long-lasting organisational change.

Step 1 - Digital evolution pushes the transformation

In light of such premises, a scenario emerges in which the ubiquitous incorporation of the digital everywhere brings the entire market system facing an inevitable transformation. The consequence is that economic and social changes enormously alter the mediascape (Appadurai, 1990), pushing society toward a scenario in which relationship becomes a key element of communication and market innovation mechanisms, especially in its newer forms. In this sense, the shift from multichannel to omnichannel paradigm and digitization (Bloomberg, 2018; Mazzone, 2014; Rogers, 2016; Westerman et al., 2011) revolutionised outcomes and also work processes in many fields of application. Suppose we strive to read the contemporary in these terms. In that case, DT presents itself as a process of the evolution of business culture and a re-interpretation of the tools available to the enterprise.

These reflections prompted us in 2018 to investigate the role design, marketing, and communication can play in organisational change processes. The output of this first phase was a book that allowed us to focus on the insight that guided the research's development: DT is human-driven. Then, the main evidence was the understanding that to activate a DT, we must first activate a listening process. Therefore, figures who can listen, translate the needs gathered and mediate this information with the technology, and business aspects are needed.

From which a series of assumptions were then detailed:

- DT is a process of identity evolution;
- DT is a process of changing managerial culture;
- DT is a reinterpretation of the tools available to the enterprise;
- DT directly impacts people, and this determines the real revolution.
- DT is NOT a simple implementation of digital technology within business enterprises.

Step 2 - Focusing on design opportunity

From these insights, we wondered what the role of design and designer could be within the DT processes that become value-driven and human-driven.

Then, in 2019 we started to investigate the characteristics of the designer who leads the transformation, with the identification of the design opportunity: what characteristics enable design(er) to activate and lead the transformation?

Therefore, we decided to conduct experiments carried out in collaboration with different companies, applying a Research through Design (RtD) approach (Frankel & Racine, 2010; Frayling, 1993) that involved the collaboration of different stakeholders: researchers, practitioners, companies and students from the School of Design were involved in educational and design experiences that applied co-design methods (Björgvinsson et al., 2012; Sanders & Stappers, 2008) and open innovation (Chesbrough & Bogers, 2014).

All the experimentations allowed us to identify the design practice as an attitude to change. A design attitude, capable of fostering a cultural change and a new mindset that integrates design, techne, leadership and emotional intelligence: what we identified as competencies for transformation, investigated in the next step.

Step 3 - Design competencies for transformation

In 2020-2021, we focused on understanding the competencies potentially stimulated by design education curricula and professional pathways, following the adoption of the knowledge, skills, and attitudes model (henceforth KSA's Model) (Bloom, 1956; Krathwohl et al., 1956) for mapping human competencies and supervising three Master's theses on the topic.

The pathway stems from an in-depth study of the digital transformation process of the Italian business unit ABB Sace, a leading multinational company in the technological sector, carried by the design agency *Twig* (www.twig.design) between 2016 and 2019. In 2020, Giulia Sormani and Marco Ronchi were interviewed several times by Professor Paola Caiozzo, co-founder of the Commercial Excellence Lab (CEL) at SDA Bocconi. They illustrate with which mindset the organisation of processes, roles, skills, tools and actions was rethought: it emerges how much design has been recognized by the sponsors of the transformation as a discipline with a high contribution to agility and complexity resolution. Several questions emerge from the debrief, including those related to the distinctiveness of design dealing with organisations' transformation:

- What are the differences between a design-driven versus a technology-driven or economy-driven transformation?
- What competencies does design bring to make its contribution to transformation unique?

If we talk about design's authority:

- How fully is design recognized as a discipline capable of managing a transformative process?
- Why does the (Italian) market struggle to recognize the designer's governance of a transformative process, but more so its execution?

If we talk about design awareness:

- What prevents design from dialoguing at an equal strategic level with the (Italian) engineering, technology or business communities?
- Are there moments of organised awareness within design education pathways that allow young designers to question the transformative capabilities of the discipline and the strategic-executive ones?

The connection of Imagis Lab with Paola Caiozzo confirms the importance of involving a scientific community external to design and intrinsically linked to management and business organisation. Of all the areas explored, what forms the basis for further study is the common need to understand what competencies made design peculiar to change in an organisation with a strong engineering culture.

The master's thesis of Alice Cassanmagnago (2020), deepened the previous reflections of Bartram and SHL Group's model "The Great Eight" (Bartram, 2005; Bartram et al., 2002) within a methodological and cultural excursus that 1) analyses the competencies of the designer through the eight domains presented in the model, 2) selects among the 112 listed competencies those most consistent with its figure, and 3) classifies them into:

- Core competencies: the "know-how" classically acknowledged to design;

- Strategic competencies: the "knowing how to be," not yet fully recognized to design;
- Transformational competencies: "knowing how to change," not recognized to design.

The mapping activity highlights significant areas of overlap with the disciplines historically devoted to business management, identifying planning, listening, and collaborative approach as the distinctive characteristics that form the basis for the subsequent investigation of design's "transformative attitudes." Not forgetting all those "know-how" skills already recognized.

Then, Marco Ronchi and Serena Ballabio continue the investigation by supervising two more theses, focusing the insights of the first investigation into areas of high transformative need:

- The thesis of Filippo Collura (2020) investigates the role of the designer in sustainability-related processes using the framework previously developed by Alice Cassanmagnago (2020), and focusing on what skills can contribute to the adoption of effective circular economy processes. The dissertation 1) analyses models from The Circular Design Guide (*The Circular Design Guide*, n.d.), research from Delft University of Technology, and the Cyclon case study; 2) links insights from these sources with to the transformative skills identified in the previous dissertation; and 3) proposes a new tool aimed at design practitioners with an aptitude for sustainability. The result is a useful tool for navigating within circular economy processes and understanding how design skills can make an effective contribution to the development of circular economy processes: the *Design(er) for Sustainability Framework*.
- The thesis of Giorgia Calloni (Calloni, 2021) investigates the needs of the third sector in Italy through a side-by-side journey with the *Cooperativa Rapsoidea*, committed to solving the educational emergency triggered by the first wave of the Covid-19 pandemic in the province of Bergamo, Italy. The cooperative's mission is to build co-design experiences with different stakeholders in the area, pushing young people to take charge of the territory's needs by exploiting and investigating the possibility that the discipline of design supports them in the construction of their "life project". In this case, the output is the ETS Partnership activation toolkit: a tool aiming at guiding social workers in engaging third-sector entities, engaging youth, gathering needs, forming a group for the related development of design responses, and using a design-driven approach.

Step 4 - Humans through transformation

At the end of 2021, the collaboration with Cooperativa Rapsoidea took a specific shape during the Final Design Studio in Communication Design involving design students, local youth and stakeholders from the province's social, cultural and productive fabric of Bergamo.

Twenty-five young designers were provided with the basis for investigating the transformative competencies previously identified in themselves. Then, after framing the concept of competency, the students were asked to step into the shoes of coaches and facilitators of 20 youth from the area (aged 16 to 19), guiding them in listening to the needs of stakeholders and redesigning some symbolic places in the area:

- Stimulating in themselves the skills preparatory to activating, orienting and guiding a transformation process;
- Transmitting these competencies to youth who have never studied or heard of design, without directly contributing to the solution but exclusively transferring mindset and method (design thinking) to them.

At the end of the four-week course, students analysed their experience and skills through a questionnaire based on "The Great Eight" model to make them reflect:

- Whether in their undergraduate design journey, they had ever been aware of or had ever been placed in the conscious condition to question the above transformative skills;
- Whether in their undergraduate design journey, they had ever been trained explicitly on the transformative skills that emerged;
- Whether prior to the just-completed co-design experience, they felt that they were naturally predisposed to some of these skills;
- Whether, after the just-concluded co-design experience, they felt that they had activated some of these previously dormant skills;
- Whether they had questioned the importance of one or more of these competencies for their professional future.

Future framework for contemporary transformation

Through our experiences in the field and analysis of data from open innovation in education, we have identified three key moments in the design process in which transformation is enabled:

- Needs: design formalises the ultimate purpose of transformation (meaning), traces the processes to activate it (systemic vision) by placing human needs at the centre of inquiry (empathy);
- Competencies: design identifies externally (designers) and internally within the organisation to be transformed (internal stakeholders) the competencies (knowledge, skills and attitudes) needed to initiate and guide the process;
- Community: design creates moments of shared design (co-design) that enable designers to stimulate the transformative attitudes naturally present in internal stakeholders (engagement), transferring the design mindset (culture).

In particular, the area of "competencies" emerges as a moment to be further explored. Indeed, we understand that a better classification of competencies based on the continuous exchange and contribution from other fields can offer our discipline a different positioning towards managers who choose the path of transformation.

From this value proposition comes a new self-awareness framework dedicated to those who want to transform and those who want to support people that are getting things done. A tool based on four specific attitudes that design inherently promotes in the development of what we call "transformative courage," through:

- Listening to the self and the ecosystem as a whole (emotional agility) (David, 2017; Siegel, 2020), e.g. showing empathy and dealing with ambiguity;

- The search for purpose is what nowadays unites distant worlds (leadership) (Bruttini, 2007; Grant, 2013), e.g. making decision and motivating others;
- The breaking of automatisms and devising contemporary solutions (creativity) (Brown, 2019; Kelley & Kelley, 2015); such as analysing, evaluating information and thinking broadly;
- Identifying and constructing new shared meanings (storytelling) (Hansen, 2020; Roche & Sadowsky, 2003) in terms of negotiation and proactive communication.

These four fundamental competencies can be used transversely in design-driven transformative processes. However, they emerge in different proportions depending on the design process stage and the designer's characteristics leading the process. Whenever a designer addresses a path of organisational transformation in which the impact of change is primarily about people and their involvement, it happens systemically.

We understand through empirical observation in the field that the moment the designer comes alongside the ultimate target of the transformation–the user who will experience the outcome–he or she can decree the commitment and evolution of the process itself.

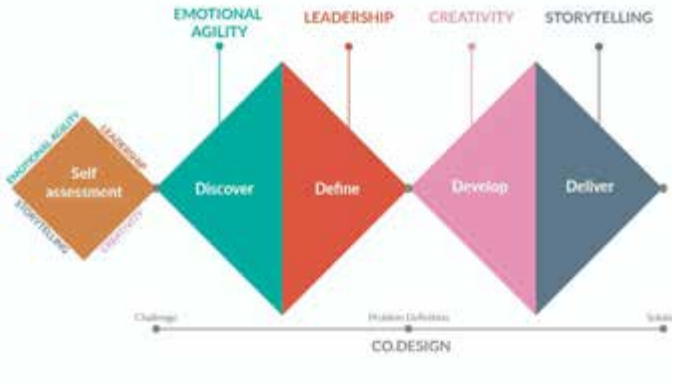

Figure 1. Visualisation of the 4 design attitudes across the double diamond in the design-driven transformative processes.

Final reflections

Historically, polytechnic culture has been credited with a multidisciplinary approach of intersections and tangencies between art, technology and humanistic culture, methods and technologies. Today, however, becoming a designer is not just about having acquired these skills and having gone through theoretical and design experiences: it is not (only) so much about "knowing how to do something better than others," but rather about "knowing how to stimulate in others what they have best to give," thus "knowing how to be without allowing for knowing how to do," interpreting contemporaneity and its scenarios, enabling the space and rhythm where others carry on the path according to their vision, while respecting their own identity and ability to contribute to the evolution of the ecosystem. The technical and tactical approach is fundamental. However, suppose we want to grow a new generation of designers "with transformative courage" to face the challenges of the contemporary world. In that case, we need to complement the technical skills with an expansion of the strategic ones that enables them to have a systemic vision by going beyond the strong pragmatism of Western culture (Morin, 2001).

In light of such premises, our purpose as a design research group is to propose the design(er) as a figure able to challenge contemporary complexity (strategy) through active listening and empathy (human-driven approach) for identifying contemporary solutions (marketing, product, and service) developed by sequencing seemingly distant dots (design) and conveyed through new meanings (storytelling). According to this, we must continue to promote and investigate these four aptitudes in the form of a framework.

To conclude, our goal for 2023 is to present and test the framework based on these four domains, which is useful 1) to design students as a pathway to self-awareness, 2) to business and public administration managers as a professional engagement tool, and 3) to designers themselves, to support the positioning of this new design attitude for transformation.

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Change agents: designers interpreting 'the social' and 'social' interpretations of design

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Abstract

Designers are a positive breed, and many scholars studying the extensive field of design and its professional history – including some involved with Cumulus Antwerp 2023 – seem to agree that designers can contribute to positive 'societal impact.' In this paper I investigate how these optimistic views of designers' alleged 'social agency' are actually constituted, by describing how – over time – different notions of design have been mobilized in relation to various understandings of 'the social.' In current times of complex, layered, and interrelated crises especially, designers and design theorists need to get their vocabulary straight in order to specify what design *can* actually do – as well as what it *can't*. I therefore argue that to articulate relevant and meaningful roles design might play concerning various problematic entanglements, it is essential to differentiate *problems* that can be fixed, from *issues* that can merely be stabilized (Marres, 2007), and approach both phenomena precisely for what they are. Moreover, by acknowledging that both problems and issues are not a given but rather need to be *constructed*, 'designerly agency' in relation to 'societal change' can be understood as consisting of both the framing, setting and solving of problems, as well as the articulation of issues, through the creation of objects, environments, services and systems.

Author keywords

Design theory; sociology; social theory.

Introduction

Typically, designers are an enthusiastic, future-oriented, and positive breed. And by extension, many scholars studying the extensive field of design and its professional history seem to agree that designers – for better or for worse – can contribute to 'societal change' or, at the very least, emphasize the potential 'social agency' of the design profession as a whole. Numerous publications – not seldom featuring ambitious, if not plain out pretentious, titles – endorse high expectations regarding the agency of designers and their alleged potential for positive impact on 'the social,' 'societies,' or – even more overwhelmingly – on 'the world' as such (see, for example, Monteiro, 2019; Scalin & Taute, 2012; Van der Zwaag, 2014).

Whether designers are regarded a "class of aware, well-informed, trained and educated people who can navigate … complexity, negotiating the snaky processes of technosocial change and guiding them toward the sustainable" (Sterling, 2005, p. 75), or understood as 'activists that can disturb existing narratives' (Fuad-Luke, 2009), the design profession is often held in high esteem regarding its alleged capacities to engender 'societal change.' Accordingly, design scholar Alastair Fuad-Luke (2009, p. xxi, italics in original) describes designing as "an essential human expression that will help us *all* to move towards more sustainable futures" and design critic Alice Rawsthorn (2020, p. 8) states "design has always had one elemental role as an agent of change that interprets shifts of any type – social, political, economic, scientific, technological, cultural, ecological, or whatever – to ensure that they will affect us positively, rather than negatively." These bold claims and statements regarding designers' alleged 'social agency' make one curious how these optimistic views regarding design's positive 'societal impact' are actually constituted. Has contemporary design then really transformed itself from an "agent of capitalism" (Dunne & Raby, 2001, p. 59) – primarily concerned with desirable, but essentially unimportant, superficialities – into an "agent of social change" (Resnick, 2019, p. 15) – a field of practices that concerns itself with the transformation (or even emancipation) of the more substantive facets of life?

In this paper I describe how different notions of design have been mobilized in relation to various understandings of 'the social' during different periods of design's professional history. I will suggest that relations between 'the social' and the ever-expanding realm of design are shaped both by 'solution-oriented' and 'problematizing' approaches – two fundamentally different ways to entangle 'the social' and 'the material' through design. I will attempt to demystify and specify notions of 'social agency' contributed to various design approaches. I will conclude this paper by highlighting a number of key concepts I deem essential to sharpen our vocabulary when addressing (in practice) and debating (in theory) design's potential for 'social agency' or for contributing to 'societal change': the crucial differences between *problems* and *issues*.

Designers interpreting 'the social'

With the fairly recent emergence of terms like 'socially responsive design' (Thorpe & Gamman, 2011), 'design for social innovation' (Manzini, 2015) and 'social design' (see, e.g., Resnick, 2019), one might get the impression that the professional field of design has only just recently 'discovered' its entanglements with social life. However, from its 'modern' emergence in the eighteenth century onwards – characterized by the division of labour (Sparke, 1987, 2010) in which, for designers, the activities of *forethought* and *planning* are often paramount (Buchanan, 1989, 1992) – authors such as

William Morris (1882), Walter Gropius (1935), or Victor Papanek (1971) have written extensively on the 'social aspects' and presumed 'societal impact' of designed artefacts (objects, environments, services and systems), both positive *and* negative.

Whether through 'top-down,' designer-led 'social engineering' (Argamakova, 2017; Caroll, 2006) or 'participatory design' aimed at 'social innovation' (Manzini & Rizzo, 2011; Mulgan, Tucker, Rushanara, & Sanders, 2007; Thorpe & Gamman, 2011), numerous designers have explicitly sought to engender and/or support 'societal change,' motivated by divergent objectives and interests (Colomina & Wigley, 2016; Van Helvert, 2016; Whiteley, 1993). Bound up with the development of industrial-capitalist societies, design was simultaneously mobilized to create new consumer markets (Whiteley, 1993), to 'elevate the general public's taste' by disseminating 'universal aesthetic values' (Sparke, 1986), and to engender large-scale behavioural change – for example, towards 'a modern way of living' (Colomina & Wigley, 2016; Wilhide, 2016).

Although contemporary design approaches referred to as 'social design' or 'social innovation' often promote 'bottom-up' and 'egalitarian' methodologies that typically involve participatory, open-ended creative endeavours (Manzini, 2016; Manzini & Rizzo, 2011), these present-day approaches just as well seek to "enhance society's capacity to act" (Murray, Caulier-Grice & Mulgan, 2010, p. 3) by engaging with impactful developments taking place within industrial-capitalist societies, such as the restructuring of welfare states (Mulgan et al., 2007) or the local consequences of globally dispersed economic activities (Manzini, 2016). Therefore, from the eighteenth century up until the present day, both through 'top-down' and 'bottom-up' approaches, design has been mobilized as an instrument for *social engineering* – understood here as activities geared towards the "organization of social activity for the solution of existing problems and achievement of specific goals" (Argamakova, 2017, p. 70).

Interpretations of design as a 'change agent' with 'societal impact' align particularly well with the concept of social engineering as the latter notion presupposes a modernistic, mechanical worldview that objectifies social life, and therefore interprets 'the social' as *a mechanism to tinker with*. As many designers – especially those working in fields heavily informed by the sciences – are familiar with navigating complex contexts where research and marketing meet future-oriented creative practices of conceiving, planning and producing (see, e.g., Forty, 1986), their particular field of expertise seems especially promising when it comes to 'engineering the social.'

Against 'the social' as a distinct category

If one speaks of 'social housing,' 'social work,' or 'social design,' 'social' is understood as a distinct class of phenomena existing alongside other categories such as 'ecological,' 'political' or 'commercial.' Employing a less fragmentary and more 'entangled' perspective, however, scholars such as philosopher, anthropologist and sociologist Bruno Latour (1984, 1999, 2005) argue that 'the social' cannot, and *should not*, be considered a pre-given category or separate domain as such. By regarding 'the social' a particular *type* of relations that can be set apart from, for example, politics or economics, 'the social' is being mobilized as a specific means to specific ends. Accordingly, also within the realm of design, different approaches and perspectives render 'the social' in various and divergent ways.

Consider, for example, how design is regarded an important contributor to 'social innovation,' a phenomenon understood as "new ideas that work in meeting social goals" (Mulgan et al., 2007, p. 8) and regarded a decisive catalyst "for types of economic growth that enhance rather than damage human relationships and well being [*sic*]." In short: 'social innovation' is considered a means to "tackle social problems" (Mulgan et al., 2007, pp. 5-6) – an objective that is also typically associated with a 'branch' of design referred to as 'social design,' defined by Armstrong, Bailey, Julier, and Kimbell (2014, p. 6) as a field of activities that highlights "design-based practices [geared] towards collective and social ends, rather than predominantly commercial or consumer-oriented objectives." As such, various authors within the realm of design treat 'the social' as a distinct category that is specifically connected to so-called 'social goals,' 'social problems,' 'social innovation,' and 'social design.'

Bruno Latour (2005, p. 5), by contrast, states how one might describe 'the social' as "a trail of associations [or] a type of connection ... between heterogeneous elements" that aren't all necessarily 'social' themselves. He argues how 'the social' is shaped by – and constructed through – relations between human and nonhuman elements that make up 'collectives.' These elements – 'actants' in Latour's (1993) words – mutually constitute each other's conditions, whether intentional or unintentional (Verbeek, 2014). Hence, scholars such as Latour (1999) and philosopher Peter-Paul Verbeek (2014) argue that features like 'intentionality,' 'autonomy' and 'agency' – which since the Enlightenment are often considered typically *human* characteristics (see also, Taylor, 2004) – are actually the result of sophisticated interactions between both human beings *and* nonhuman 'actants,' such as (technological) artefacts. Latour (1993) and Verbeek (2014) therefore put forward that it is untenable to maintain a dichotomy between autonomous human subjects and solitary nonhuman objects, as it is the sophisticated *relations* between human and nonhuman elements that mediate phenomena such as intentionality and agency.

Entangling social and material elements through objects, environments, services, and systems might be considered the core business of designers. This begs the question what specific factors might then possibly constitute '*designerly*' forms of 'social agency'? Do designers indeed entangle 'the social' and 'the material' in specific ways that boost design's potential for 'societal impact'?

Demystifying 'designerly agency': what *can* design do?

Especially in those branches of design where engineering is a key component, designing is often primarily considered a range of problem-solving activities. This (ubiquitous) solution-oriented perspective on design is underpinned by the stubborn habit to consider even the most complex and layered phenomena *problems* – suggesting that they are *solvable*. Consider, for example, how designers Bruce Mau and Jennifer Leonard (2004, p.18) in their quest for 'massive change' render "the welfare of the human race ... a design project, a practical objective," or how design scholar Elizabeth Resnick (2019, p. 18) describes design as giving "shape and form to the material and immaterial products and services that can address problems and contribute to the well-being of humankind." These optimistic statements explicitly forge links between design and a worldview wherein humanity's welfare and well-being are considered *engineerable objectives*. A modernistic, me-

chanical worldview, moreover, which focus on life's presumed *manufacturability* is often reflected in contemporary design discourse (see, e.g., Escobar, 2017; Fry, 2009).

Accordingly, many (Western) definitions of design(ing) choose to specifically underline aspects such as intentionality, future orientation, and problem-solving. Design is described as "courses of action aimed at changing existing situations into preferred ones" (Simon, 1969, p. 55) or "the intentional solution to a problem within a set of constraints" (Monteiro, 2019, p. 21). Architecture scholar Samer Akkach (2003, p. 324, italics in original), however, interestingly points out that within the Arab language the relatively young word for 'design' depicts: "an act of determination, of sorting out possibilities, and of projecting a choice. It has little to do with problem-solving ... as the designer (*musammim*) seems to encounter *choices*, not *problems*, and to engage in *judging merits*, not *solving problems*."

This latter – 'Arabic' – understanding of both design and the designer *does* acknowledge intentionality and future orientation as key characteristics of design, but additionally stresses the importance of the many *contingencies* designers encounter within *any* design process. More specifically, it underlines that designers do not work on solving 'self-evident' problems, as it relates the agency of designers to the various contingencies they (un)deliberately may, or may not, *choose* to explore. Contingencies that, after a process of "judging merits," result in "projecting a choice" (Akkach, 2003, p. 324). According to Akkach (2003), therefore, this deliberate navigating and processing of contingencies render *any* act of designing inherently political.

Like Akkach (2003), authors such as Evgeny Morozov (2013, p. 3) problematize the tendency of many designers to first and foremost consider themselves *problem-solvers*, not seldomly unable to resist an "urge to fix problems that don't exist." Morozov (2013) argues that by primarily focussing on 'providing solutions' for situations, inconveniences, or even aspirations, *framed* as 'problems,' designers might consequently pay less attention to *issues*: problematic entanglements or disputes that – following sociologist Noortje Marres (2007) – are *not* necessarily solvable by political or scientific means, but instead need a perpetual exchange of perspectives, perceptions and ideas. In short: whereas *problems* might be fixed, *issues* are controversies that – at best – can only be temporarily stabilized. As such, they require different design approaches.

Problematic entanglements such as inequality of opportunity, poverty, or discrimination are so intricately complex and layered that they might – for better or for worse – be temporarily stabilized, but are very unlikely to be permanently fixed or solved by political or scientific means. This, however, does certainly *not* imply that these controversies fall outside of the scope of the subject matter which designers might work on. It just means that the approaches, aims and purposes within this particular field of political design work should be different. Addressing issues through design does not require a problem-*solving*, but a *problematizing* approach. As issues are *not* self-evident facts, designers can play meaningful roles in both supporting their construction and sustaining their articulation.

Problems versus issues

Art historian Claudia Banz (2018, p. 91) warns designers not to oversimplify problems or even *create new ones* by "incorrectly describing or delimiting the actual issue." As such, Banz (2018) underlines that problems and issues are distinct phenomena that are not self-evident consequences of particular circumstances, but instead come into existence through the purposeful activities of *problem setting* (Schön, 1983), and *issuefication* (Marres, 2012, 2014).

Social theorist Donald A. Schön (1983, p. 40, italics in original) describes 'problem setting' as "a process in which, interactively, we *name* the things to which we will attend and *frame* the context in which we will attend to them." In short: a situation first has to be understood, acknowledged, and framed *as a problem*, before it actually *becomes* one. Likewise, Noortje Marres (2007, p. 768) argues that "before a problematic entanglement counts as a matter of public concern, it must be actively articulated." Again, while both problems and issues are actively constructed, problems might be solvable by political or scientific means, whereas issues can merely be stabilized. Thus, besides providing solutions for situations that have been actively 'set' as problems (Schön, 1983), designers also have roles to play in the articulation of *issues* and the sustainment of a perpetual exchange of perspectives, perceptions and ideas regarding these controversies.

Problematizing design practices

Within the ever expanding realm of design practices and design discourse, one can identify several approaches that *do* explicitly oppose solution-oriented and problem-solving perspectives, and instead use designed objects, environments, services, and systems as a medium to address issues. Approaches that seek to *cause* friction, instead of to *prevent* it; approaches that purposefully employ design as a discursive catalyst, as a means to 'challenge mainstream perspectives,' 'raise awareness' about values and beliefs, or 'critically assess mass production and consumerism' (see, e.g., Malpass, 2017; Thorpe, 2012; Whiteley, 1993).

Designers and educators Anthony Dunne and Fiona Raby (2001, 2013) refer to a particular breed of these 'alternative' design practices as 'design fiction,' 'critical design,' or 'speculative design' – polemical forms of design that seeks to engage people with the political connotations and social contexts of designed artefacts. Design scholar Carl DiSalvo (2012, p. 35) describes a number of these overtly political practices as 'adversarial design' – design approaches that employ "a tactic of exposing and documenting the forces of influence in society and the means by which social manipulation occurs." Still other authors use labels such as 'interrogative design,' 'reflective design,' or 'design activism' to depict design practices that explicitly seek to bring about "dissensus through aesthetic activity" (Markussen, 2012, p. 45; Tharp & Tharp, 2018). Notwithstanding the wide variety of terms used to describe them, the various 'alternative' design practices in this field typically do not focus on problem-*solving*, but instead are geared towards problem *setting* (Schön, 1983) and *issuefication* (Marres, 2012, 2014). Moreover, beyond partaking in the mere *construction* of problems and issues, many of these design approaches actively support the perpetual exchange of perspectives, perceptions and ideas regarding these concerns, controversies and disputes.

Keeping it real

In current times of complex, layered, and interrelated crises especially, designers and design theorists need to get their vocabulary straight in order to articulate what design *can* actually do – as well as what it *can't*. In their enthusiasm to solve

problems, designers should be weary not to become instrumental in disguising the complexity, dynamics, and interrelatedness connected to issues. Primarily framing the renewable energy transition as a design project and engineerable problem, for example, might steer attention away from crucial related factors such as capitalist modes of production, consumerism, and geopolitics related to critical mineral resources needed for renewable energy technologies (see, e.g., Boehnert, 2018; Thorpe, 2012).

As such – instead of using the two terms interchangeably – I deem the conceptual differences between 'problems' and 'issues' fundamental for design discourse in order to articulate specific, relevant, and meaningful forms of 'designerly agency' in relation to 'societal change.' When problematic entanglements such as inequality of opportunity, poverty, or discrimination are approached by the design community *precisely for what they are* – inherently complex and layered controversies underpinned by a perpetual exchange of perspectives, that are therefore unlikely to be settled permanently – they can be addressed by specific forms of design work accordingly. Instead of proposing 'solutions,' designers rather have roles to play in engendering and/or sustaining public engagement with these issues.

Consider, for example, how designed artefacts by companies such as *Fairphone* or *Tony's Chocolonely* contribute to the issuefication of, and public engagement with, conflict-ridden supply chains. While the latter company uses design to forge relations between the hitherto 'innocent' chocolate bar and contemporary forms of slavery, the former business' brand name and its alternatively designed products render all other smartphones potentially 'unfair.' Beyond setting an issue and 'raising awareness,' however, the artefacts these companies design and mass-produce facilitate publics engaged with conflict-ridden supply chains with new ways to address their concerns. By employing design to entangle the social and the material in specific ways, these businesses have rendered using a specific smartphone or eating a particular bar of chocolate, a material form of political participation (see also, Marres, 2012).

Whereas *Fairphone* and *Tony's Chocolonely* are hopeful that their (future) products and services might be part of some sort of solution by engendering 'systemic change' (see, e.g., Georgi, 2022; Ibrahim, 2019), other designers use their professional skills to imaginatively entangle the social and the material into artefacts that do not seek to provide any solutions whatsoever.

Design supporting spaces of contest

When it comes to addressing *issues*, designers have a role to play in supporting the perpetual exchange of perspectives, perceptions and ideas concerning these disputes and controversies. Design projects such as *Smogware* – in which crockery is finished with a glaze that contains particulate matter 'harvested' from urban environments (Carlson, 2022) – or *the Rain Project* – in which unfiltered rain water collected from multiple locations is converted into consumable popsicles (Tharp & Tharpe, 2018) – provide publics with new ways to articulate their concerns with the issue of environmental pollution. Ways, moreover, that are not solution-oriented, but rather seek to "establish linkages among objects, people, and actions to create open, interpretive, and participatory spaces of contest" (DiSalvo, 2012, p. 93).

In short: one might understand 'designerly agency' in relation to 'societal change' as consisting of both the framing, setting and solving of *problems*, as well as the articulation of *issues*, through the creation of objects, environments, services and systems. More importantly, however: in order to address them in *relevant* and *meaningful* ways – and thus neither frame trivialities or critical parts of social life as 'problems' (Morozov, 2013), nor create new problems by ignoring underlying issues (Banz, 2018) – it is important for both designers and design theorists to acknowledge that problems might be *fixed*, but issues – that need a perpetual exchange of perspectives and therefore can never be permanently settled – can merely be *stabilized* (Marres, 2007). Therefore issues especially, need to be approached by the design community *precisely for what they are*. Instead of proposing 'solutions,' designers have roles to play in underpinning public engagement with these disputes, and supporting the perpetual exchange of perceptions and ideas regarding these controversies. Designers can use their expertise in entangling the social and the material through the creation of objects, environments, services, and systems, to imaginatively shape new and alternative ways for publics to address their collective concerns.

Conclusion

In this paper I have described how design has been mobilized in relation to different interpretations of 'the social' in a number of divergent ways. Ways that describe various assumptions regarding the notion of designers as 'change agents' with 'societal impact.' Ways, moreover, that suggest both problem-*solving* and *problematizing* design approaches. In current times of complex, layered, and interrelated crises especially, designers and design theorists need to get their vocabulary straight in order to articulate what design *can* actually do – as well as what it *can't*. Let us therefore refrain from describing even the most complex and layered phenomena as *problems*, suggesting that they are *solvable*. Instead – in order to articulate relevant and meaningful roles design might play concerning various problematic entanglements – it is essential to differentiate *problems* that can be fixed, *from issues* that can merely be stabilized (Marres, 2007), and approach both phenomena precisely for what they are. By acknowledging that both problems and issues are not a given but rather need to be *constructed*, 'designerly agency' in relation to 'societal change' can be understood as consisting of both the framing, setting and solving of *problems*, as well as the articulation of *issues*, through the creation of artefacts.

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The changing role of designers in transition processes

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Abstract

In the last twenty years, design research and design practice have mutually influenced each other in rethinking the role of design in an increasingly complex world. New areas, for example, service design, systemic design, and transition design have emerged out of this research-practice interaction. With the rise of these new fields, designers have developed new skills, new responsibilities, a different sense of agency, and, sometimes, a new mindset. This is especially the case for transition design, a field that deals with design processes over longer periods of time and that requires close collaboration with multiple other disciplines, exposing the need to reflect on the role and agency of the designer. In this research, ten design practitioners in the Flemish design agency landscape were interviewed to gain a deeper insight into the skills and mindset designers need today and in the future. During these interviews, the time was taken to thoroughly discuss agency in the design process, the changing relationship between client and service provider, and the concept and consequences of transdisciplinarity. This resulted in an overview of the changing characteristics of design and designers regarding their soft and design skills, their role & ethics when dealing with complexity, the business model of design agencies and changes in the design process and team. With the insights from this research, we invite design education researchers to reflect on design education addressing our complex world. Besides training designers how to design, they could teach them about the world in which design exists and is implemented. Additionally, the results could motivate service providers to rethink the composition of their teams, their relationship with the clients, and their business strategy, so they will be fully prepared to navigate through the rapid transitions of our current and future world.

Author keywords

transition design; design skills; design for complexity; transdisciplinarity; design education

Introduction

The world we live in today, driven by technological changes and globalization, is changing rapidly, increasingly resulting in the emergence of **wicked or complex problems** (Weber, 2021). These problems are described as multiple, circular problems with no obvious relationship between causes and effects (Kurtz & Snowden, 2003). A need for a transition to more regenerative and resilient systems with a focus on planetary health and life-conducive mindsets as an answer to these challenges, is expressed. Research on **socio-technical transitions** has known a quick rise since 1990 and finds its roots in innovation research and sustainability sciences (Loorbach et al., 2017). Gaziulusoy defines transitions and system innovations as "multi-phase, multi-level dynamic processes which take place over extended periods of time and result in mainstream practices becoming outdated and being replaced by a set of new practices. Transitions and system innovations cover not only product and process innovations but also changes in user practices, markets, policy, regulations, culture, infrastructure, lifestyle, and management of firms." (Gaziulusoy & Brezet, 2015).

In dealing with this complexity, combining the knowledge and skills of a multiplicity of people and perspectives is necessary. Since designers are predominantly trained and involved in problem-solving and innovation, it seems obvious that they too can have an interesting added value in these contexts. **Transition design** (together with service and social innovation design) emerged from this changing context and was originally introduced by Gideon Kossoff (Kossoff, 2011). It promotes social transitions towards a more sustainable future which is to be led by design as well in lifestyle, as existing systems and infrastructures. Typical characteristics of transition design are: working towards a long-term vision to tackle complex problems, integration of deep research, and working transdisciplinary on diverse levels of scale (Irwin, 2015)

The role of the designer has been through significant changes throughout the years. In the past, designers were primarily concerned with the aesthetics of products. However, as technology advanced and the scope of design expanded, the role of the designer evolved to include user experience, interaction design, business & strategy design as well as data visualization and information design. This shift led to the recognition of the significant role that designers play in shaping the functionality and usability of products, services, and systems. As a result, designers are now integral members of cross-functional teams, collaborating with professionals in fields such as engineering, marketing, and research to create innovative and effective solutions. The modern designer must have a broad skill set that includes both creative and analytical abilities as well as a series of soft skills (Yin, 2013). The skill set and role of the designer

can vary for these different fields and has been thoroughly researched for most of them (Fiore, 2020; Hansson et al., 2018; Tjahja & Yee, 2022; Yin, 2013). For transition design, this remains theoretical and speculative as it is not yet established as a widespread design practice.

Besides the role of the designer, **the environment** in which they work is also affected when dealing with complex problems. Subsequently, the current consultancy business model and design education system are questioned (Meyer & Norman, 2020; Rozentale & van Baalen, 2021): how will the design discipline deal with these changes and how will the new generation of designers be prepared for them? Gradual changes in the **education system of design** can be observed: research has been criticizing the current design education system and multiple universities offer courses in rising design disciplines such as service design, systemic design, and transition design (*Academic Programs*, 2023). Additionally, a shift in focus is found in students at Design Universities: they show an increased interest in tackling global and complex challenges such as climate change or inequality. This is visible in the program of design fairs like the Dutch Design Week, where a strong sense of urgency and a collective mission facing these challenges is a recurring theme in the submissions from students and young designers (*DDW22*, 2022). According to Mintzberg, an organization focused on innovation should not be led by (economical) efficiency and have an organic structure with project teams consisting of experts from different specialties (Hendrick, 2017; Notebaert & Delagrange, 2019). Since the essence of transition demands transdisciplinary work on a long-term scale with many different stakeholders, it is assumed that this **business model** should be reconsidered: how would a design agency that deals with transitions and complexity differ from regular design agencies?

This paper explores the changing characteristics of design and designers regarding their soft and design skills, their role & ethics when dealing with complexity, the business model of design agencies and changes in the design process.

Method

Given this is an emerging topic involving many perspectives, qualitative research methods were used. Semi-structured in-depth interviews with ten design practitioners in the Flemish design agency landscape were conducted. The interviews featured open-ended questions as well as exercises that were used to gather different sorts of data and spur conversation. They were structured as follows:

1. The interviewer asked which skills the interviewees (and their colleagues) use to deal with complexity, and which skills they lack at this moment.
2. The interviewee rates a chosen set of skills on importance (1 = not important, 10= very important), firstly for now and secondly for the future. The rated skills are a mix of design skills, soft skills, and skills needed for transition, based on literature (Jordan et al., 2021).
3. The interviewee is asked about their practices when dealing with complex topics: do they see a difference in project phases, how do they feel when handling these topics, what skills do they need.
4. The interviewee places cards with different actors involved in the design process on a chart according to their involvement. The design process is the core of the chart, with concentric circles around it that indicate decreasing involvement further away from the core. Follow-up questions are asked about the difference in relationships between actors. The same exercise is done for transition design processes in the future.
5. Finishing questions on the role that respondents would assign to themselves as designers, how that could change in the future and what is needed for that change.

Interviewees

This study focused on designers working in design agencies. Interviewees who have extensive experience working on various kinds of complex issues were recruited, based on their previous projects: did they experience a certain degree of complexity in the issues they addressed as a designer? Designers from different agencies and with different grades of experience were interviewed, with interviews taking between ~1h and ~2h. Out of ten interviewees, nine have an education in product development and one is educated in philosophy.

Table 1. Overview of interviewees and context

Interviewee (Self-described role)	Years of experience	Sector focus
1. Systemic designer	35	Service- & systemic design for public sector
2. Participation designer	3	Participation design
3. Business designer	12	Regenerative design & consulting
4. Service designer	3	Commercial product & service design
5. Business&strategy designer	2	Business innovation
6. Business&strategy designer	11	Commercial design & innovation agency
7. Business&strategy designer	7	Service design for public sector
8. Design researcher	15	Commercial product & service design agency
9. Product designer	20	Social innovation
10. Process designer	20	Strategy design consulting

Data analysis and interpretation

To analyze and interpret the data in a meaningful and holistic way, steps were taken to go beyond the typical phases of thematic analysis. With a Describe – Compare – Relate approach (Bazeley, 2009), themes were linked and a clear coordinated picture was formed to draw conclusions from. To start, all interviews were transcribed and coded using the NVivo software. The context and background were specified for each interviewee (sector focus, self-described role, and years of experience). Then the authors discussed the clustering and naming of discovered themes in a collaborative workshop. To interpret the data, recurring themes were linked to the context of the interviewee, as to see under what conditions themes arise or what could cause them. The different themes were also viewed in relation to each other. The conclusions drawn from this data analysis are discussed in the next section.

Results

Skills

When investigating the necessary skills for design teams in the future, the respondent's answers fell into two key areas: soft skills and design skills. Taking a closer look at the soft skills, multiple interviewees brought up **deep listening** and **creating networks**. "Critical listening is key, they might say A but that can have B, C and D hiding behind it" (4, personal communication, 23/11/2022) The transition designer needs to be **assertive** yet even more **empathic**, to see which societal needs there are. Their ability to listen and understand is key to working out a sound strategy. (6, personal communication, 25/11/2022) The ability to **communicate** allows professionals to effectively engage with stakeholders and build consensus around change initiatives. "There is a need for a certain diplomacy in your interactions with clients and stakeholders, there is no room for political baggage or general tension in the room. You want to keep people close since they remain involved" (6, personal communication, 25/11/2022). **Another important skill is adaptability, which allows professionals** to respond to challenges and pivot as needed.

In addition to soft skills, design-specific skills are frequently mentioned, such as being **facilitators**. This brings diverse perspectives together and helps create a shared understanding of the challenges and opportunities at hand (Lor, 2017). Facilitating collective learning processes, meetings and co-creating processes is an important strength in design as it is today. "You have to be fast at making links between things stakeholders bring to the table, ask the right questions in response, without pushing them in a certain direction." (1, personal communication, 11/11/2022). The interviewees mention that their less experienced fellow designers struggle with this: they tend to be more specialized in visualizing designs rather than facilitating workshops and discussions (6, 1, personal communication, 2022). Furthermore, **holistic synthesis** was mentioned, a way of synthesizing information without losing sight of the system as a whole. "It is important to synthesize all the information so you can communicate it in bite-size to the stakeholders to encourage them to take action" (7, personal communication, 30/11/2022) Lastly, we noticed **visualizing** played a significant role. "90 percent of my job is meetings and massaging people about ideas. You need to visualize your ideas to the stakeholders to get them on board" (3, personal communication, 22/11/2022). This skill is already an essential design skill but will be even more important when dealing with complex problems and abstract futures.

Role of the designer, the design team, ethical considerations

Nowadays, designers take on different roles during the design process. "When interviewing you are doing research, then you are a journalist. At a certain point you also really have to choose, you must decide. You are more of a judge. Sometimes you must be able to go completely wild and dream visionary." (9, personal communication, 19/12/2022). Designers guide and connect people, they make strategies, concepts, and visions tangible. Additionally, it was mentioned that "Designers talk to different stakeholders to synthesize all findings." (8, personal information, 2022). In the future, the role will become more strategic (1, 3, 4, 5, 6, 10, personal information, 2022). According to some interviewees, designers should even be involved on a policy level (4, 6, 9, personal information, 2022). They will become the link between different areas of expertise and ensure that the right knowledge will be deployed at the right times (4, 9, personal information, 2022). This shift also has an impact on the composition of **design teams**. A close collaboration with experts in other fields and a different role for stakeholders as part of the design team, together with a strong connection both with policy and the academic world will be necessary when tackling the complexity of transitions. One of the interviewees added to this with the value of experience: "(...) you will understand that you have your limits as a designer, which will entail a certain modesty, I guess. By becoming more mature as a professional, you grow towards what I call a systems being." (1, personal communication, 2022). With this changing role, the interviewed practitioners reported a shift in the importance of **ethical considerations and values**. Although these topics were not explicitly questioned, they came up in multiple interviews. Designers put a greater emphasis on inclusivity and empathy for stakeholders (2, 3, 6, 9, personal information, 2022). Having a strong moral compass can aid professionals in making ethical decisions and ensuring that their actions align with their principles and benefit the well-being of all stakeholders. Particularly regarding balancing short-term gain with long-term sustainability.

Complexity and design process

Transition processes concern wicked problems. When asked to define a wicked problem all interviewees could give a clear definition. They were also aware of the difference between straightforward problems, and wicked problems. However, the respondents reported no structural changes in the design process when asked about the ways these complex problems were approached differently from other design challenges. The types of phases stay the same, remarkably close to the traditional double-diamond model (Kochanowska et al., 2022). Most interviewees mentioned that more work goes into the analysis phase, as it is of higher importance for complex problems, and deep insights into the system are required to define a solution space (2, 4, 6, 8, 9, personal communication, 2022). But the business model of design agencies working for clients calls for efficiency, which limits the possibilities in the analysis phase. Another difficulty in this first phase is that there is no clear cutoff point. Many interviewees mentioned it is difficult to conclude the analysis and start to design. This could be because they approach analysis in the same way as traditional problems. An alternative could be a system mapping approach (Jacoby & Van Ael, 2021), where three phases are defined: framing the system, listening to the system, and understanding the system. This is a better fit for complexity analysis, but clearly not an established model in the design agency world.

Some designers also discussed that they miss an implementation phase after they deliver a product or service or that they feel like they could also have been valuable in the phases before they are usually consulted by clients. Interviewees reported they sometimes feel frustrated with the current model and would like to approach things differently. Therefore, designers and/or design agencies might have to rebrand themselves and promote what they could offer beyond the design of a product or service. That also implies changing the design

process and methodology, since it is currently most fit for straightforward problems.

Business model

The business model of design agencies is mostly focused on consultancy, where a design team is hired by a company at an hourly rate, cooperates with the company for a short amount of time, and needs to work as efficiently as possible (1, 2, 7, 8, personal communication, 2022). This manifests itself in an internal-external paradox: the designer becomes a part of the client's company until the assignment is finished and splits off again: never being integrated completely, but having to cooperate intensely, often in change processes. The limitations of this work process result in limited room for long-term thinking or reevaluation with the client afterward (1, 2, 4, 8, personal communication, 2022). This in turn impacts the implementation phase of the solution, which is lacking in many projects (2, 4, 7, 8, personal communication, 2022). Both elements are of big importance to transition design in order to have impact and organize change. When asked about alternatives for the current business model that would suit design for complexity, some suggestions for essential elements are given. A shift from a short-term to long-term mindset is necessary. Only consulting external designers for a short amount of time to create something is not enough to foster transition. According to interviewees, a continuous collaboration between designers and the client is essential (2, 4, 8, personal communication, 2022). Some even question the agency model and advocate for a more design-led organization (2, 8, personal communication, 2022).

Discussion

To understand the changing role of the designer in complex design processes, ten interviews with a homogenous group of Belgian design practitioners were conducted. The study is constrained by a limited sample size and the fact that the concepts of transition design and systemic design are still relatively unfamiliar within the Belgian design sector. This homogeneity allows for the isolation of similarities in perspective but also means that a more diverse range of views on the importance of transition design and the designer's role may be missing.

It would be interesting to expand upon these findings by comparing them with the experiences of other countries and cultures. Ideally, we would opt to implement a more diverse group of designers (*Twomey & Gaziulusoy*, 2014). To implement significant changes across all aspects of society, we need to reinforce the co-evolving areas of knowledge, action, and self-reflection to develop new methodologies for design (*Irwin*, 2015). A transdisciplinary team is necessary to cross-contaminate each other's fields to shape desired societal development. To approach complex problems holistically, we should zoom in to relate to the context and the stakeholders, as well as zoom out to grasp the interconnectedness within the broader system(s).

Furthermore, the changing landscape challenges designers and design agencies. The findings from the interviews suggest that traditional problem-solving approaches are still being utilized for complex issues. An additional inquiry is needed to understand why design agencies continue to rely on the traditional methodology and agency model when addressing such problems, despite the availability of alternative techniques such as system mapping and the three horizons model. And finally, further research is required to alter the business model and the client-designer relationship, to engage designers during appropriate stages that align with their specialized and useful abilities, rather than simply being temporarily consulted for specific tasks.

Conclusion

A radically changing and increasingly complex environment has a substantial influence on all professions, one of them being the field of design. Socio-technical transitions have increased pressure on society, producing some new design disciplines such as service design, design for innovation and transition design. The paper focuses specifically on transition design and examines - through qualitative analysis of ten semi-structured interviews - the extent to which design practitioners are familiar with this field and the skills and mindsets required to work in this context. Should the design education system and the consultancy business model be reconsidered?

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Fashion design matter: the role of design in guiding a sustainable transformation in Europe

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Abstract

Today, sustainability is one of the main, most dynamic, and influential topics, for all sectors. The growing emphasis on sustainability is relevant to everyone, as today, there is a need to focus on sustainable objectives, approach them, and consider all the modern processes to implement sustainable development and value-creation strategies. As underlined by several scholars, over the next few years humanity needs to adopt a paradigmatic change from a consumeristic society where well-being is measured in terms of economic growth to a new society that can reach the same levels of prosperity but consuming less and relying on renewable resources (Vezzoli et al., 2021; Keitsch, 2015; Thackara, 2005; McDonough and Braungart, 2002). It is, therefore, necessary to change the way demands are met and to develop sustainable consumption patterns and lifestyles that are based on better consumption of far fewer resources. There is an urgent need to move towards new socio-technical systems capable of operating within the planet's limits. This means operating inside the nine planetary boundaries that are the spaces within which humanity can continue to develop and thrive for generations to come (Rockström et al., 2009). These systems will address not only the technological sphere but also the environmental, social, cultural, institutional, and organizational ones. The proposed understanding suggests that sustainability is the defining concept of the whole system and not a characteristic of its individual elements. Therefore, achieving sustainability requires a process-based approach, sustainable development, which must be intrinsically applied systematically and in different dimensions to plan new virtuous paths. In the presented scenario, the Fashion industry is one of the main actors as it influences ecosystems making a sizeable contribution to climate change, resource exploitation, and systemic pollution. But it also shapes cultural developments, their driving forces, and patterns of change (Bertola et al., 2016). According to the above, the presented paper discusses the fashion necessity of facing the challenges of sustainability - and the related complexities – with a radical transformation of the current development model. Through the analysis of different case studies, possible directions for the sustainable transformation of fashion systems are defined and presented. Specifically, such direction addresses how it becomes essential to review development paths with the aim for the fashion sector to dissociate sustainable innovation from the notion of exploitation of resources through a strong focus on proposing material and meaning that are alternatives to the very notion of "new".

Author keywords

Fashion Design for Sustainability; Sustainable Development; Industry Transformation.

Introduction

Today - fashion is one of the most significant, dynamic, and influential industries, as well as one of the most impactful due to its highly invasive processes, especially the ones involving environmental aspects and consumption of the finite resources of our Planet (EU, 2022; EMF, 2017). Moreover, this industry profoundly influences with its approaches and practices the environmental and economic dimensions due to its vocation to codifying current patterns of change (Bertola et al., 2016). In this context, it also strongly impacts changes related to the social and cultural spheres. As argued by Kate Fletcher (2018), the fashion industry is a powerful cultural driver which influences the consumerist economic model based on mass production that currently characterizes the economies, even if our experiences of fashion are now dominated and limited by this same model that involves fashion in essential issues.

Niinimäki et al. (2020) argue that the industry consumes vast quantities of water, land, and raw materials. For example, the fashion sector produces 8% of all carbon emissions and 20% of all global wastewater, with an anticipated 50% increase in greenhouse gas emissions by 2030 (Bailey et al., 2022). The sixth annual State of Fashion report by The Business of Fashion and McKinsey & Company (2022) reveals that globally, the fashion industry is responsible for around 40 million tonnes of textile waste a year, most of which are either sent to landfill or incinerated. This can be attributed to the current development models promoted by the industry that encourage an increase in clothing consumption and, therefore, fashion production. Pro-capita fiber consumption almost tripled from 1950 to 2008, increasing from 3.7 kg to 10.4 kg per person (Sanchis-Sebastiá et al., 2021). From 2007 to 2014, textile fiber production increased by an additional 20.2 million tons to 90.8 million tons, and this number is expected to grow by 3.7%, compounded annually (Pensupa et al., 2017). These phenomena are the direct results of the economic model based on the linear development of the fashion sector (Dissanayake and Weerasinghe, 2021). This model is dominant, a legacy of the first industrial revolution, which is based on so-called cradle-to-grave dynamics that exploit natural resources and then directly dispose of them without taking into account their regeneration potential and

the possibility of reusing them in the next production and/or consumption cycle (Braungart and McDonough, 2009). This fuels the phenomena of production overabundance, compulsive consumerism, physical and semiotic obsolescence of the fashion product, and disaffection culminating in irresponsible behaviors of serial accumulation and early disposal of garments. This context is so alarming that it prompts the Global Fashion Agenda, a leading forum for sustainability in the fashion industry, to conduct a study to quantify global fashion consumption in the Pulse Report (2017-2019). The purpose was to return a numerical figure that would allow manufacturers, and their consumers, to compare their impacts. The study estimated that if current trends remain unchanged, apparel consumption will increase 63% to 102 million tons by 2030 (Global Fashion Agenda, 2019). Since consumption is no longer focused on satisfying a need but on fulfilling a desire, it is bound to remain unavoidably insatiable by its very nature. This realization is also the direct consequence of a garment's semiotic and physical impoverishment. This deficiency allows production costs to be drastically lowered. And the consequent lowering of prices will enable buyers to purchase garments more easily. In this landscape, the logic of waste is established as a direct consequence of a supply chain that turns out to be excessive, misleading, and distorted. Waste becomes an entity in this context and acquires all its characteristics: value, importance, and impact (Binotto and Payne, 2017).

Considering what has been discussed, reviewing linear development paths is essential. This can be done by adopting more sustainable models of development, such as the circular economy model, which is to date recognized as the leading entrepreneurial model for meeting the goal, for the fashion industry, of decoupling sustainable fashion innovation from resource exploitation through a strong focus on proposing alternative materials and meanings to the notion of "new" (Dan and Østergaard, 2021; Rathinamoorthy, 2019; EMF, 2017). In this context, this paper investigates how, from a design perspective, new trajectories are being defined in the contemporary fashion industry to contribute to the development of a closed-loop system in which the goal is to recover or recycle secondary raw materials in multiple stages of the supply chain (Muthu, 2018).

Methodology

The article aims to present the result of an investigation conducted on how fashion companies are pursuing circular initiatives, making it possible to create strategic actions that can stimulate a new understanding of what virgin material is and encourage a reinterpretation of the concept of new. The data analyzed were extracted from the knowledge repository produced by the – *Fashion in Process* - Research Lab. at the Design Department of Politecnico di Milano of which the author is a member. The data were generated from: (1) the research conducted by the research Lab (DGGROW, Mapping Sustainable Fashion Opportunities for SMEs, 2019; Erasmus+, FashionSEEDS, 2019) and (2) the doctoral research of the author (D'Itria, 2022). According to the authors' investigation, a mapping of "secondary" raw materials-driven circular practices of European fashion companies is carried out through an iterative process: an initial desk research phase followed by applying a case study methodology. This process allowed the selected research field to be narrowed into topics that emerged from the analysis and codified the main approaches to circularity that inform the definition of directions for addressing sustainable development issues. Defining the directions allowed the boundaries of the study to be identified. A selection of best practices is presented among the case studies identified. The author focuses on specific cases and uses them as a sample of the context of interest. However, as Johansson (2007) discussed, such a methodological approach includes many variables and qualities for reworking explanatory knowledge.

Methodologically, three phases were conducted: (1) the first phase was desk research to identify current practices in the fashion industry. This mapped current sustainability practices and identified best practices; (2) the second phase was an in-depth qualitative analysis of the best practices identified during the desk research; (3) and the last phase systematized the previously produced knowledge to define business directions for implementing sustainability through practices of recover or recycle of secondary raw materials at multiple stages of the supply chain, from design to retail and waste collection. The mapping led to the identification of 68 companies located in 21 nations in the

Figure 1. Companies' locations.

European continent, which have addressed aspects related to new sustainable development models by using secondary-raw materials in their practices (Fig.1).

The choice to focus on the European region was driven by the interest in investigating a context undergoing a solid transformation due to policy initiatives put in place for the sustainable transformation of the examined sectors (Green Deal, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_it; EU Strategy for sustainable and circular textiles, https://www.interregeurope.eu/news-and-events/news/new-eu-strategy-for-sustainable-and-circular-textiles), by reasons of geographic proximity, and by past experiences of collaboration with local companies. The composition of the company was heterogeneous. They were textiles companies (24%) and brands of shoes (9%), apparel (60%), and accessories (7%). Of the 68 companies mapped, 6 were selected as case studies (Table 1).

Table 1. Case studies list.

Country	Name of Initiative	Description of Initiative	Sector	BIG	MEDIUM	SMALL	MICRO
France	Vestiaire Collective	Online marketplace for second hand high-quality designer fashion.	Apparel			X	
Italy	Fulgar	Sustainable textiles brand.	Textiles	X			
Italy	Manteco	Sustainable textiles brand.	Textiles	X			
Sweden	Filippa K	Longer technical life, lease, sharing own product take back.	Apparel	X			
United Kingdom	Christopher Raeburn	The RÆMADE ethos in particular has pioneered the reworking of surplus fabrics and garments to create distinctive and functional pieces.	Apparel			X	
United Kingdom	Helen Kirkum	The studio ethos in particular has pioneered the reworking of surplus fabrics and shoes to create distinctive pieces.	Footwear				X

All these companies stand out for the way they are pursuing implementations of sustainable practices within their system, often adopting a design-driven approach as support. The following phase consists of further desk analysis to prepare for long-distance interviews with representatives from selected companies. These companies have distinguished themselves for their approaches to designing waste out of the system, using it as new raw materials or products. This phase allowed for exploring possible theoretical relationships and allowed for a deeper understanding of the subject through the use of these case studies (Tellis, 1997). The third phase focused on data interpretation. This phase supports the author in understanding the criteria a company must meet when working on design-led sustainable practices to move to new circular development models for better use of available resources. These aspects are now linked to the concept of waste recovery and lead toward circularity, decoupling economic growth from increasing environmental problems by imagining and implementing processes and practices with sustainability characteristics with three particular approaches at different stages of the supply chain: (1) *reducing/sourcing*, redesigning materials, products, and services so that they are less resource-intensive; (2) repurposing/manufacturing, recycling waste, and scrap, without destroying them, to create products that have more value; (3) and reusing/retailing, making products and values last by transferring them to another user.

The Directions

This paper codifies the data collected to identify the directions that drive current design-led practices related to a new concept of waste in the fashion industry. This section discusses the results of the presented methodology by introducing several case studies that illustrate the main approaches identified by the study. Such approaches could inform and foster relevant new directions in sustainable fashion design. This paper aims to define potential pathways for developing a closed-loop system that aims to either reduce resources exploitation, repurpose secondary raw materials, or reuse the fashion product - at different stages in the supply chain (Fig.2).

From an operational point of view, the work identified three macro directions in the approach to sustainability through design-driven practices that emerged from the case analysis. Companies such as Manteco or Fulgar are acting upstream in the supply chain. They are working to improve their strategies to capitalize on the circular distinctiveness of their products. They are now pursuing actions to develop

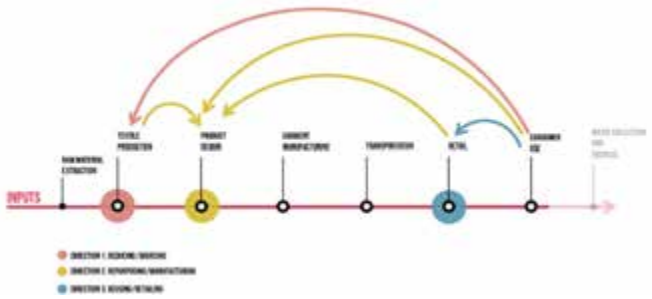

Figure 2. The directions model.

a new approach that can significantly reduce textile waste by rethinking sourcing practices through traceability. On the other hand, Christopher Raeburn and Helen Kirkum are experimenting with the designer's role in reworking surplus textiles and garments to create distinctive and functional pieces, underscoring their attributes of conscious manufacturing. Companies like Vestiaire Collective or Filippa K work down the supply chain. They keep items out of landfills, changing traditional retail's linear "take-make-away" model (EMF, 2017). So the author discusses strategies with a common pattern of avoiding waste and working on the meaning of "new." The study examines how these identified directions work for a common goal but differ from each other. The analysis offers insight that aims to describe the behaviors identified comprehensively. However, the author acknowledges that there are limits within which these behaviors are adopted. Although a common guideline is highlighted, the different cases need to be understood in the specificity of their context, territory, and actors involved. In the following sections, the selected cases are explored.

Reducing/Sourcing

The first direction refers to companies working upstream in the fashion supply chain. They work on their sourcing to achieve sustainable supply chains by leveraging their position at the beginning of the flow of goods and services. Companies rethink the system by redesigning the processes of buyers' access to materials, production, logistics, and transportation, and distribution. To achieve this, transparency in supply chains is critical to validate the origin of sustainable materials (Fung et al., 2021). For example, the Italian textile company Manteco launched Project43. This is a unique strategy based on circular economy principles. They aim to optimize existing materials and design pre-consumer waste out of the system by recovering offcuts from the garment manufacturers that

use their fabrics. The collected materials are then regenerated into 'new' fabrics. Manteco acts as a single point of contact between all the actors along the supply chain to monitor the material lifecycle. Project43 is now reducing and regenerating textile waste using the company's facilitates through a transparent system. (Fung et al., 2021). By addressing the critical issue of traceability, Project43 is also a tool capable of overcoming the linear waste model and providing the fashion sector with a different understanding of "new" materials. Another company that is making a significant contribution on this front is Fulgar. It is a leading manufacturer of synthetic yarns. It is now experimenting with the traceability of its eco-friendly Q-nova yarn. This is an environmentally friendly fiber made exclusively from raw materials regenerated through a mechanical process rather than a chemical one. A special ingredient in polyamide, the innovative traceability system called ID (Identity), makes it possible to verify the authenticity of the recycled origins of the yarn. The ID system allows third-party organizations, such as consumer groups and governments, to verify the reliability of the data provided. All the presented companies working on this first approach recognize that traceability is a crucial aspect of supply chain sustainability (Naden, 2017; Sodhi and Tang, 2019). While for some companies, traceability helps to identify environmental issues and is a starting point for the improvement of the entire supply chain, which is actively involved in the process of mapping the existing material, in other cases, the monitoring process takes place directly within the company, acting on the material, in the intimate mixture, to generate a cascading effect on actors inside and outside the fashion supply chain.

Repurposing/Manufacturing

The second direction characterizes the rising strategies fashion companies adopt through a project approach that enhances the use of discarded goods' materials and components to transform them into new, high-value products. Christopher Raeburn is a pioneer of upcycling in fashion. He started his eponymous brand in 2008 using British Army parachutes as his primary fabric source to create new garments. Since then, he has developed expertise in reconstructing military surpluses, such as parachutes, parkas, and military jackets. This process is called reappropriation by the designer. The designer's approach is guided by research on the garment and the process of deconstruction itself; even the shape and silhouette of his designs are developed based on the source of the fabric rather than being cut and shaped on the design. Designer Helen Kirkum carries out similar experiences. Through her work, Helen Kirkum is hacking the footwear industry using waste as a raw material. The designer uses recycled and dead stock materials as sourcing. These materials are transformed into sneakers crafted to provide an individual experience to consumers. The design philosophy applied to these products is to mix the components of the "repurposed" products, allowing the seams between the different parts that compose the final shoe to be visible. Accentuating these points of connection aims to stimulate emotional value to allow the user to own something inherently personal and unique. The approach developed positions her as a pioneer of the "deconstructed" aesthetic in the sneaker industry and at the forefront of the sustainable footwear movement. In all the cases presented in this section, the circular link with the development of products made through innovative and disruptive craftsmanship becomes a challenging tool for maturing the meaning of consumption and the way we interact with the products we own. Moreover, creating a story around the product gives additional intangible value to the object.

Reusing/Retailing

The third direction addresses sustainability issues related to bringing second-hand clothing back into the market, creating a circular system. Fashion companies in this category must devise and implement innovative business models that reflect the changing landscape and evolving consumer behaviors. One example of a company engaging consumers in using products as long as possible and keeping them in the market loop is Vestiaire Collective. This online platform, launched in 2009, allows customers to buy and sell secondhand fashion items. Sellers place items on the marketplace and, after validation by Vestiaire's team of curators, the items become available for sale. Vestiaire is exploiting the enabling power of digital technology to recontextualize the concept of new applied to unused clothing items. Providing these products to new customers increases the number of uses, giving a second, third, or even fourth life to existing products. In addition, through the creation of a community the company has created a sense of belonging among those who share values and actively choose to enter a circular system. Filippa K proposes a different approach to this direction, which involves - in its practices - actors within its supply chain such as logistics departments and retail. In 2008, the brand opened its first second-hand store in collaboration with a local entrepreneur, Judit's Second Hand. The initial model operated as a consignment store where customers returned their Filippa K clothes, shoes, and accessories for resell. What characterized this initiative was the fact that the customer maintained ownership of the product and after the product was sold, the customer received 50% of the profit. If not sold, the product was returned to the owner again or donated to a charity. The success of this resale initiative allowed the brand to recognize the program's potential to enable a circular business model. The company's pilot program was scaled up to become the "Preowned" program. This program is now running only in Sweden. Customers return a used garment from the brand to the store, or if the physical location cannot be reached, the customer uses the brand platform. In return, the customer receives a monetary incentive. Garments brought to a physical that are ready for resale are machine or dry-cleaned using environmentally friendly cleaning processes. Users that post garments on the platform earn either cash and receive 60 percent of the resale price, or they can choose to receive 100% as a credit toward the purchase of Filippa K garments from the current season. The cases presented here discuss how the same product creates revenue multiple times by offering new ways to involve stakeholders, both when consumers resell their clothes and when different actors along the stages of the supply chain (logistics, retail, collection/waste management) engage in reintroducing "new" second-hand clothes back into the market.

Conclusion

From what has been illustrated, the rethinking of waste and its connotation of "new" emerges as a strategic factor that is now leading the transformation of fashion companies towards a sustainable development model. Here are presented

the opportunities that have occurred, for fashion companies, to trigger innovative processes that favor iterative activities to disrupt the linear economy logic of waste and nurture a change in operating models. Such models could inform directions toward a circular paradigm enabled by adopting design-led practices in the European fashion industry. One of the most critical levers the fashion industry can pull to preserve non-renewable resources and eliminate waste is to design it out of the system. The different approaches suggest that to reach this goal, the link between circularity and design-driven innovation in the fashion field is related to a systemic perspective. The one illustrated here represents a system that is now starting to be rolled out at scale, promising to limit the extractive production of virgin raw materials and decrease textile waste. As these approaches mature, companies will need to embed them into the design phase of product development while adopting reducing, repurposing, and reusing processes. The key element linked to this systemic transformation is the reorganization of the supply chain to achieve the goal of eliminating the concept of waste by involving all stakeholders, from designers to consumers. Each company connected to the supply chain must develop company-specific strategies. Directions for further development of the work based on this study are being outlined within the specific framework of the Italian Recovery and Resilience Plan (https://www.mef.gov.it/en/focus/The-National-Recovery-and-Resilience-Plan-NRRP/). The author is involved as a researcher at her institution in SPOKE 2 - Circular and Sustainable Made in Italy. The material presented here provides the initial impetus for the work that is being developed on the investigation of possible directions for the evolution of waste reduction practices towards the complete reintegration of materials into production flows and design-led strategies that impact upstream through the decisions of designers (e.g. choice of materials, garment construction, and finishing) that could implement design practices to plan waste out of the system by intention. Directions for further development of the work based on this study are being outlined within the specific framework of the Recovery and Resilience Plan presented by Italy, in which the author is involved as a researcher at her institution in SPOKE 2 - Circular and Sustainable Made in Italy (https://www.mics.tech/). The material presented here provides one of the initial knowledge inputs for the work that is being developed on the investigation of possible directions for the evolution of waste reduction practices towards the complete reintegration of materials into production flows and design-led strategies that impact upstream through the decisions of designers (e.g. choice of materials, garment construction, and finishing) that could implement design practices to plan waste out of the system by intention.

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Convincing fashion consumers to go green: a brand communication problem?

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Abstract

If it is true that in recent years the concern with climate change has been growing (Bell, Poushter, Fagan & Huang, 2021), there is still a long way to go to make our lifestyles more sustainable. Several companies and brands have been thinking of strategies that allow them to become more sustainable (Hodgson, 2021), albeit with very different levels of success.

The fashion industry is, in this context, a very paradigmatic case since it is responsible for the emission of more than "1.2 billion tons of greenhouse gases each year, accounting for more than 10% of the world's carbon footprint" (Motif, 2021). With such a large footprint, several brands and designers have sought to transition to more sustainable fashion. However, despite the efforts made, the truth is that the message does not always reach consumers. Thus, if, in fact, consumers' awareness of the environment and sustainability has grown in recent years, if it is true that consumers have become more demanding in relation to the processes used by brands, we still continue to see a gap between the willingness to buy more sustainable brands and the effective purchase of these brands (Wong, 2021).

In this context, consumers are looking for more transparent and sustainable processes and where brands are already working in this direction. For a long time, it was believed that the price prevented the effective purchase of more sustainable products. Still, this idea has been removed in recent years, which leads us to question whether the problem is not in the communication strategies developed by brands to communicate their processes and products. Are consumers aware of what sustainable fashion really means? How have brands been able to convey and explain the difference between concepts such as Ethical Fashion, Circular Fashion, Slow Fashion or Conscious Fashion?

Unsure about the effectiveness of this communication, in this work, we seek precisely to analyse how some of the leading brands that are assumed to be sustainable (Abbas & Shipin, 2021; The Good Trade, 2021) have communicated, particularly in social media, spaces that aggregate a large number of consumers, but above all capable of defining trends and habits. On the other hand, these are also the platforms where the new generations are present, gaining even more importance in conveying the message to those who are the consumers of tomorrow and the guarantors of the planet's future.

Author keywords

Fashion, Sustainability, Communication, Brands, Social Media.

Introduction

According to "The Pulse of the Fashion Industry 2019 Update" report, the efforts made by the fashion industry in terms of sustainability are slowing down. The document, created by the Global Fashion Agenda and Sustainable Apparel Coalition in partnership with Boston Consulting Group, reveals that "the fashion industry has improved its social and environmental performance in the past year (2018) but at a slower rate than the previous year (2017)" (Pulse of the Fashion Industry, 2019, p. 1). Following an indicator created to evaluate the goals and sustainable practices by entities of the fashion industry, the report alerts to the fact that "fashion companies are not implementing sustainable solutions fast enough to counterbalance negative environmental and social impacts of the rapidly growing fashion industry" (ibidem). However, the problem no longer resides only in fashion companies, it is also a cultural matter. Thus, only can we comprehend the fact that consumers continue to adopt fast-consumption habits. As the report also states, "the question is no longer whether it is necessary to improve sustainable business practices, but rather how long it will take before consumers stop buying from brands that do not act responsibly" (op cit. 2019, p. 11).

This situation is clearly aggravated by our society's way of normalizing extreme consumerism, promoting wasteful lifestyles, and following online trends such as "clothing hauls" or "beauty empties" videos, where YouTubers display their newest acquisitions until their next binge-purchases to their followers. In this sense, we found ourselves in a paradox since social media are used to promote fast fashion, yet these platforms are also used to build consciousness among consumers. Customers are using digital means to interact with their brands. Therefore social media is highly important to a new fashion brand (Scheide & Marques, 2018).

The report finds that "mentions of sustainability in social media increased a third faster than overall social media growth between 2015 and 2018" (op cit. 2019, p. 2). However, sustainability is still not a priority during buying decisions. If quality and aesthetics truly dominate consumers' decisions, as "Pulse of the Fashion Industry" indicates. In that case, it is up to the industry to transition to a more sustainable world. Following this logic, this study seeks to col-

lect several examples of Portuguese brands with sustainable motivations, both in production and culture. Our proposal is to identify these brands, their products, and their communication strategy, namely taking into account their interaction with social media users. In terms of methodology, this research uses content analysis of the brands' websites and their social media pages.

With this work, we attempt to reflect not only on fashion industry problems but also on how these issues are intrinsically linked to lifestyles, culture and communication habits. Per Byrum (2017, p. 219), "the connection between mass communications messages disseminated via social media and the diffusion of information among environmentally conscious consumers requires further study". Considering the Portuguese sustainable fashion market, the current paper is structured as follows: the next section provides the literature review, and then we present the methodology and results in sections. Finally, conclusions, implications, and further research are presented.

Communicating sustainability through social media

Per The State of Fashion, consumer behaviours and social media transform fashion industry communication.

> (...) the attitudes of executives also reflect evolving consumer behaviours that are forcing industry players to "self-disrupt" (the #1 trend identified by executives for 2019.) (...) Social media has an increasingly important voice in dictating consumer demand, helping small brands grow explosively. Across the industry, speed-to-market and responsiveness to consumer needs are becoming critical success facts (2019, p. 12).

The report is clearly highlighting the recent decisions and moves made by fashion industry players, who recognized the need to disrupt the system with new ways of thinking and communicating, using social media as a platform to touch consumers directly and obtain data, a trend also approached by The State of Fashion the year prior, as executives considered "mobile obsessed" consumers as the most important prediction made by the 2018 report (The State of Fashion, 2019, pp. 12-13).

Fashion brands also need to recover from bad press and communicate better with their consumer; the fashion industry has ignored sustainability and ethical practice for a long time, this is mainly due to the lack of information and transparency from fashion brands, and therefore, the need for brands to communicate about sustainability and ethical measures is more-than-ever crucial. Yet, in this case, transparency is much more important for consumers than sporadic "good public actions" from brands. Generations that are now the main target as consumers, both Gen Z and Millennials, have been defined by their quest for more sustainable economies and industries based on their preferences for digital solutions and their concerns about our planet's fate. In the quest for sustainability, however, emerging brands seem to have more success with these generations (especially Millennials), than established brands, as they are capable of relating with these generations through social media and have a more approachable and conscious image than their counterparts. These smaller companies are, for the most part, being very careful with production by choosing national manufacturers, and keeping a close look on their supply chain by producing less, preferring quality over quantity, thus allowing them to transparently communicate their brand's values to their consumer through social media live streams from their factories. Per The State of Fashion (2019, p. 74), "digital technology gives small brands an easy way to engage with consumers, who are increasingly glued to their smartphones and the internet".

Social media is more than a communication system; modern consumers have used it to praise brands and destroy them (Byrum, 2017). Consequently, brands have to be very cautious when advertising on social media, as their every move is captured, and a simple comment by an angry customer can make headlights. Consumers are now more informed about the actual cost of their fashion statements. They can no longer ignore what this industry has done to the planet and its inhabitants over the last roughly 100 years of industrialized production of garments, and since the apparition and escalation of fast fashion over the last 50 and 30 years (Dopico and Crofton, 2007).

Social media phenomena and trends such as Fashion Hauls, GRWM (Get Ready With Me), OOTDs (Outfit Of The Day) or Unboxing Videos have also contributed to this "buy now, think later" mechanism. The popular demand for "influencer's merch" (merchandising pieces, such as t-shirts or hoodies with an influencer's brand or catchphrase), sometimes sold at high-end prices, still made from cheap materials and produced in non-audited Chinese manufacturers, is also part of the problem.

On the other hand, new lifestyle trends have appeared on social media, such as minimalism (a modern re-take on the late XXth century movement), the Zero-Waste movement and methods to buy less, and influencers of these movements have been praised for their way of living. Emerging brands have clearly used social media to their advantage, challenging established players by getting closer to customers and taking the time to explain and be as transparent as possible to their followers. According to Minton, Lee, Orth, Kim and Kahle (2012), "sustainability is inherently social", which could explain why brands have chosen social media platforms to communicate their sustainable practices, as well as the 50% annual growth of advertisement spent on Instagram by brands (The State of Fashion 2019, 71).

Exploring businesses and their online influence on consumers, Loureiro, Serra and Guerreiro (2019, 375), found that the brands' interaction with consumers, their consistency in posting and updating content, as well as their product's endorsement by celebrities and influencers were the main factors of their online success. As per Byrum (2017, p. 210):

> the consumer who chooses to engage in environmental purchasing may be influenced by multiple motivations, including social pressures and the desire to escalate in status. These desires, fulfilled through eco-purchasing involvement, may further contribute to the consumer's willingness to share information with a corresponding peer set via social media.

Hence, social media platforms are a weapon of choice for emerging sustainable brands (Huang, Clarke, Heldsinger & Tian, 2019), as they allow tight communication and a relatable environment for consumers, who are also the best at communicating and spreading their love for a brand via their social media accounts.

In their 2020 Fashion Transparency Index, Fashion Revolution ranked 250 of the world's most prominent and established fashion brands on their environmental and ethical practices (Fashion Revolution, 2020). The organization concluded that "most brands and retailers lack transparency on social and environmental issues. More than half (54%) of brands score 20% or less". However, compared to the year prior, the report was also pointing at silver linings, "there are fewer low-scoring brands this year compared to 2019, 28% of brands score 10% or less, compared to 36% of brands last year", the report also shows that "of the new brands added to the Index in 2020, 15 brands score 5% or less, including Canada Goose, Fashion Nova, Pepe Jeans and DKNY" (Fashion Revolution, 2020, p. 4). Nevertheless, it is essential to note that transparency does not guarantee sustainability, as fast-fashion brands such as H&M ranked in the best brands in 2021 and 2022 (Fashion Revolution, 2021; 2022).

In general, the report also related that brand needs to communicate their efforts better and improve on transparency, as well as international policies such as the Paris Climate Agreement, as "only 16% of brands publish Science Based Targets, which means their environmental goals are aligned with the Paris Agreement's aim to limit global heating to below 2°C above pre-industrial levels" (Fashion Revolution, 2020, p. 6). So, who is to blame for the continuous success of fast fashion and the non-sensical "buy now, think later" logic still happening?

Social media is a powerful tool for fashion brands. As consumers are now more than ever informed about the fashion industry's toll on the planet (Mosca, Civera & Casalegno, 2018), brands have understood that they can use social media to their advantage to communicate their changes and environmental policies more efficiently. Yet, they are not the only ones who need to inform their consumers, as social media influencers have a great responsibility when endorsing products and advertising their lifestyles. Influencers have a real duty to educate themselves on the products they recommend, even if a brand does not pay them. By sharing products and services, they influence others to try something they might not need to feel closer to an influencer's lifestyle. Finally, consumers have a right to know and an obligation to search for better alternatives, answers, and solutions to buy smarter.

Methods

The present work fits in the line of the case studies since it is an empirical investigation that explores "(...) a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident and (...) relies on multiple sources of evidence, with data needing to converge in a triangulation fashion" (Yin, 2018, pp. 45-46). Since our work is centred on the online environment and in particular on the online social networks of a set of specific brands, but also in the analysis of their way of communicating sustainability, we believe that this strategy was the one that best suited our purpose, since we:

> might favour choosing case study research, compared with others, when (1) your main research questions are "how" or "why" questions, (2) you have little or no control over behavioural events, and (3) your focus of the study is a contemporary (as opposed to entirely historical) phenomenon - "a case" (Yin, 2018, p. 32). The strong descriptive dimension of the case studies and the fact that the researcher is involved in the investigation means they are normally associated with qualitative plans. But the case study in this article ends up appearing in the context of a mixed investigation plan (Coutinho, 2015), as in addition to the descriptive and qualitative dimension, it will be considered a quantitative dimension, namely in the identification of terms used by the brands to communicate sustainability on social networking sites.

Considering that the main objective of the work is to analyse how fashion brands communicate sustainability on their websites, especially on social networking sites, we decided to use multiple sources of data; that is, we decided to collect data using different techniques, following the principles of Yin which state that "one principle is to use multiple sources of evidence (evidence from two or more sources, converging on the same findings)" (2018, p. 153).

In this work, we decided to make a direct observation of recording patterns in terms of the brands' websites and social media networks, trying to understand what aspects are used in these online spaces to communicate the sustainable purposes of the brand.

The selection of the brands that we analyzed in this work was made in a completely random manner. Still, following the indications of some magazines in the fashion area, articles specialized in generalist magazines and also the indication of associations and organizations that promote sustainable consumption. Thus, different sources were considered, and an analysis was made of articles that in different media refer to various brands as models in terms of sustainability. Although the selection process was random, as we mentioned, without concern for representativeness, we tried to select at least one brand per product type, thus trying to avoid over-representing specific sectors. The selection resulted in choosing 24 Portuguese brands, which we will present briefly later in the presentation of the main results (see Figure 1).

On the other hand, since "the data obtained with this type of instrument are quantitative (numerical) and their analysis

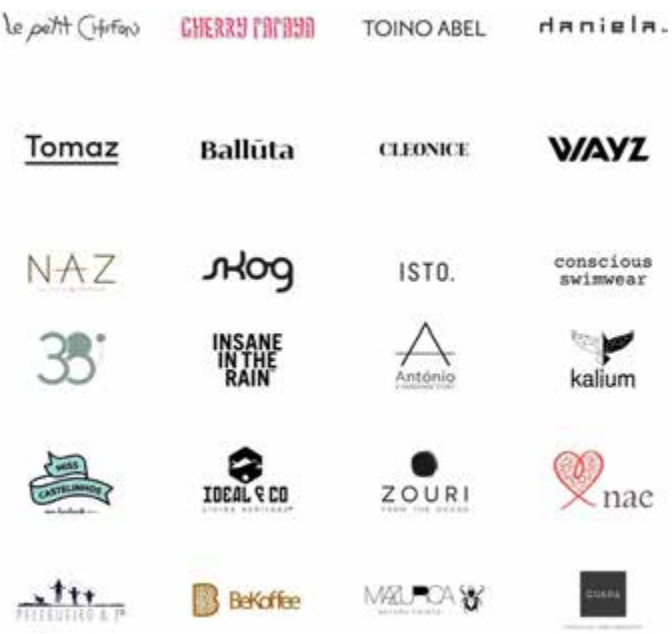

Figure 1. Brands analysed in this study
(Source: Made by the authors from the brands' websites or social media pages)

is carried out using descriptive and even inferential statistical analysis techniques" (Coutinho, 2015, p. 137), in part dedicated to results, we will present the main trends registered for each brand in the form of percentages, to display and discuss precise numbers (see table 1).

Discussion of the results

In table 1, we inserted the main data collected. At this point, we will try to summarize the principal aspects that caught our attention in the observation made and through the notes we were taking during that observation. Based on the gathered data, we can verify that only 16% of the brands studied are older than five years. It can indicate that the creation of brands in the fashion area with concerns in relation to sustainability is a recent trend, or at least it has been a gamble of recent years. On the other hand, we must highlight that one person founded 64% of the brands, an aspect that also helps to understand the context of brand development, that is, with small teams and structures often supported by the families themselves (table 1).

Table 1. Comparison of the brand's social media pages/webpages at the time of the study.

Brand Name	DoC	Market	Founder	Online presence		Social media followers			
				Website	*Social media*	*Facebook*		*Instagram*	
						Likes	*Followers*	*Posts*	*Followers*
38 Graus	2017	Womens Beachwear	Marta Oliveira	Yes	Yes	6309	6418	620	40,1k
Antonio Handmade	2017	Accessories	Ana & Sara Mateus	Yes	Yes	2269	2358	380	5396
Balluta Shoes	2018	Footwear	Catarina Pedroso	Yes	Yes	1485	1525	564	8629
Bekoffee	2018	Jewellery	Fernando Duarte	Yes	Yes	967	1149	765	683
Cherry Papaya Kids	2014	Kidswear	Sandra & Vera Barradas	Yes	Yes	10642	10845	1830	13,3k
Cleonice	2016	Womenswear	Kaleigh Tirone Nunes	No	Yes	1858	1878	335	5636
Conscious	2019	Womens Beachwear	Joana Silva	Yes	Yes	1090	1143	1086	44,8k
Daniela PontoFinal	2010	Unisexwear	Daniela Duarte	Yes	Yes	4845	4991	3287	3097
Guapa_Co	2016	Accessories	Tom Williams & Fábio Gião	Yes	Yes	2358	2412	1289	14,3k
Ideal & Co.	2012	Accessories	Rute Vieira & José Lima	Yes	Yes	31911	32112	1017	3827
Insane In the Rain	2017	Unisex Rainwear/ Kids Rainwear	Hannah Edwards	Yes	Yes	2347	2395	351	8326
Isto	2017	Menswear/Womenswear	Vasco Mendonça, Pedro Palha & Pedro Gaspar	Yes	Yes	5021	5280	934	34,2k
Kalium	2017	Womenswear	Kátia Almeida	Yes	Yes	1097	1130	181	941
Le Petit Chiffon	2015	Kidswear	Rita De La Bletière	Yes	Yes	6917	6998	2136	14,6k
Mazurca Handmade	2019	Accessories + Womenswear	Sara Esteves	No	Yes	3795	4010	1351	6181
Miss Castelinhos	2017	Kidswear	Diana Pais	Yes	Yes	1108	1156	1199	2714
Nae Vegan	2008	Footwear + Accessories	Paula Pérez	Yes	Yes	49859	49859	459	53,1k
Naz	2016	Womenswear	Cristiana Costa	Yes	Yes	7000	7332	754	18,1k
Pecegueiro & F.os	2017	Kidswear	Sara Lamúrias & Pedro Noronha Feio	Yes	Yes	7101	7186	510	7307
Skog Eyewear	2014	Eyewear	Nuno Pinto, Afonso Caldeira & Hugo Janes	No	Yes	24660	24557	290	2723
Toino Abel	2010	Bags	Nuno Henriques	Yes	Yes	-	-	595	14,5k
Tomaz	2015	Lifestyle Accessories	Eliana Tomaz	Yes	Yes	2319	2389	1284	3076
Wayz	2018	Footwear	Pedro Maçana & Daniel Gonçalves	Yes	Yes	1560	1612	546	4401
Zouri Shoes	2017	Footwear	Adriana Mano	Yes	Yes	21048	21795	1263	40k

The brands analysed, which, as mentioned above, were chosen at random and from a set of articles that highlight them as being sustainable, working in specific sectors and having well-defined targets. The data collected allowed us to verify that 20% sell kidswear, 16% produce footwear. These aspects should be highlighted since they help to prove how sustainability has expanded to various sectors and is not exclusive to clothing production. On the other hand, we cannot fail to mention that 44% of the brands target specifically women, relevant data not only because women remain at the top of the biggest consumers, but above all, it also tells us that brands most often direct their messages to women. This aspect is also interesting because men are less challenged by brands, which can also be explained by the fact that women created 71% of the brands analysed.

Looking in particular at the online presence, we can see that the totality of brands owns a website, in addition to being present on different social media, but above all in two: Facebook and Instagram. Most brands bet mainly on these two social media platforms, although some are on other platforms, such as Pinterest, Youtube, Twitter, Vimeo and Linkedin. We also found that 60% of the brands concentrate their social media following on Instagram, which is assumed as the platform of choice for brands to communicate. This fact is evident not only at the level of followers but also in updating publications. Most brands have posts from the last two days or the last week on Instagram, which is no longer valid on Facebook pages. So, we can consider that Instagram, due to its characteristics, is the social medium privileged by brands to disseminate news about their products. However, it seems that in terms of transmitting messages related to sustainability, both the website and the Facebook accounts play an important role. In this regard, we must emphasize that many brands even dedicate specific separators in their websites to explain the sustainable dimensions of the brand, both in terms of production and distribution.

At this point, it is also important to remember that a small number of brands that are part of the sample, and that was considered when we started this work, meanwhile interrupted their activity or have at least paused the projects they were developing, mainly due to the COVID-19 pandemic. However, they were considered because of the analysis that had already been carried out, but also because despite having temporarily interrupted their projects, the ideas presented helped us to understand the importance of the communication and positioning of a brand, which claims to be sustainable.

Observing in particular how brands present themselves, we tried to register which are the main terms used, that is, which words and expressions are privileged by brands to make themselves known as sustainable brands. It is, therefore, at the level of sustainability communication that we are located at the level of the brands' own identity. Thus, considering the previously established categories, we can observe that 63% of the brands refer they are local and producing in Portugal, 50% declare they produce "premium" or "high quality" and 50% claim to be sustainable. It is interesting to see that there is a bet in local production by these brands and that this is a fact highlighted in terms of the presentation of brands and also in the communication of products, at the same time that it is associated with high-quality, on the one hand, and with a reduction in the number of products that are made. These dimensions are necessarily related to sustainability, but above all, to how sustainability is communicated. By highlighting the national production and the quality of the products, the brands try to make themselves known as sustainable brands. It is not just about asserting themselves as sustainable, but about showing, namely through local producers and the durability of products.

Directly linked to the issue of sustainability, we also find that 46% of the brands consider themselves "ethical", with 38% re-using materials/excess supply and 29% even producing "vegan" products, even if "vegan" derived leathers and products cannot be necessary considered sustainable (Minh & Ngan, 2021), and many examples of greenwashing derive from the use of "vegan" in fashion. It is also worth mentioning that the brands are concerned with presenting themselves as ethical brands which respect not only the workers but also the raw materials and the entire production process. Also standing out in communication, the bet on reusing materials and even using new materials to create innovative and differentiated products in ecological terms. It is, therefore, not just a matter of using a label but of embracing and communicating the adoption of a whole set of responsible practices in sustainability during all phases of production.

Finally, it is also worth mentioning that 38% of the brands use terms such as "heritage", "tradition" or "tribute" in their presentation and in the communications they establish with consumers and society as a whole, which is relevant from the point of view of the brand's identity, since it is not just communicating the way you decide to face the market. Still, it is something deeper rooted in the history of brands.

Conclusions

The fashion industry is far from sustainable, despite recent improvements and consumers' higher level of information. Findings show that fashion companies are not implementing sustainable solutions fast enough to counterbalance the rapidly growing fashion industry's negative environmental and social impacts. In Portugal, recently created SMEs try to improve their consumers' and collaborators' quality of life. However, 23% of consumers prioritize quality, and only 7% purchase with sustainable goals, although good quality can also mean fewer purchases in the long run (The Pulse of Fashion, 2019). Among the brands observed in this study, 84% were created in the last five years. Not only do they try to create sustainable fashion pieces, but they also aim to influence consumers on social media by showing the importance of sustainable practices and adopting a lifestyle respectful of the environment.

These creators try to send this message through other vehicles in the creation of associations, workshops, courses, podcasts, and other activities. We can say that although mass culture and fast fashion continue to dominate, the idea of a sustainable society is slowly beginning to grow, with designers who have already realized the need to convey this lifestyle on social media, not just as a marketing tool.

This study aimed to comprehend how sustainability is communicated online by fashion brands. Through our observations of the brands' online websites and social media accounts, we observed that sustainable brands mostly use social media to communicate their mission and values and raise consumer awareness. We also found that 60% of the brands concentrate their social media following on Instagram, which is also in line with the target audience and following of these brands.

Further research is encouraged on this topic by gathering more information on sustainable brands and their communication, observing different countries, and still focusing on emerging brands through ethnographic methodologies. On the other hand, it could also be highly interesting to perceive how consumers receive the information and how influencers can be real game-changers in disseminating conscious messages and sustainable awareness.

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Prototype dialogues: re-balancing design thinking through negotiations with fabrics, form and future

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Abstract

In this paper, we discuss and challenge design thinking as a process model. Though initially intended as a process for solving wicked problems, including inequality, environmental issues and poverty, focus in the later years appears to have been mainly on development for growth. Faced with the emergent need for green transition and connectivity in times of disruption and conflict, new ways of thinking and conducting creative processes are needed. Thus, a re-balancing of design thinking seems to be beneficial.

The implementation of design thinking as a process model has contributed to an increased focus on the early research phase, particularly on the interaction between user and products/services with an emphatic approach to understanding users. While we in no way wish to undervalue knowledge of user needs, we contend that this intense user focus partly cannibalizes the emphasis on research through experimentation and prototyping in the fuzzy front-end of a design process. We explore if it is possible to re-balance the design thinking process by re-connecting experiments and prototypes to the very early phases?

At VIA Design & Business we have observed that Fashion BA-students in their graduation project tend to carry out predominantly desktop research and some fieldwork for a considerable amount of the project time. Consequently, they postpone hands-on experiments and prototyping, apparently feeling that prototyping is the physical outcome of the research and process instead of prototyping actually being research and process; sometimes to a degree where the knowledge generated from tangible experiences emerges too late to bring value to the project. The students thereby miss the opportunity to include and benefit from substantial knowledge coming from early hands-on experiments.

We discuss how didactic approaches can initiate prototype dialogues in the early stages of the design process to evaluate the consequences and to re-balance design thinking models. To support the discussion, we introduce examples of early prototyping from two BA courses with different perspectives on prototyping. With these two examples, we demonstrate ways in which early prototyping in the fuzzy front-end of design thinking supports and enhances students' dialogues with the material of a situation and how it is beneficial for the further process.

Author keywords

Design Thinking; prototyping; material dialogues; design process, green transition, scenarios.

Introduction

The fashion industry will undoubtedly experience many changes in the coming years. New policy such as EU strategy and national strategies (N.N., 2022; N.N., N.D.) are expected to place new demands on the way clothing is produced, used and disposed of. It will increase the need for new knowledge about product responsibility and resource consumption as well as disrupt our design methods and the way we act in design practice. There is a need for innovation and alternative approaches to problem solution and to prepare students to act as change agents in societal as well as industrial contexts. Future designers must be able to choose and ask for materials appropriate for the intended use, handle material flows and have skills in design for recycling, disassembly and longevity. They must also have knowledge about circular economy and business models and last but not least be prepared to learn as they go. At the same time, researchers are pointing at the challenges within the fashion industry with a significant focus on circular economy as a relevant way to go. A focus that might lead to a misplaced perception that it is possible to create a 'good Anthropocene' (Brooks et al, 2017).

In this paper, we discuss what we have coined 'prototype dialogues' as an asset in design thinking, advocating that prototyping plays a pivotal role in all steps of the design thinking process.

Background and design thinking theory

The recent years of COVID-19 lockdowns and online teaching have undoubtedly contributed to less focus on hands-on methodologies, e.g., prototype development and material experimentation. However, it is simultaneously relevant to reflect on teaching methods and approaches when the students choose work processes that the teachers consider less appropriate in relation to creating the innovative and/or alternative solutions needed by the industry and society. Based on the observation of our BA Fashion students' approaches and design process, we scrutinized the course program and curricula and realized that the processes we teach predominant-

ly are founded on a design thinking approach that includes high user focus, trend studies and market research in the front-end of the design process.

Design Thinking

The introduction of the concept of 'wicked problems' (Rittel & Weber, 1973) and the later interlinkage to design thinking (Buchanan, 1992) has been central to the initial approach in the concept of design thinking. Around the 70's, an interest emerged in the role and responsibility of the designer (Simon, 1969; Papernek, 1971). During the 80's, there was an intensified focus on the working methods within the design professions, (Lawson, 2005; Cross, 2006; Schön, 1991) and the concept of design thinking emerged. The concept began to be applied to business problems (Brown, 2009) and spread, specifically through IDEO and their working processes.

Several design thinking models emerged, including Ideo, Stanford dschool and British Design Council. Though they use different terminology, generally all models include similar phases consisting of; 1) Discover, focus on users and research, 2) Define, identify the problem based on user need 3) Ideate, generating ideas, often through brainstorming and post-its. 4) Prototyping, construct a 3D version of the idea. 5) Test, testing ideas on the market and the stakeholders. In the years 2013 – 2015, VIA Design & Business developed and launched their own design thinking process model; The Strategic Design Practice 5F model (McElheron & Harsaae, 2016a, 2016b). The model drew on inspiration from the extensive literature about design thinking, including the above mentioned and was intended to close the gap between our design and business students. 'Practice' deriving from the design disciplines, including prototyping and experimenting, 'strategic' related to the business disciplines, and 'design' as the linkage between the two.

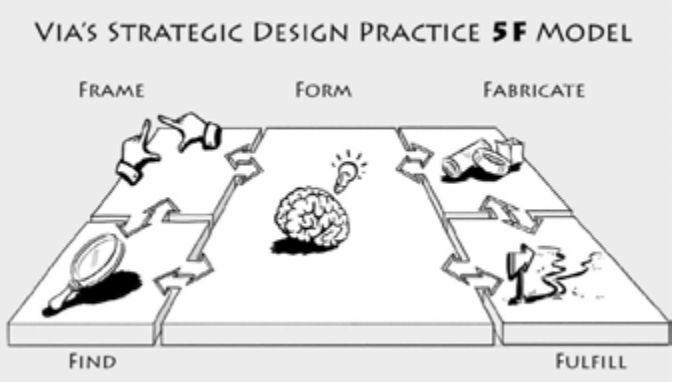

Figure 1. VIA Design 5F Model; McElheron, P. & Harsaae, M. 2013

In light of the current environmental situation and the urgent need for green transition, we are embarrassed to admit that at the time when we developed The Strategic Design Practice 5F model, the green transition was neither at the forefront of process development nor the goal of the model. The point of departure for the development was the focus on creating a process model tool which contributed to a better cooperation between design and business specifically with a focus on our students. The original idea of the model was also not to present it as a linear process, but instead to focus on a more open and unstructured process. However, during the use of the model and its diffusion within the education programs at our university, we experience that it is articulated and used predominantly linearly.

The predominantly linear approach might be the reason why we at VIA University College, Design & Business, have observed the earlier-mentioned tendency among our BA Fashion students. In combination with the need for green transition, this observation points to a need for re-balancing our approach to design thinking, supporting an urgent need for alternative didactic approaches.

VIA Design & Business students are introduced to The Strategic Design Practice 5F Model at two different common module courses, one course placed on the 1st semester and the other course placed at the 5th semester. All students regardless of disciplinary specialization build a shared knowledge about design thinking as a process tool. In addition to the two introductions common for all study programs, the various programs choose individually the extent to which design thinking should be part of the curriculum. In the following sections, we discuss how didactic approaches can initiate prototype dialogues in the early stages of the design process to evaluate the consequences and to re-balance design thinking models. We do this supported by examples from two very different course modules.

Prototype dialogues – introduction to and discussion of examples

We set out to discuss how didactic approaches can initiate prototype dialogues in the early stages of the design process to evaluate the consequences and to re-balance design thinking models. To support the discussion, we introduce examples of early prototyping from two BA courses with different perspectives on prototyping at the forefront of the design process. The two courses have very different approaches, structures and expectations to outcome in terms of learning goals.

Elective; Changemaking Design

The elective 'Changemaking Design' is offered to students in their final semester. We invite the students to experiment with a variety of biomaterials during a three-week elective. The students come from fashion, furniture, and graphic design specialties. We specifically ask the students to individually experiment with biomaterials, including bio leather and alginate composites related to individually chosen concepts within their core design disciplines. The prototypes created by the students were speculative as these materials have not yet been commercialized. This allowed the students to examine the concept, taking an early hands-on experimental approach to explore the materials. The elective focused on the process and the students' ability to learn from their

Figure 2. Prototype Dialogues: Biomaterials.

experiments and move back and forth between experimentation, knowledge generation, and insights. The output of the course was an individual portfolio documenting the process and displaying the different samples. Samples that the students evaluated as having potential for further development and commercialization were supported by recipes and reflections on further development. All of the students (9) performed really well and generated numerous material samples that pushed them in new and alternative directions that they stated have not been part of their considerations until then.

The course revealed advantages and disadvantages of the didactic approach. It was remarkable that some of the generally 'weaker' students matched or even surpassed the other students when working in this way. Some of the students were so taken up by the experimental approach that they put several extra hours into the project beyond what was expected. Others clearly had more difficulty navigating the very open approach that did not require the students to produce a specific, final result. Some students became so enthusiastic about the experimental approach that they resumed it in their final BA exam project and started with the development of materials and/or experimenting with form and shapes in existing materials. Some of them also transferred this approach to their work with deadstock or second-hand materials.

This example demonstrates how early prototyping in the fuzzy front-end of the design process supports and enhances the students' dialogues with the physical material of a situation beneficial for the further process. It does, however, also reveal that not all students adapt to and benefit that easily from this alternative approach right away. A catalogue of predefined subtasks may have supported these students in their experimental process. However, the explorative approach caused the students to develop materials that it is hard to imagine they would have developed if the point of departure had been user research, and in general the students' final portfolios revealed several material proposals worth investigating further in an industrial context.

Interdisciplinary Module

The second example is an interdisciplinary module for students across nine disciplinary study programs in the 5th semester of the BA. The aim of this module was to develop a concept for a case company that contributed to the company's sustainable development. The module is divided into two parts, a two-week introductory part and an eight-week processing a part. In the introductory part, the first task was to prototype future visions as 3D scenarios. The students worked in groups of four, and based on the identification of two megatrends and their countertrends, they created a scenario cross with four different scenarios and selected one for prototyping. Contrary to the elective described above, the aim of this exercise was clearly defined. The students should visualize a future scenario as a 3D prototype which they should present to the other students and use as point of departure for their concept development.

Figure 3. Prototype Dialogues: 3D future scenarios.

Working with scenarios gives students tools to discuss possible, plausible, probable and preferred futures (Dunne & Raby, 2013; Voros, 2022). Using megatrends as guidelines for scenario development allows students to anchor their own intuition and move between feelings and qualifications. In this way, they work with data-based descriptive scenarios and/or intuition-based prescriptive scenarios (Margolin, 2007). This early prototyping gave the students the opportunity to have a very concrete dialogue about future utopias and dystopias. The prototype functioned partly as an icebreaker through conversation with the material of a situation (Schön, 1991), a way in which the students could get to know each other across disciplines and partly as a point of departure for the subsequent concretization of their idea and concept development.

This example demonstrates a different approach to early prototyping in the fuzzy front-end of the design process. Contrary to the first mentioned approach, this approach supports and enhances students' dialogues with abstract material of a situation beneficial for imagining and discussing potential futures as a framework for the further process. Moreover, the use of scenarios is an acknowledged approach in business (World Economic Forum, 2018) and political (Fritsche et al., 2021) contexts to identify future challenges and opportunities.

Conclusion – Re-balancing design thinking as a process model

With these two examples, we demonstrate ways in which early prototyping in the fuzzy front-end of design thinking supports and enhances students' dialogues with the material of a situation, in the form of the very concrete example from the elective or the more abstract example from the interdisciplinary module. From different perspectives, both types of dialogues are anticipated to be beneficial for the further process.

Material does and makes us do

In their article "Material driven design (MDD): A method to design for material experiences, Karana et al. (2015) argue for qualifying material "[...] not *what it is*, but also for *what it does*, *what it expresses to us*, *what it elicits from us*, and *what it makes us do*", emphasizing that materials need not only to be characterized by their functionality but also how a material contribute to create user experiences.

Focusing on Karana et al.'s notions about what *material does and what it makes us do* resonates with a focus on using material experiments as the point of departure for a design process intended to create not only long-lasting products but also products that last (Fletcher, 2012). Long-lasting products as well as products that last bear the potential to foster a green transition.

What material *does* is transferable to the properties required to make long-lasting products whereas what material *makes us do* might contribute to creating products that last. We suggest that if our didactic approach focuses on employing material experimentation at the front-end of their design process, we might facilitate a design process with focus on *"material experiences when a particular material is the point of departure in the design process"* (Karana et al., 2015:37).

The two courses we have presented in this article both relate to Karana et al.'s approach. The elective 'Changemaking Design' very concretely employs a similar approach with its focus on material experimentation and how this is applied by the designer to *"create and materialize concepts which make the transition from design intention to material/product design"* (Karana et al., 2015: 39). The interdisciplinary module, however, relates more abstractly to material and material experimentation as the approach is to focus on the dialogue with the material of a situation (Schön, 1991) through the building of scenarios.

Design Thinking and the Green Transition

Evaluating these approaches against the Strategic Design Practice 5F model's FIND phase implies a need to broaden the understanding of the user studies, encouraging designers to empathize and research on reveal relevant societal challenges, by adding concrete and hands-on material experiments and scenario prototyping as part of the initial research and exploration phase and as such add more perspectives to drive the further process.

Design thinking has a great potential. However, with this paper we argue that if supplemented with an explorative and experimental approach through prototype dialogues, there is an even greater potential for fostering new ideas that will contribute to the green transition.

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Future fashion: new and ancient systems at the intersection of anthropology, ecology and innovation

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Abstract

This research offers an analysis of an emergent subculture of resistance to the fashion status quo that embraces natural, indigenous textiles in contemporary clothing. It shows how three small luxury designers employ radical indigenism (Watson 2019), soil to skin (Burgess 2019), natural fibres, slow and conscious processes, and aesthetic sustainability (Harper 2022), to offer a persuasive counter narrative to the incumbency thinking that perpetuates the prevailing fashion system. Case studies of Noir Mud Silk, Monad London, and Oma Space have been formed from semi-structured interviews and the analysis of their products and processes. Key to this research has been defining the values that inform these designers' praxis, such as the importance of craft, the rejection of growth-logic (Fletcher and Tham 2019) and the desire to promote human, environmental and even spiritual wellbeing through work that reflects a sophisticated intersection of anthropology, ecology and innovation. Research outcomes suggest the importance of reframing indigenous technologies as innovative rather than primitive and of learning - with humility - that traditional knowledge systems have much to offer our future by teaching us how to live within planetary boundaries (Watson 2019, Nakashima 2010, Magni 2017, WCED 1987). Although designer-artisan collaborations are common within the existing fashion system, a focus on the ability of material systems to reconnect us with the whole earth community, holding us within Nature's limits, has received less attention (Watson 2019, Berry 1990). When radically indigenous materials are suggested for fashion, questions of scale-ability quickly arise, as the impulse to commercialise and grow is privileged over relational modes of knowing, being and doing (Escobar 2018: xi). This research therefore, shows ways to collaborate with traditional textile knowledge systems to re-imagine, produce, value, use, and ultimately discard clothing while affirming natural and restorative systems, demonstrating a simultaneously new and very ancient paradigm of fashion.

Author keywords

Radical indigenism, slow luxury, textiles knowledge systems, fashion and nature, ecological design.

Introduction

The fashion industry is closely tied to a system of extractive globalization that contributes to the degradation of our planet and its peoples through its use of fossil fuels, over-production and mass-consumption, waste, exploitation, and human rights abuses in the supply chain (Fletcher and Tham, 2019; Ellen MacArthur Foundation 2017). Since the early 1990s, fashion industry growth has escalated around the world, but business models focused on growth are irresponsible when the imminently finite nature of the earth's resources and the impacts of climate change are no longer deniable. A reduction of 75-95% of material resource use is needed, but this is self-evidently impossible in an industry that was forecast to grow by a further 81% by 2030, at least prior to Covid-19 (Fletcher and Tham, 2020; Global Fashion Agenda, 2022).

We have now less than a decade left to prevent irreversible climate damage (Global Fashion Agenda, 2022): the fashion system must change radically and so too must our relationship with clothes. Many fashion designers now acknowledge that a change of pace and scale is needed: indeed, Giorgio Armani spoke passionately about this in an open letter published in WWD in April, 2020 (Armani, 2020), where he described the acceleration of production cycles, increased volumes and frenetic fashion seasons as 'criminal'. How we transition to postgrowth fashion is unclear, however, although it is obvious that we need to produce less, produce more slowly and consciously, and produce clothing that will last both physically and emotionally: clothing that is untied from seasonal trends and more reflective of personal values (Edelkoort, 2020; Armani, 2020; Harper, 2022). Therefore, a complete reset is needed in the systems, materials, designs and relationships embodied in and articulated by our clothing, so that we may transition to live in a "mutually enhancing relationship" with the whole earth community (Berry, 1990:53; Escobar, 2018). But where do we begin?

> *We have plenty to be sorrowful about, and are not emerging into a golden age. We need a gentle approach, a non-violent spirit, and small is beautiful. (Schumacher, 1973:129).*

Fashion, as we now conceive it, has exceeded the carrying capacity of the Earth. Instead, we need an ecology of small, diverse and conscious expressions of clothing to meet the challenges of the Anthropocene. The future must be small: smaller labels have an autonomy to make decisions about their operations that larger brands don't, are without ac-

countability to shareholders, and are able seamlessly to reflect their values and beliefs about fashion, the world, and even the cosmos in their operational models (Schumacher, 1973; Kibbe, 2015; McRobbie et al, 2016; Moulton et al, 2019). Luxury is an area of fashion that - although arguably undemocratic - is highly influential. Characteristics of true luxury products are quality, craftsmanship, exclusivity, heritage, aesthetic sustainability and creative innovation, all of which support sustainability (Danziger, 2016). This research examines the practices and values of three small, independent, luxury fashion labels that offer fresh approaches to fashion conception and realisation that embody ancient knowledge, natural systems and skilled craft traditions, and which operate within planetary boundaries, in case studies of Noir Mud Silk, Monad London, and Oma Space.

Much is claimed about the potential of new technologies to solve fashion's sustainability problems, perhaps in the hope that current, mainstream business practices focused on efficiency, profit and growth may somehow be maintained (Deeley, 2022; Manal et al, 2022; Shoaib, 2022). However, this research explains how an alternative vision for luxury fashion is grounded in the belief that the knowledge we need about how to live well on the Earth already exists, that it does not need to be invented but rather rediscovered (Orr, 2004; Berry, 1990).

Looking back to move forward: anthropology, ecology and innovation

A growing body of independent fashion and design thinkers are advocating looking back in order to navigate a better way forward, applying anthropological research and ecological systems thinking to how they locate, understand and source materials, techniques and processes, in the design of products, and the end of life of those products. In an interview for the Royal College of Art, John Thackara emphasised the importance of learning from other cultures that have historically specific, less damaging ways of making things; he suggested that we have reached "peak-digital" and that the materiality of craft is now "at the centre of where design is coming from" (Thackara, 2020). Li Edelkoort, in an interview for Bloom Brasil in May 2020, described a move towards "less and better, minimal and exceptional, sustainable and intuitive" and "the future is handmade". She foresees much stronger links between farms, fibre houses, textiles houses, fashion houses and retail – that they would belong to each other, invest in and help each other in a more relational, transparent system (Edelkoort, 2020). This model relates closely to the Fibershed movement – local and regional networks of fibre producers, 'from soil to skin' (Burgess, 2019) - which allows us not only to know who made our clothes, but exactly where and how the fibre was grown, how it was dyed, spun, knitted or woven, cut and sewn and by whom, as part of a new - but also very ancient - holistic, transparent and relational system (Burgess, 2019). In many ways, this echoes the fibre and textile production systems still found in some indigenous communities but which are at risk of being lost forever. These systems demonstrate a sophisticated and harmonious relationship between people and their local environment.

Radical indigenism

Radical indigenism is a term defined by Princeton professor and citizen of the Cherokee Nation Eva Marie Garroutte and discussed specifically in relation to design by architect Julia Watson (Watson, 2020). Reflecting the Latin origins of 'radical' – *radix*, meaning *root* – radical indigenism asserts the need to re-examine the traditional wisdom rooted in the cultures of many global communities that may rebuild our understanding of how to work in collaboration with natural systems (Garoutte, 2003; Watson, 2020). Indigenous knowledge is passed down through generations within a community, and encompasses the "understanding, skills and philosophies that span the interface between ecological and social systems" (Nakashima, 2010: 1-2) – as such it forms part of their intangible cultural heritage. Making requires local, organic materials so that connection to the surrounding environment is reinforced and production may naturally be constrained by season or by other essential activities. Material resources are considered precious, so little waste occurs: everything produced may be repaired, repurposed and will naturally biodegrade to nourish the soil. This approach is now crucial to revive if we are serious about the transformation required in how we produce and use the things we wear.

Craft as sustainable process and resistance

Craft and design have historically "reveal[ed] themselves as the forces of anti-Mammon" (Greenhalgh, 2002: 9) in times of excessive consumption. Craft is central to the textile practices of indigenous makers who use slow techniques that have sustainably been refined over time. Long supply chains and anonymous producers have disconnected consumers from those who make their clothes, obscuring the human and environmental cost of how they are made. The radical transparency of relational sourcing strategies that know and name specific indigenous makers may not only support cultural sustainability but also promote aesthetic and environmental sustainability.

Subcultures form in resistance to the symbolic order of a culture and "contradict the myth of consensus" (Hebdige, 1979:18). The three critical fashion practitioners selected for this study are part of a growing movement that is creating clothing and accessories in alternative ways to the mainstream, trend-led fashion system. Their approaches involve personal, aesthetically sustainable design strategies and slow, meditative , craft-led techniques and processes that embody a harmonious relationship between peoples and planet. This may seem romantic, but these idealists offer hope. "The world does not need to be remade but rather revealed" (Orr, 2004:32) and this small group of independents is "rediscovering old and forgotten things" (Orr, 2004:32) drawing on ancient knowledge systems that are important to maintain.

Methods

In order to understand not just what, where and how, but also why, qualitative research methods were used to construct case studies of Marcella Echavarria (Noir Mud Silk), Daniel Olatunji (Monad London), and Oma (OMA Space). Semi-structured interviews were conducted through zoom between July and October 2020 to delve deeper into their individual approaches and the values and beliefs that inspire these. The interviews asked the same questions of all participants, but offered scope for follow up questions on information that arose organically through conversation. Their collections were analysed - through their websites, through social media, through journal articles, and through physical examination in the case of Monad London - to define the distinctive material and aes-

thetic characteristics of their work and how these might promote sustained relationships with between consumers and their clothing.

Case Study 1 - Marcella Echavarria

> *When you have certain pillars that define your life, then your work is not a separate thing (Echavarria, 2020).*

Sourcing and cloth

Marcella Echavarria, currently based in Spain, describes a profound sense of gratitude for everything she has personally: for nature, for family and for the beauty in the world that informs her practice. Although reluctant to describe herself as a designer, Marcella's entire career has involved her working closely with artisans to develop luxury, artisanal products - respecting people who "work with their hands and their hearts". She is co-founder of the XTANT textiles festival that takes place in Mallorca each year. She describes the fabrics she uses as "embodiments of nature" and is committed to sustaining indigenous knowledge systems.

Marcella started Noir Mud Silk as a way of honouring and promoting Chinese mud silk, which has been designated part of the Intangible Cultural Heritage of Humanity by UNESCO. She first came across the silk in Beijing, attracted by the distinctive, almost musical sound it makes when worn and by its unique texture. She began to research the cloth, to learn more about its 2,500-year history, as part of the material culture of the Hakka people of Guangdong Province, and its tangible and intangible properties. Naturally 'white' silk fabric is dipped in a solution containing the juice of a species of yam to mordant the cloth, transferring its medicinal properties and improving its durability while also dyeing it a rich red-brown. The cloth is laid out to dry on the ground in the sunshine and may be dipped and dried many more times, before coating on one side only with iron-rich mud from the Pearl River to create a unique surface: shiny, black – sometimes looking like leather, like paper, like parchment "so many textures in one". The finished cloth is stronger and more water resistant than other silks, washable and comfortable to wear in humid summer conditions.

Figure 1 & 2. Ancestral shapes in mud silk by Noir Mud Silk.

The production of the cloth is closely tied to natural, seasonal rhythms, constrained by the drying season from March to November and in conjunction with the artisans' other activities, such as farming. It represents an ecologically sound model of textile production.

The design strategy

Marcella's designs draw consciously on "ancestral shapes" that are based on indigenous Asian cutting techniques, working sympathetically within the physical properties of the cloth such as width, available length and drape, rejecting season, size and gender to create timeless limited "editions" rather than seasonal collections, and responding to the naturally constrained availability of the fabric (Figures 1 and 2). Because Marcella appreciates the fabric so much no scraps are wasted, so many items contain elements of patchwork: "I don't call it upcycling or recycling: I call it appreciating". This is reflective of the ways that many indigenous communities in the world (and indeed most communities, historically) work resourcefully with the materials available to them. The designs consciously embrace any imperfections and inconsistencies in the cloth and how this wears over time. Noir Mud Silk has a following of customer-collectors, who understand that the garments and materials not only look beautiful but also feel beautiful on the body. Many Chinese customers have come to appreciate Marcella's interpretation of their cultural cloth, suggesting that "someone has to put value into something of your own for you to value it". She describes herself as honouring something that already exists: first of all – and foremost – respecting the fabric, of looking back in order to move forward. She has no plans to grow her business, but rather organically to be limited by what is possible to produce within Nature's systems and timeframes.

Case Study 2 - Daniel Olatunji

> *...the Fulani tribesmen that are growing the cotton I work with are very much limited to what they can grow...they can only produce a certain amount, handwoven, and it kind of works hand in hand with nature, so you're not over-producing anything. (Olatunji, 2020)*

Sourcing and cloth

Daniel Olatunji, based in the United Kingdom, emphasises the importance of slow craft traditions in every aspect of his menswear business Monad London. Central to Daniel's business model is sourcing materials directly from small, indigenous producers, emphasising the benefits of the relational and of "meeting people with really interesting stories". He identifies James Rebanks' The Shepherd's Life (2015) as a major inspiration for him, in revealing the value of the local and specific place of origin, leading him to seek out rare wool weavers and ultimately to work with one of the few remaining handweavers of Donegal Tweed, Eddie Doherty. Traditionally, Donegal tweed represented a perfect, ecologically-sound symbiosis between animal, land and people: using wool from local sheep, dyed with local lichen, berries and moss, as part of a small cottage industry that supplemented income from subsistence farming (Hoad, 1987).

In addition to Donegal tweed, Daniel sources the cotton he uses from Fulani tribesmen in northern Nigeria, who grow it in certain quantities and at certain times of the year, around other crops and activities (Figures 3 and 4). This, and the amount of

Figure 3 & 4. Handloom, indigo dyed cotton, wabi-sabi aesthetics by Monad London.

Figure 5 & 6. Handwoven, textural garments by Oma Space

time it takes to pick, spin and strip-weave the cotton by hand, places natural limits on fabric production to operate within planetary boundaries and results in irregularly textured fabrics that powerfully communicate the maker's hand. The community also comprises indigo dyers that continue a 600-year-old tradition passed down from father to son for centuries. Daniel buys this fabric for specific orders, never asking for more than can be produced slowly and consciously.

The design strategy

Craft is where Daniel draws his inspiration from and how he develops and produces garments for his customers, primarily in the UK and Japan. His philosophy of making embraces the Japanese concept of *wabi-sabi*, of finding beauty in the imperfect, which can accommodate and even celebrate irregularities in surface and weave. The deceptively raw edges on his garments are impeccably finished inside to ensure their durability (Figure 4). He is also inspired by the way that garments take on characteristics of their wearer over time, for example, how sleeves may start to fold in distinctive ways, or become distressed in a manner that is both beautiful and personal. The precious fabric scraps from cutting are incorporated in new garments. Monad's editions are small – never more than four of a specific piece - working within the availability of slow, traditionally-made natural materials. It is this specialness - Daniel's craft, the craft of the makers behind the exquisite, timeless garments, and the knowledge that these embody - that his customers appreciate most (Figures 3 and 4). He plans to grow slowly and organically, only in response to demand, but maintaining his values as a slow, artisanal brand and working within the boundaries of what may be produced without compromise. He hopes to educate and inspire others to work with unique, artisanal fibres and indigenous materials, to keep these skills alive, and that this will lead people to ask about who made their clothes, where and how.

Case Study 3 - Oma Space

> *Something made with an awake mind and with good spirit in it is real luxury. (Oma, 2020).*

Sourcing and cloth

Oma Space is a small, independent fashion and textile studio in South Korea whose design practice is materials-led, working solely with natural, biodegradable fibres and the innovative application of traditional processes to which Oma attaches a spiritual dimension: "to dress the body and soul". The fibres used are hand spun and include wild silk, cotton, linen, ramie, hemp, wool, and Korean Hanji paper, naturally dyed with plant matter including fermented ebony fruit that changes shade over time, or with indigo to "detoxify the bad energy accumulated in the body" with its natural, antibacterial properties. Hemp, in particular, is beneficial to soil health, growing well without use of fertiliser or pesticide. Oma works closely with weavers in northern-eastern Thailand, who grow indigenous species of cotton that they spin and weave themselves, and who are very receptive to the collaboration because their skills and knowledge are otherwise at risk. Central to Oma's work is a desire to prevent handcrafted, traditional textiles from disappearing: keeping them alive by keeping them worn, rather than preserved in a museum.

The design strategy

Oma believes that a radical change in production systems is needed, that we must make things consciously, avoiding trends. She suggests that another word for fashion is now required: one that reflects an alternative paradigm - not clothing, not garments, but something different. She is mindful of the consequences – and indeed the responsibility - of making anything at all now: that it must be able to disappear [biodegrade] very naturally, as everything comes back on us, so carefully considers the ecological impact of her decisions and processes. She begins by playing with a fabric for a few days, to touch, smell and feel it, trying to "hear how the fabric wants to be expressed"; only then does she begin to draw. Oma's limited editions of slow, handcrafted clothing can be worn for any occasion, using shapes that are simultaneously timeless and modern, local and transnational (Figures 5 and 6) supporting their aesthetic sustainability.

Customers predominantly are based in London, Amsterdam, Tokyo and Seoul and share Oma's appreciation for the craftsmanship and unique properties of artisanal materials. The irregular surfaces and natural colours convey the spirit of the makers' hand and the natural world, reflecting Oma's Buddhist beliefs and embracing natural imperfections (Figure 6). Process is promoted: Oma's atelier in Seoul includes videos and images of the artisan's techniques and a loom to reinforce the fact that the fabric is the results of slow skill. In addition to

Table 1. Summary of research findings

Measure	Noir Handmade	Monad London	OMA Space
Values	Gratitude, appreciation; artisanal craft; respect for makers; preserving nature and indigenous textile knowledge. Fabric first.	Slow craft, perfectly imperfect, relationship with makers, preserving local, rare, indigenous textile knowledge. Fabric first.	Preserving nature and indigenous textile knowledge by keeping it worn and used; responsibility; promoting conscious practices. Fabric first.
Sourcing	Directly from artisans in Guangdong Pearl River Delta region, China.	Directly from artisans in Northern Nigeria and Ireland; collaborations with artists.	Directly from artisans; collaborations with artisans in Northern-Western Thailand, Laos, Japan and in South Korea.
Names makers/groups	Groups	Yes	Groups
Indigenous textile knowledge system	7500-year-old tradition, using local, natural resources: scale limited by seasonal nature of production due to weather and other activities; at risk due to laborious production processes, climate change affecting the drying season and water pollution affecting iron content in local river.	Kano, Nigeria – traditional hand spun, strip-loom woven indigenous cotton species; supplementary income for indigenous communities; naturally dyed in 600-year-old indigo dye pits; knowledge at risk as younger generation seek other employment; handwoven Donegal tweed from one of the last remaining handweavers – at risk due to labour intensive nature of work deterring apprentice weavers.	Traditional hand-spinning and weaving, natural dyeing systems; supplementary income for indigenous communities; at risk as new markets are needed for their work and older artisans are dying out; Korean hemp traditions were almost eradicated after the war but now are being revitalised.
Fibres	Silk	Indigenous species of cotton, wool, silk	Hemp, wild silk, indigenous species of cotton, wool, ramie, Hanji paper.
Fabrics	Traditional mud dyed silk. Plain or crepe weave.	Handwoven strip loom cotton; wool tweed.	Handwoven; felted, textural, tonal.
Dye	Diospyros cathosa with iron-rich mud; indigo. Dyes that carry beneficial properties	Indigo carries beneficial properties; tweed dyed with local plant matter from Donegal, such as lichen.	Indigo; ebony fruit; always natural. Dyes with beneficial properties to body and soul.
Waste strategy	All scraps are kept and reused, patched together to make more garments	Scraps are kept and reused in other clothing products.	All materials are fully compostable, can safely be returned to the earth.
Aesthetic qualities	"Ancestral shapes" traditional, simple and timeless styles. Exceptional quality. Aesthetic sustainability.	Timeless garments that adopt a wabi sabi approach – the aesthetics of wear. Exceptional quality. Aesthetic sustainability.	Simple, timeless, traditional shapes; highly textural; aesthetics of the hand made Exceptional quality. Aesthetic sustainability.
Collections	Editions – new pieces added depending on the availability of the fabric. Natural constraints due to seasonal availability.	Editions – never more than 4 made of any garment. Naturally constrained by the availability of the cloth.	Editions – new pieces added depending on current collaborations with artisan groups. Also creates an textile art installations and combines tradition with new technologies.
Showcase	Exhibitions; showrooms; events; online.	Showroom; Horizon in London, other stockists in Japan.	Own studio on Seoul; galleries; specialist stockists, such as Livingstone Studio in London; online.
Position on growth	No desire to grow.	Would like slow, organic growth – without compromise.	No desire to grow.

clothing, Oma Space creates experiential textile installations that promote artisanal processes and improved consciousness, sometimes introducing digital technologies. Oma Space has no intention to grow their business, but rather is happy to stay the same size year on year.

Conclusion

This research is significant in showing how a subculture of independent, luxury fashion labels has developed small, distinctive, and successful practices while refusing to be complicit in a problematic system (Table 1). Marcella Echavarria, Daniel Olatunji and Oma share a strong appreciation for unique, locally specific, natural, indigenous materials, sourced directly from artisans who use slow, traditional, craft processes conducted in symbiosis with natural systems in ways that have sustainably been performed for many centuries. They show us how these materials may be used to create limited editions of clothing that is physically, aesthetically, and environmentally responsible. Their clothing primarily is installed in gallery spaces, exhibitions, showrooms and online platforms, rather than in conventional fashion stores. This has the potential to change perceptions of the garments, by framing them as artefacts to be examined, understood and valued in ways that promote responsible consumption, rather than as disposable commodities, and which provides opportunity for information to be shared about the indigenous people and systems that formed them (Geczy and Karaminas, 2019).

While the price points of their clothing reflect the investment of time and skilled craft knowledge which positions their work as exclusive, and therefore inaccessible to many fashion consumers, these labels do provide role models to some young designers who wish to produce luxurious clothing in meaningful and sustainable ways. Their approach contrasts dramatically with that of major global luxury brands that have similar price points, but which produce unsustainably. As such, they form part of an ecology of diverse fashion practices that contribute ideas for a responsible future. If, like many indigenous communities, we are to live in synchronicity with natural systems rather than in opposition, this diversity is key: too much of one species is detrimental to local ecology. There is no single solution or business model that by itself will solve the problems created by a global fashion industry that has exceeded the carrying capacity of the Earth. The transformation of the fashion industry to become truly sustainable requires a radical, whole-systems approach involving multiple stakeholders – including governments with the vision, integrity, and courage to commit to, support and incentivise meaningful change through policy and legislation. The three case studies demonstrate one possible approach; further research is needed to explore the transferability of this to other markets and contexts.

Important to this research has been defining the values that inspire these designers' approaches, which include their rejection of the orthodoxy of growth, having a strong sense of sufficiency and their desire to promote human, environmental and even spiritual wellbeing through clothing. Their business models are naturally constrained by their use of indigenous textiles that are closely identified with specific peoples, places, materials, and techniques – and which are part of ancient knowledge systems that reflect natural limits to growth. These systems demonstrate a harmonious relationship between human creativity and nature, using local, natural resources wisely, preserving culture and knowledge, and supporting artisans' livelihoods and dignity. Marcella, Daniel, and Oma demonstrate that it is possible to have small, successful fashion businesses that are not growth-focused, sharing a mission to draw attention to, preserve and learn from indigenous textiles knowledge systems that are at risk of dying out.

However, when radically indigenous materials are suggested for clothing, questions of scale-ability quickly arise as the impulse to commercialise and grow is privileged over the relational modes of knowing, being and doing that these embody (Escobar, 2018: xi). If we are ever to transition fashion to be produced and consumed within planetary boundaries, then scalability is the wrong focus: small is beautiful. The research underlines the importance of reframing indigenous technologies as innovative rather than primitive, in operating within planetary boundaries. These traditional knowledge systems now have a crucial role to play in re-orientating fashion towards a future where we all may thrive (Watson, 2019; Nakashima, 2010; Magni, 2017; WCED, 1987; Berry, 1990). We must look back - before it is too late - to navigate a way forward.

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Figure References

Figure 1. Echavarria, M. https://www.noirmudsilk.com

Figure 2. Echavarria, M. https://www.noirmudsilk.com

Figure 3. Monad London. Photographer Michelle Helena Janssen. https://www.instagram.com/p/CkXxL_sLSvG/?utm_source=ig_web_copy_link

Figure 4. Monad London. Photographer Mishael Phillip. https://www.instagram.com/p/ByAQ5WhgrDe/?utm_source=ig_web_copy_link

Figure 5. Oma Space. https://omaspace.com/garments/couture/

Figure 6. Oma Space. https://omaspace.com/garments/couture/

Design fiction localised

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Abstract

This paper presents results of an ongoing research aimed at analysing design fictions created in the Baltics. This research is put forward with purpose of rendering the geography of design fiction more complete and fostering appreciation for diverse worldviews and a pluriversal imagination. The paper introduces the method of design fiction, offers a concise overview of its history, and explains its functionality and use. It discusses the necessity to increase visibility of design fictions from diverse geographical and cultural contexts and places a particular emphasis on Eastern Europe and the Baltic states. Four examples of design fictions generated in this region are presented, all of which are related to a recurring topic of interest in this region: a confident and even intimate relationship with nature. The paper demonstrates that these design fictions reflect (on) one or more of the following factors: 1) arguably nation-wide societal beliefs, assumptions or concerns; 2) a specific natural or artificial environment typical to the area in consideration; 3) a personal lived experience of the author in the given context.

Author keywords

Design fiction, critical design, diversity, localised, futures.

Introduction

Design fiction as a medium for creative expression as well as a research tool is becoming increasingly popular. It is a trend that ought to be cultivated as this kind of reasoning is of political significance. Design fictions are propositions of alternatives; however, they are not projects or designs to be implemented, nor hypothesis to be verified. Rather, they are "advanced with the consciousness that it is an inadequate, subjective and pictorial manner of conception, whose coincidence with reality is, from the start, excluded" (Vaihinger, 1925, p. 268). The purpose of design fiction is "to suspend disbelief about change" (Sterling, 2017, p. 18), to offer new insights and perspectives.

This paper discusses the significance of geographical locality and cultural context of design fiction and aims to counteract the occasionally criticised Western "neo-liberal worldview" (Thackara, 2013) that dominates this branch of design practice. The author claims that fictions generated in various locations can increase the diversity of our collective imaginary and illustrates it by analysing four examples of design fictions created in the Baltics (term used to denote three countries in North-Eastern Europe, Estonia, Latvia and Lithuania). The insights communicated through these fictions have the potential of being relevant and applicable also elsewhere; however, the purpose of this study is not to claim any kind of universal knowledge, as it would be contrary to the author's aspiration of promoting the pluriversal imagination, as formulated by Arturo Escobar (2018, p. 21). Rather, the value of this ongoing research lies in discovering and fostering appreciation for this rich ecosystem of design fictions that are both a result of and a food for our collective imagination.

The examples discussed in this paper are not an exhaustive overview of design fictions that are produced in Baltics and present embeddedness in the local context. It is merely a selection that supports and illustrates the argument, while also complying with the restrictions of the paper length.

History of design fiction

Employment of design fiction as a tool for research, reflection, and inquiry is not only a present-day phenomenon. One of its most significant episodes in design history has been the radical design movement that took place in Italy and Austria in the 1960s and 1970s. Collectives and designers such as *Superstudio*, *Archizoom*, *Memphis*, *Alchimia*, *Haus-Rucker-Co*, Walter Pichler, Hans Hollein, among others, conceived utopian and dystopian visions that were presented by means of various media, such as photocollage, video, drawings and writings, but also tangible objects, performances and exhibitions. They challenged modernist values and worldview and refused the idea of design and architecture as tools in service of the industry, used to promote consumerism and conformity. Their method was aimed at "introducing strange bodies into the system [...] in order to draw attention, arouse interest [...] and inspire actions and behaviours" (Superstudio, 1969). These projects were not intended as proposals for alternatives to the existing reality, but rather—as radical and critical reflections on this reality (Dautrey & Quinz, 2015, p. 24).

The next crucial episode in the history of design fiction is the emergence of the critical design movement in the United Kingdom in the 1990s. Critical design follows in the footsteps of radical design and its "primary intention is to make us think: to raise awareness, expose assumptions, provoke action, spark debate, and even entertain in an intellectual way like literature or film" (Raby, 2008, p. 94). It also employs fictional objects and stories in order to reflect on a vast range of topics, such as implications of technological development, the impact of the material environment on the society, aspects of professional and civic ethics, industry and consumerism (Jakobsone, 2022). The term 'critical design' was first coined by Anthony Dunne and Fiona Raby (Dunne & Raby, 2013, p. 34), who were among the very first to practice and theorise this approach. They were soon followed by others, such as James Auger & Jimmy

Loizeau, Noam Toran, Alexandra Daisy Ginsberg, Tobie Kerrigde, *Sputniko*, Thomas Thwaites, Revital Cohen & Tuur Van Balen, *Superflux, Near Future Laboratory*, and many more.

However, not all designers who produce critical work in form of design fiction, outside the realm of industry and marketplace, identify themselves with the term 'critical design', hence many other denominations are in use to describe this practice, such as speculative design, design fiction, design futures, interrogative design, adversarial design, and discursive design (Dunne & Raby, 2013, p. 11). Many practitioners refuse to be associated with critical design as defined by Dunne & Raby, because Dunne & Raby conceive it as the opposite of the so-called affirmative or conventional design. Although "the direction of this thinking is appealing, its present formulation is [..] vague [and attaches] strong value judgments to it: affirmative design is [..] amoral [..], while critical designers are described as moral agents who seek to change society for the better" (Bardzell & Bardzell, 2013, p. 3299). Design fiction as a tool and approach, however, is not discussed similarly. It is more about envisioning alternatives but without attaching value judgements to them.

Functional fiction

The approach of fiction and speculation is still gaining relevance and is increasingly considered a useful instrument in generating and communicating new knowledge. Speculative design can be employed as a method of inquiry since it "has transcended design and become a contribution to the world of research" (Boserman, 2019, p. 125). Critical design that involves creating fictional products and scenarios can also provide valuable insights for diverse commercial design practices "if adopted by the designer as part of a critical mindset" (Jakobsone, 2019, p. 561). And this method of visioning can prove useful in activating stakeholder reactions, considering that "compelling future-oriented visions are needed to inform and inspire projects in the present" (Irwin, Kossoff, & Tonkinwise, 2015, p. 8).

Design fictions and design futuring have a political significance as well, for "without serious propositional clashes between different materialized futures, we have no politics, and we have no democracy" (White, n.d.). It is within these alternative, critical design environments that the conformity of mainstream design is acknowledged and problematized (Dunne & Raby, 2001, p. 58), and prevailing ideologies [1] and dominant social paradigms[2] are challenged. It can be argued that design fiction is necessary because Western societies have ceased dreaming (Dunne & Raby, 2013, p. 1). Faced with unsolvable problems, designers too seem to start realising that there will be no more 'technological fix' and that we need to change our values, attitudes, beliefs, and behaviours (Dunne & Raby, 2013, p. 2). This is where design fiction plays an important role. Fiona Raby claims that "this kind of design has a value within future decision-making processes", and therefore calls them 'functional fictions' (Raby, 2017, p. 41-42). This term is conceived as the opposite of 'fictional functions', which, according to Raby, characterises many existing, commercial products that may be desirable, but have functions with "no relationship to reality" (Raby, 2017, p. 41). This point of view situates design fiction within the problem-solving design paradigm, even though it acknowledges a different kind of 'usefulness' and 'functionality'. Design fiction can offer other perspectives and worldviews, other points of view that allow us to notice both the unusual and the ordinary that otherwise remain unseen.

Giving voice to the periphery

Lately, awareness in academia of the limitations of the current knowledge production has been growing, followed by an ambition to decolonise knowledge through encouragement of other-than-Western perspectives. It has been widely acknowledged that not only the realities, but also peoples' experiences of reality in various parts of the world can be diverse, and hence such are the imaginaries of our collective futures as well.

Design fictions are predominantly (but not exclusively) future related: they attempt to envision a reality that is credible, but different from the actual one. They are often provocative as well, allowing us to question our collective future without suggesting the preferable path to follow. Design fictions offer insights on potential alternatives that expand our understanding of the world and challenge our assumptions about it.

This paper presents an ongoing work of filling in the blanks in the geography of design fiction, which itself is the result of the imagination. This endeavour builds upon the author's preceding research of critical and speculative approaches in design, and Tony Fry's assertion that there is a false "assumption that, like thinking, imagination is intrinsic to the mind." Instead, according to Fry, "[t]he 'stuff' of imagination comes from what one's being-in-the-world has been exposed to as the basis of what the imagination assembles, transforms and reacts against in its process of prefigurative construction" (Fry, 2022, p. 15). The same applies to the critical potential of design fictions, as one and the same thing can seem unusual and provocative for certain cultures and absolutely mundane for others (Bardzell & Bardzell, 2013, p.3299).

However, in the attempt to decolonise knowledge there is an increased interest for the communities of Global South, while the Eastern regions (the post-Soviet and post-socialist space) of Europe have been almost entirely overlooked (Müller, 2018); or, instead of being viewed as a place where considerable knowledge can be (and is) generated, they have been used merely as research subject (Jehlička, Grīviņš, Visser, & Balázs, 2020). In addressing this issue, the paper proposes an analysis of selected design fictions developed in the Baltic countries that can in certain respects be linked to the local context. The research methodology includes unstructured interviews with designers in question and a review of their writings in relation to the selected projects. These sources, aside from the researcher's interpretation of the fictions' form and content, also allow tracing the designers' intentions and motivations, revealing their interest in research questions and design solutions that are determined by their natural and artificial environment and personal experiences. This research shows how lived experiences in combination with physical surroundings and social habits characteristic to the region translate into design work and allow to arrive at place-specific discoveries.

1 This refers to the writings of Dunne & Raby who discuss the role of designed object as the medium of ideas, values or, in other words, ideologies: "[...] all design is ideological, the design process is informed by values based on a specific worldview, or way of seeing and understanding reality. Design can be described as falling into two very broad categories: affirmative design and critical design." (Dunne & Raby, 2001, p. 58)

2 Dominant social paradigm is a term for a constellation of common values, beliefs, and shared wisdom about the physical and social environments which constitute a society's basic worldview (Dunlap & Van Liere, 1984).

Local stories

A design fiction can be tied to a specific context and based or determined locally in various ways. The examples discussed further represent fictions that reflect (on) one or more of the following factors: 1) supposedly nation-wide societal beliefs, assumptions or concerns; 2) a specific natural or artificial environment typical to the area in consideration; 3) personal lived experience of the author in the given context.

Although many more examples can be given, this paper, due to the limit of length, focuses on only one of the recurring themes for designers in the Baltic region: nature and people's relationship with it. Baltics, along with Scandinavia, is characterised by a relatively low population density compared to the rest of Europe, and by "beliefs of the close ties between the natural and social environments" (Agarin & Grīviņš, 2016, p. 245). Some authors, drawing from the political, social and ideological occurrences of the past couple of centuries, even claim that "the natural environment of the Baltic peoples was actually a national environment" (Sikk & Andersen, 2009, and Agarin, 2009, as cited in Agarin & Grīviņš, 2016, p. 246). The nature seems to be abundant and very meaningful in the Baltic region, and people's peculiar relationship with it also manifests in the topics chosen and approaches taken by designers further described.

Figure 1. Aistė Ambrazevičiūtė, computer renderings of fictional lichens.

For several years, Lithuanian architect **Aistė Ambrazevičiūtė** has been carrying out an interdisciplinary research and design practice that focuses on lichens as a source of new knowledge. As she later realised, her creative practice had been defined by her fascination with nature, in particular, with the wild forests of her homeland: "After my walks [in the forest] I always had plenty of dried lichens at home and it inspired me to document and imitate, play, deconstruct that emotion in 3d space" (Ambrazeviciute, 2021, p. 98). She has studied the biology of lichens, their behaviour as a species as well as separate plants, their materiality, form, logic of construction and growth patterns. Her objective is to explore the "grammar of lichen" and to build her own "alphabet of design" inspired by that of nature (Ambrazeviciute, 2021, p. 98). By means of 3D design software, she then creates an enticing but entirely fictional virtual universe of incredibly intricate volumes and shapes that all comply with the grammar of lichens (figure 1). However, unlike other organic forms and constructions that are quite common throughout the history of architecture and design, these creations are not aimed at being adopted for real-life objects and buildings; instead, they remain virtual and fictional, without ever assuming any specific scale, materiality or function. For Ambrazevičiūtė, this project is more about "searching for unexpected and scattered manifestations of beauty" (Ambrazeviciute, 2021, p. 98). Nonetheless, it is not a mere imitation of visual characteristics, but also an attempt to reveal the "hidden wisdom" of nature (Ambrazevičiūtė, n.d.).

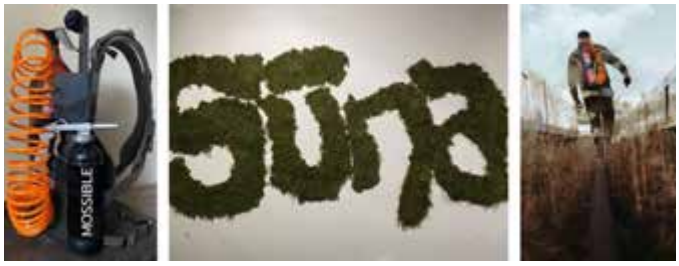

Figure 2. Viesturs Reinis, Mossible.

Similarly, the project *Mossible* by Latvian designer **Viesturs Reinis** manifests the author's personal and familiar relationship with local nature [3] that is expressed by his ongoing interest in moss, considered both for its material and ecological characteristics, and its perceived symbolic meaning (Reinis, 2022, p. 14). In this work, he conceives a fictional product: a device that would allow to create graffiti by using a mash made by mixing water and desiccated, crushed moss, instead of paint. The object is supported by a use-case scenario that, in videos and photocollages, depicts a graffiti artist in action, and it is exhibited along with a realistic reproduction of a graffiti tag in moss (figure 2). Reinis's work seeks to change people's rather negative attitudes towards graffiti by turning it into a tool for capturing CO_2, filtering fine dust and lowering temperatures in cities. When explaining his conceptual approach, he draws parallels (Reinis, 2022, p. 7) with the speculative design project *Pigeon d'Or* by Revital Cohen and Tuur Van Balen (Cohen & Van Balen, 2010). In this project, Cohen and Van Balen consider pigeons as part of the solution for the problems they cause in the city: by use of synthetic biology, they develop bacteria that can modify the metabolism of pigeons in order to make them defecate soap, thus cleaning the surfaces instead of making them dirty. For the sake of the argument, it is worth noting that this fiction too is influenced by a specific context—Belgium[4], where pigeon breeding and races have historically been particularly popular. Hence, we can observe how these very similar topics, both involving purification of the built environment, are approached from two different perspectives that both draw inspiration from local culture and personal experiences.

In their project *Arion Vulgaris*, Latvian designers **Tīna Alise Drupa** and **Jana Ločmele** tackle the complex ecological, ethical and emotional issues related to the Spanish slug: an invasive species that causes serious threat to horticulture in Latvia and elsewhere. There are various methods of containment and elimination of Spanish slug in gardens, but most of them can be considered emotionally disturbing, especially for present-day gardeners (Jakubāne, Pilāte, Stalažs, & Ruņģis, 2022, p. 31-46). Hence, almost like inviting us to some sort of therapeutic session, Drupa and Ločmele challenge our imagination even further by offering a scenario that posits people as natural

3 Reinis is based in Latvia, and furthermore, his hobby reportedly requires him being in the woods. (Reinis, 2022, p. 14).

4 Although currently based in London, Tuur Van Balen is originally from Belgium (Cohen & Van Balen, About, n.d.).

predators for Spanish slugs in a speculative attempt to re-establish equilibrium in the ecosystem. This fiction builds upon the local tradition of gardening and that of pickling as a method of preserving home-grown food for the long winters. Designers propose fermenting Spanish slugs to make them edible for humans, but they materialise this fiction in a very traditional and locally recognisable kitchen scene, thus hinting at how our habits, perception and worldviews oftentimes change faster than our material environment (figure 3).

The choice of the topic for this fiction is clearly prompted by the popularity of gardening in Latvia. Throughout the times of scarcity—both during the Soviet occupation, the transitional period in the 1990s after the fall of the USSR, as well as the crisis of 2008 and the one caused by Covid 19—gardening has been an important source of sustenance and has provided a sense of sovereignty to people in this region. Aside from food provisioning, gardening as an activity and the garden as a place are intimately bound to people's identities providing connection with knowledge and legacy transmitted across generations.

Figure 3. Tīna Alise Drupa & Jana Ločmele, Arion Vulgaris.

The project *Sartorial space* by the Estonian architecture practice ***b210*** also proposes engaging in a close and intimate relationship with nature. From local sheep wool that is otherwise discarded by the industry, they create an object that can be described as something between a piece of clothing and a nomadic shelter housing one person (figure 4). These architects imagine a future world where "owning land and real estate is less attractive and people's freedom and mobility have increased", where "our own space also accompanies us" and "adapts to the body and environment" (b210, n.d.).

Figure 4. b210, Sartorial Space.

Aside from the material used, this fiction seems locally bound also in terms of geographical specificity—a sparsely populated region where one readily gets a feeling of privacy whenever out in nature. This allows designers to suggest that this shelter, which might seem rather individualistic, would actually encourage cooperation and refusal of real estate ownership, since "only someone [..] who doesn't feel the need to defend their personal boundaries" (b210, n.d.) would be willing to share more with fellow humans.

Conclusions

This research into the relationship between the designers' environment, societal or personal beliefs, experiences and the products of their imagination as content for design fiction, is advanced with the ambition of promoting awareness of diversity in knowledge, worldviews and perception in various geographical regions. The author does not claim that all the fictions of a particular region are related only to certain topics, nor that the same subjects could not be considered for design fictions elsewhere. Rather, it aims to show how design fictions can be locally inspired and determined, and it uses concrete examples as illustrations for this claim. These examples are all related to the local context and personally relevant issues; they stem from designers' own experiences, as well as local culture, traditions, upbringing, etc.

Designers' own descriptions and comments on their reasoning and intentions play an important role in this research as they clearly reveal the significance of lived experiences. These experiences are certainly not universal, and nor are the visions and fictions generated as a result. Interviews carried out during this research demonstrate that designers themselves often do not even realise or pay attention to this diversity: for them the issues tackled in their work seem rather obvious. In a broader context, however, certain designs can seem quite radical and offer a new worldview or paradigm, and in any case—increase diversity.

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Transit oriented development used to formulate design guidelines for an improved bus network in Malaysia

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Abstract

Transit Oriented Development (TOD) underpins the innovative use of urban spaces to create more compact and walkable (more accessible) urban infrastructure. The TOD approach is an innovative form of development that helps diversify transportation systems and provides a new range of development patterns for households, businesses, and cities. In this paper, we outline the TOD method and show how it was used to influence design guidelines for an improved public bus network in Malaysia. We use the TOD Standard Metrics Scorecard to evaluate the current bus system in Kuala Lumpur and highlight the main issues requiring design intervention.

The TOD Standard scoring system distributes 100 points across 12 categories and these points reflect the level of impact of each area when using TOD. The accumulated points within the TOD scoring system refers to how well the studied area is supporting sustainable urban infrastructure. Applying the TOD principles for Kuala Lumpur is intended to form a long-term solution, with short-term impact. As the changes required according to the TOD principles can involve significant urban restructure, there are suggestions given that are not possible in the short-term but should be considered for long-term benefit. A longer-term change proposal will reflect the TOD principles as an optimal outcome to improve the current state of Kuala Lumpur's public transportation networks (beyond 10-years), however, for this paper a shorter-term change is put forward with realistic implementation possibilities within the next 5-years.

Understanding how to use the TOD Standard metrics helps assess existing infrastructure against proposed improvements and gives a clear view of how TOD can radically change the urban landscape with public transportation at the core of all activity. There are obvious limitations to this as certain infrastructure simply cannot change, such as surrounding buildings and major road networks. However, it is important to include TOD principles where possible to establish a framework for design with consideration of what is possible, what is impossible, and what could be possible. From a design point of view, TOD provides a strong justification for design decisions used to better educate stakeholder's around future change. By supporting design proposals with evaluative research underpinning the design intent, we provide greater certainty for design when used to inform decision makers that may not understand or appreciate the impact design intervention can have on urban environments.

Author keywords

Transit Oriented Development; Human Centred Design; Public Transportation; Design Intervention

Introduction

Aligned with the Malaysian governments response to the National Automotive Plan (NAP), this study provides a structured plan to improve the current state of the bus network in Kuala Lumpur, Malaysia. The NAP includes bus development to increase the patronage of sustainable public transport, which is identified as the weak link in the current Mass Rapid Transit (MTR) in Kuala Lumpur. This study presents the outcomes of using Transit Oriented Development (TOD) as a tool to evaluate eight core criteria against the current Malaysian network which is then used to guide design interventions. We provide opportunities for improvements for the Malaysian government to prioritise a sustainable bus system with an aim of increasing patronage for the ailing public transportation network.

Transit Oriented Development was first identified by an American architect and planner named Peter Calthorpe in 1993. As a leader of the New Urbanism Movement, Calthorpe describes TOD as a mixed-use community within walking distance with transit stops and core commercially developed areas (Calthorpe, 1993). Calthorpe argues that transit is more than merely the transportation system; it also comes with fundamental land use logic. He established the general accepted walking distance of 0.8 km in between train stations and 0.4 km walking distance in between bus stops. This is further noted by Jarrett (2012) who describes the unglamorous but essential struggle over the spacing of consecutive stops or stations on a transit line being an area where there's a huge difference in practice around the world.

Figure 1. The geometry of stop spacing as identified by Jarrett (2012).

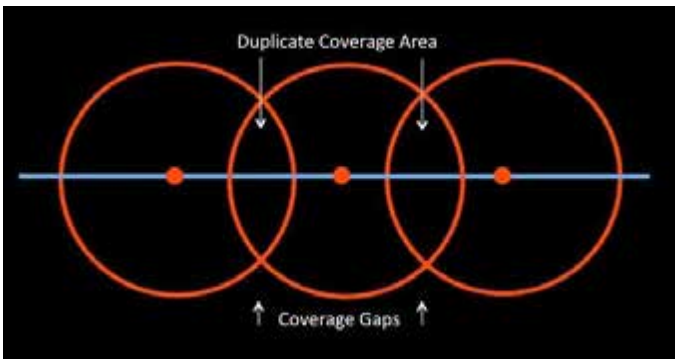

Figure 1. The geometry of stop spacing as identified by Jarrett (2012).

Literature

Support for walking and cycling has a clear need in urban planning (Newton & Bai, 2008). Most current public transportation models operate at the metropolitan scale and fail to include aspects of local scale walking and cycling (Stradling et al., 2007). However, there should be an emphasis on walking and cycling support when developing a public bus system with a human centred design approach (Kuys et al., 2022). This is particularly important to Kuala Lumpur where temperatures rarely drop below 27 degrees Celsius. The hot, humid, sub-tropical climate is uncomfortable and this leads many people to the comfort of their air-conditioned vehicles. While it will be very hard to replicate the comfort of an air-conditioned private vehicle, there will be many other benefits to using an improved bus system that will be much better than a private vehicle such as costs, commuter time, parking, sustainability, safety and the ability to complete other tasks along the journey rather than having to concentrate on driving.

These positive reflections can be evaluated using TOD principles to provide the necessary guidelines to improve the current state of transportation systems in developing countries. By using a TOD approach it aims to reduce vehicle usage and encourage the use of public transit and human-powered transport modes through high density, environmentally friendly development within areas of walking distance (Sung & Oh, 2011). Such TOD approaches have been recognised as one of the key planning methods to solve traffic congestions and to promote uptake in public transportation usage in Asian countries such as Korea, China, and Taiwan (Sung & Oh, 2011). TOD has been increasingly promoted and implemented as a solution to the problems of urban growth (Galelo, Ribeiro & Martinez, 2014). Using the TOD approach provides greater potential in the reduction of vehicle use, increased public transportation usage, and giving a sense of community to the neighbourhood (Newman & Kenworthy, 1999). TOD can be done in different scales depending on the local context it is implemented in. Some cities can implement minimal change while still improving the neighbourhood while others can implement maximum change that drastically improves the community.

Kuala Lumpur has the density which gives locational advantage for using the TOD approach to be successfully implemented. Human centred design studies conducted prior to this study (Kuys et al. 2015; Kuys et al. 2022) shows there are more pedestrians negotiating their way around public infrastructure than those using the public transportation options available. Understanding human behavioural factors is critical to achieving the successful implementation of sustainable public transport systems through more effective and more considered urban design. An improvement in public transportation service quality can attract new users and promote modal shift from private vehicle to public transportation (Eboli & Mazzulla, 2007). Public transport users in the city are mainly concerned with safety, reliability, ease of transit, comfort level while using the public transport system, safety and supervision of the bus stop (Andaleeb, Haq & Ahmed, 2007). These elements can be addressed when introducing the TOD approach in such public transportation development. The TOD approach will not only provide possible future solutions, but also give highly feasible outcomes.

Method

To better understand the present problems with the public transportation in Kuala Lumpur, Malaysia, a field research study based on user observations was carried out. The "fly on the wall" technique was employed as a tool to gather accurate user data in a covert and cost-effective manner (St. Matthew-Daniel & Kamper, 2001). Following this, an online questionnaire was conducted to better understand the present issues that require attention and to demonstrate the value of a HCD strategy. The structured questionnaire was completed by 102 Malaysians and asked ten questions about the participants' experiences with public transportation were posed (refer to Kuys et al. 2022). Major findings from the user observation revealed common pain points and issues when using the current bus system in Kuala Lumpur. Six key themes were identified as follows:

1. Getting on and off the public transport (ingress and egress)
2. Access to remote bus stops and train stations (safety)
3. Smart ticketing system (better integration)
4. The road condition (physical constraints)
5. Real-time display (wayfinding and timetables)
6. Stricter rules around other road users (dedicated bus lane)

These findings were then used to formulate key questions for the questionnaire. Major findings from this phase showed significant favouritism for private car transportation revealing that 75 % of all respondents use their private car daily. Disturbingly, bus usage was one of the least popular choices of daily (7-days per week) and/or often (4–6 days per week) transportation at 8 %, and further to this, over 60 % of respondents had never used the bus system before. 80% of respondents were dissatisfied of the physical design of the bus (interior and exterior), and when evaluating the HCD principles associated with the current bus system, convenience formed the overwhelming majority, followed by the choice of daily transportation and improving the bus shelter location and access (Kuys et al. 2022).

The outcomes of both the user observation research and the questionnaire were used to evaluate the TOD scorecard which is the focus of this paper. We highlight the TOD Standard method used to identify objectives for each principle with measurable indicators evaluated according to the closest approximation of performance against the objectives. The scorecard evaluated the eight key principles of TOD against a score for each section. The maximum score for the evaluation is 100 points divided amongst the following, and the evaluation was determined through careful review of the literature and the aforementioned research from the authors (Kuys et al. 2015; Kuys et al. 2022).

Table 1. Scorecard of the TOD Standard metrics developed by ITDP.

TOD principle	Maximum score
Walk: Walkways, crosswalks, visually active frontage, physically permeable frontage, shade and shelter	15
Cycle: Cycle network, cycle parking at transit stations, cycle park-ing at buildings	5
Connect: Small blocks, prioritised connectivity	15
Transit: Walking distance to transit	Requirement
Mix: Complementary uses, accessi-bility to food, affordable hous-ing	15

Evaluation

To triangulate data and verify our evaluation, a workshop was organised with Dr Luc Nadal, Technical Director of the Institute for Transportation and Development Policy (ITDP) Urban Development to support the proposition of using TOD as a method for improving the current state of Kuala Lumpur's transportation network. This workshop was held in New York and formed a critical part of this study by setting boundaries around TOD principles to help focus the design intent. ITDP is an organisation that was prominent within the literature for TOD principles. ITDP manages a wide range of sustainable urban transportation solutions to improve urban living worldwide and were responsible for developing the eight key principles for the future of mobility in cities with multimodal integration.

For this research, the focus was on the bus network for Kuala Lumpur, however the conversation around TOD principles is relevant to all areas of urban design linking people to transport. The workshop which ran for 3-hours and consisted of four members from ITDP and both authors of this paper, broadened the scope of this research by focusing on the external influences associated with design development, rather than just the design outcome itself. Discussions were focused on implementation using real-world examples where TOD has successfully been implemented. The authors used this workshop as a key milestone to ensure the research had direction from ITDP for validation and oversight of this project.

This demonstrates the translation of literature and research methods into research outcomes based off referenced theory. Along with this previous research, the below evaluation received expert advice from Dr Luc Nadal at ITDP during our workshop. The following summary relates to the TOD Standard Metrics Scorecard used to evaluate the current bus system in Kuala Lumpur. This was useful to provide an informed understanding of the current context to identify areas in need of design intervention.

Table 2. TOD Standard Metrics Scorecard used to evaluate the current bus system in Kuala Lumpur.

TOD principle	TOD Evaluation	Max. score	Score given
Walk	• Walkways: 0 points. Less than 100 per cent of block frontage had safe wheelchair accessible walkways. • Crosswalks: 1 point. 90 per cent of intersections or more have basic requirement meeting local accessibility standards. • Visually active frontage: 2 points. 50 per cent or more have visually active frontage segment measured by windows and accessible open space located along the street wall. • Physically permeable frontage: 2 points. Average number of entrances such as shop entrance per 100 metre of block frontage is 5 or more. • Shade and shelter: 0 points. Less than 75 per cent of all walkways have adequate shade or shelter amenities.	15	5
Cycle	• Cycle network: 0 points. Less than 90 per cent of street is safe for cycling resulting in maximum walking distance to cycling streets is more than 200 metres. • Cycle parking at transit stations: 0 points. Multi-space racks are provided only in some transit stations. • Cycle parking at buildings: 0 points. Less than 95 per cent of buildings provide ample secure cycle parking. • Cycle access in buildings: 0 points. Cycle access is not required by building codes or bylaws.	5	0
Connect	• Small blocks: 4 points. Some blocks within the development is less than 150 metres in length. • Prioritised connectivity: 1 point. Number of intersections representing prioritised connectivity ratio is low.	15	5
Transit	• Walking distance to transit: Does not meet TOD standard requirement. Maximum walking distance is more than 1 kilometre to a high-capacity transit station or more than 500 metres to a direct service station.	—	—
Mix	• Complementary uses: 0 points. Less than half of the floor area of a development in predominantly residential uses have non-residential uses. • Accessibility to food: 1 point. 80 per cent or more of the buildings are within walking distance to a source of fresh food. • Affordable housing: 4 points. 20 per cent or more of all residential units are affordable.	15	5
Densify	• Land use density: 0 points. Total residential population, jobs and visitors is lower than the baseline density. Baseline density is determined by estimation of total residential population, number of jobs in the area.	15	0
Compact	• Urban site: 1 point. One side adjoins built-up sites creating low interaction points. • Transit options: 1 point. Minimal number of different transit options that are accessible within walking distance.	15	2
Shift	• Off-street parking: 1 point. Non-residential parking area is equivalent to 35 per cent or less of site area. • Driveway Density: 2 points. Average driveway density is 2 or less driveways per 100 metre of block frontage. • Roadway area: 5 points. Motor vehicle area is 20 per cent or less of site area.	20	8
	TOTAL	**100**	**25**

This evaluation shows significant improvement required for the Malaysian bus network having received a score of 25/100 when scored against the TOD Standard Metrics Scorecard. Results were then used to convert the TOD metrics into specific issues with suggested plausible solutions. Key criteria for this evaluation showing how the initial TOD analysis led to design intervention is as follows:

- To identify gaps and opportunities for improvements.
- Implement walkability and cycle friendliness where possible.
- Evaluate existing structure to identify investment opportunities.
- To provide guided policy and regulations relevant to urban planning, transport planning and urban design.

This criterion was then used to effectively highlight defined issues mapped against proposed design intervention as follow:

Table 3. Main issues identified as needing design intervention to improve the current bus system in Kuala Lumpur.

Issue identified	Design intervention
Getting on and off the public transport (ingress and egress).	Ensure buses have a low-floor platform and the bus stop aligns with the bus floor, while accommodating all users (eg. Wheel-chair bound patrons).
Access to remote bus stops and train stations.	Overlaying TOD principles to the entire bus network ensures walking distances to bus stops are reduced and network recon-figurations connects different modes of transport to the new bus network.
The condition and size of the pave-ments (and roads) – public infra-struc-ture.	Recommendations to prioritise public transport usage over private car ownership. Development of new bus stops to im-prove the public infrastructure along the bus routes. Emphasis on a human centred design approach to ensure the user is at the forefront of development.
Efficiency of service – frequency of bus-es.	It is anticipated that an improved bus network will increase patronage allowing for more frequent services. Infographics and improved bus stops will be more informative and users will better understand waiting times. Dedicated bus lanes and priority given to the bus network will significantly improve the efficiency of the service.
Comfort and recog-nition of bus stops.	Complete redesign of bus stop allowing for modular construc-tion for installation in different contexts – such as terrain, space allocation, popularity of area (heavy tourist usage), and existing infrastructure.
Wayfinding and public communica-ti-ons including timetables.	Digital displays (solar powered) integrated into each bus stop and buses are colour coded to align with each route. Bus routes are developed to be more recognisable and link to each bus within the network. Bus service times are displayed on each bus to allow the user to know exactly how long the waiting time is. Clear and accurate information improves the overall customer experience.
Stricter rules around other road users – dedicated bus lanes that are not infringed upon.	Proposing clearly defined dedicated bus lanes which could include concrete step barriers on the central reservation of motorways. This would physically prevent vehicles from using these dedicated lanes and will ensure they are reserved specifi-cally for the Kuala Lumpur bus network.

These suggestions are realistic and based off significant research by those that would use the newly developed bus system for Kuala Lumpur. The solutions identified above through the TOD evaluation were all advanced into design proposals. Due to size limitations of this paper, we provide two examples. The first shows the inclusion of dedicated bus lanes, improved footpaths and dedicated cycling lanes to existing infrastructure, and the second shows an improved bus stop which includes multiple solutions listed above.

Application

TOD principles have helped define parameters for change – some significant, and others incremental. The below section shows how TOD principles can be used to change existing city infrastructure with minimal negative effect to the streetscape. This has been done by many cities around the world ensuring that buses, pedestrians and cyclists have priority over vehicles. By making positive change to the infrastructure, the bus and the developed bus stops will further be enhanced. The holistic view of this system needs to address all negative elements seen within the research to maximise acceptance of this new system. The two examples provided below have been developed within one identified area of Kuala Lumpur. These examples show how TOD principles informed design development and are used for others to better understand how a design method (TOD) is applied to design recommendations.

Dedicated bus lanes, improved footpaths and dedicated cycling lanes

The Kuala Lumpur CBD centres around the high tourist area of the Patronas Twin Towers. Surrounding this highly populated area is a network of two and three-lane highways circling the city. A network of interconnected roads in a city that is dominated by private car ownership makes this area highly congested. Figures 2 and 3 show one identified area on the fringe of the CBD – A three-lane highway with adequate room for improvements without having to change much of the infrastructure. The main changes would be dedicated bus lanes either side of the highway, a dedicated cycling lane on one side of the highway, and improvements to the footpaths on both sides of the highway. It is understood that this would still cost a considerable amount of money, however this is significantly lower than major public transport interventions such as improved rail. Private car owners and bus drivers will also need education of the changes suggested and the laws will need to be enforced to ensure bus lanes are not interfered with.

The inclusion of dedicated bus lanes (burgundy), improved footpaths (yellow) and dedicated cycling lanes (blue) are all possible in the current infrastructure without radical development. By doing this, we would immediately address a number of issues identified in Table 3.

Bus stop design

A major intervention based off the TOD evaluation is the design of an improved bus stop. Research showed that promoting bus usage requires wider consideration of the whole system. When people have a poor experience at bus stops while waiting for the bus to arrive it directly relates to the whole bus riding experience. As mentioned by Beirão (2007) improving the quality of the bus stops will result in better service quality. Often time waiting at a bus stop can exceed the actual time on the bus, so the experience commuters have while waiting is just as important as the experience commuters have while travelling.

Figure 2. A major highway on the fringe of Kuala Lumpur CBD.

Figure 3. Intervention to the current road network of KL using TOD principles to suggest immediate change.

Designing a bus stop must consider user needs and should include user wants. Creating an informative and pleasant space for the users to wait for their bus is particularly important given the hot sub-tropical weather conditions in Malaysia. It is understood, however that creating an improved bus stop environment may actually cause a transverse effect and bus stops may become a social space people enjoy being at. Creating a multipurpose waiting area for people to use will have a positive reflection on using the bus, however intervention may be required if people misuse this space to simply relax and stay out of the sun if they occupy all the available space away from genuine commuters.

Effective and safe spaces need to be developed to understand the relationship between systems, environments and the entire systems structure which sets the design guidelines for design development in this area. The following is a selection of initial concept sketches exploring new developments for the bus stop for Kuala Lumpur, based largely off TOD principles.

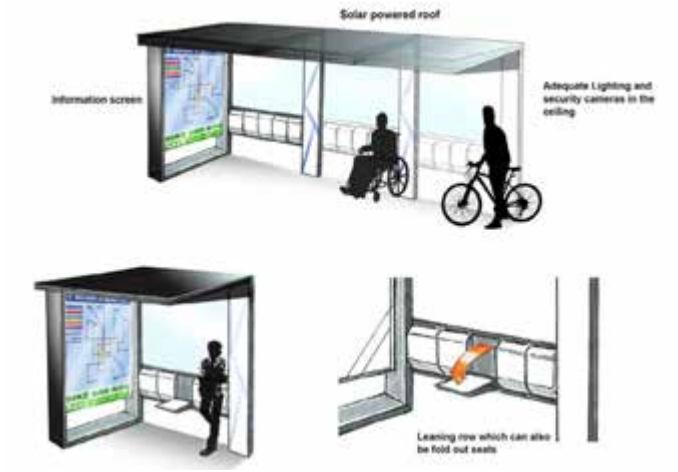

Figure 4. Concept sketching of bus stops incorporating proposed design solutions.

Refinement of selected concepts was completed with emphasis on passenger comfort during waiting, information graphics and wayfinding, as well as passive cooling techniques. Ingress and egress design elements were also a major focus to ensure the bus stops accommodate a wide range of users and integrate seamlessly with the bus network.

Conclusion

Field research and analysis of the questionnaire, along with the application of TOD principles, helped define the research objectives by narrowing down the focus in areas of specific importance to Kuala Lumpur. Observations found inadequate pedestrian and road conditions in Kuala Lumpur, as well as a lack of priority given to the bus network. Overall, the user experience of travelling by bus in Kuala Lumpur is poor. Alarmingly, the questionnaire revealed that over 60% of respondents never use the bus system available in Kuala Lumpur, showing the overwhelming majority of potential patrons are private car users creating a large segment to target with an anticipated modal shift. In order to entice people from their private car to a public transportation system, improvements must be made. This led to the urban planning metrics using the TOD Standard. This framework focused on an improved bus system to create a more sustainable city and attract patrons back to public transport. With an improved public bus system, there will be increased uptake resulting in more vibrant, sustainable communities. This is where the true value of TOD implementation lies and with small steps implementing these principles in critical areas comes large change. To put simply, a better system working off a very poor current base in Kuala Lumpur, will create greater uptake and influence modal shifts toward a more sustainable alternative. This is a slow process to implement, however governments must not be complacent and lead change in a positive direction. By supporting and changing the physical infrastructure and improving the existing networks, people will see the benefits. This is critical as the human behaviours toward such systems have to change and positive government intervention will help influence this change. TOD can be used as an alternative form of urbanism that reduces heavy reliance of the private vehicles (Cervero & Day, 2008). As highlighted in the eight principles of the TOD approach, integrating TOD principles will bring positive change to current lifestyles by better connecting people with the city they live in. Many successful businesses and organisations embrace user involvement methods in their innovation process (Steen, 2011). TOD is used to support community vitalisation and to gain great benefit for the community, not only environmentally but also socially.

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Exploring sustainable ecosystems in the "15-minute" urban living circle — take Shanghai Urban Space Season 2021 as an example

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Abstract

As a new urban model, the 15-minute city has gradually become a touchstone to measure the future sustainability of cities. With the time-limited planning of urban living circle, urban residents can be allowed to access basic daily needs such as food, health and education while walking or cycling, thus reducing motor traffic and carbon dioxide emissions and contributing to the improvement of people's well-being and the environmental climate. The proposition of building the 15-minute Community-life Circle has been put forward in Shanghai Master Plan 2035. Since 2016, such working standards as Shanghai Planning Guidance of 15-Minute Community-Life Circle, Spatial Planning Guidance Community Life Unit have been continuously released and updated for gradually conducting progressive and incremental circle practices and exploring a path of low-cost, low-emission and low-pollution urban sustainable development. In September 2021, with the theme of 15-minute Community-Life Circle – People's City, SUSAS2021 carried out a two-month urban space art season in 16 communities and 1 theme exhibition area, demonstrating the construction practice of low-carbon life suitable for living, working, traveling, learning and raising in Shanghai.

With SUSAS2021 as a specific case, this paper is aimed at exploring a system design method of sustainability concept in the construction of urban life circle with a time limit of 15 minutes. By applying the method of interdisciplinary research, this paper makes a systematic analysis and impact evaluation on its climate adaptability from four aspects: urban renewal, shared community, low carbon living and smart network platform. With the practice results as the research evidence, this paper summarizes the experience of sustainable ecological construction in urban life circle, introspects and discusses the practical problems and comprehensive feedback during the practice, and then puts forward a sustainable system design framework for 15-minute urban construction and a feasible adaptation scheme for studying this method. Under the ever-changing climate environment, the new zero-carbon city model will be an extensively, profoundly systematic change in economic and social development.

Author keywords

15-minute city, Urban Ecosystem, Sustainability, Community-Life Circle, SUSAS2021

Introduction

The concept of the "15-minute City" was proposed by Professor Carlos Moreno and widely used by the mass media in 2016. It was then adopted by policy makers in Paris and sparked discussion in other cities around the world. The concept supports the demand for indicators based on proximity to better serve urban areas (Moreno et al., 2021). It also points out that the quality of life in cities is inversely proportional to commuting time, especially in the use of cars. Excessive car use on city streets can significantly increase greenhouse gas emissions and energy consumption, resulting in poor urban air quality and lasting negative impacts on biodiversity and quality of life. In addition to psychological and social losses, the negative consequences of traffic congestion are also translated into time, economic and ecological losses (Gössling, 2020). So, the re-thinking of cities to facilitate walkability and cycling would, in turn, inspires the creation of parks, squares and public places within neighborhoods (Gehl & Rogers, 2013) and helps realize the vision of urban sustainability and resilience and build a sustainable climate adaptation framework for urban ecosystems.

At present, Paris, Melbourne, Ottawa and other cities have started the practice of chrono-urbanism planning to actively deal with urban problems. In 2017, Shanghai put forward the idea of creating a "15-minute community life circle (CLC)" in its 2017-2035 development blueprint, and formulated unified action guidance. Since then, Shanghai has progressively put the concept into practice. Shanghai Urban Space Season 2021 (SUSAS2021), which will be studied in this paper, is a concentrated demonstration of the practical achievements of the "15-minute CLC" in Shanghai. This paper adopts the research method of case analysis. Firstly, the paper combs the key theories and relevant research literature, then summarizes a feasible sustainable system design method based on the case of Shanghai Urban Art Season, and finally discusses and reflects on the adaptability of sustainable system design in the

15-minute city based on the actual case feedback. The study of the ecological characteristics and convenience of urban renewal based on the theory of chrono-urbanism. The purpose is to explore a sustainable system design scheme based on the 15-minute urban concept to address many challenges brought by future urban problems and climate change.

Literature Review

15-minute CLC

At present, urban development is facing multiple challenges caused by climate change and social ecology. In this context, reconsidering the sustainable urban development model and transformation has been regarded as the future direction and inevitable choice of global urban development (Jabareen, 2013). As early as the 1950s and 1960s, Japan put forward the concept of "life circle" in a broad sense for the first time in response to urban problems such as resource concentration, regional differences and environmental pollution (Zuopeng et al., 2014). The concept defines the space scope of work, shopping, leisure, education and medical care required for daily life based on the residence of residents, and defines this scope as the basic space unit of the life circle. Subsequently, South Korea and Taiwan(China) in Asia have also carried out research and practice on the concept of life circle. At the Paris Climate Summit in 2016, Carlos Moreno first put forward the concept of a 15-minute city based on " chrono-urbanism" (Mulíček et al., 2014). This concept emphasizes the proximity of all basic services to solve the dependence on cars, thus promoting ecological sustainability, social interaction and public participation. In the same year, Shanghai formulated the planning guidelines for the construction of the "15-minute CLC", and proposed the community as the platform for urban basic life. The goal is to build Shanghai into a sustainable, safe, friendly and comfortable smart city. Residents can meet the needs of education, culture, medical care, elderly care, sports, commerce and other public service facilities within the 15-minute walking range. From the perspective of radiation scope, they all radiate outward from the center, emphasizing the accessibility of space within the time limit, whether it is the concept of life circle proposed by Japan in the early years, the 15-minute city proposed by Carlos Moreno, or the 15-minute CLC plan implemented in Shanghai. However, there are still obvious weaknesses in the current urban environment. The city vision of a 15-minute city (or 15-minute CLC) has not been achieved, and more research and practice need to be invested in the future.

Sustainable System Design

Design for Sustainability, derived from the concept of sustainable development, is a design practice that seeks innovative solutions to cope with environmental, social and economic factors. Systematic thinking is a holistic view of people's view of the world. In the 17th century, French philosopher, mathematician René Descartes (Capra, 1997) created the method of analytical thinking, which promoted the emergence of modern science (Capra & Luisi, 2014), but is not a clear theory. Since the 1920s, system science has experienced a hundred years of development from its infancy to its maturity. At present, as an emerging interdisciplinary discipline, it is at the forefront of international scientific research (Liu & Vrenna, 2021). However, system design is the process of designing a new system that can meet the target requirements to the maximum extent by using the theories and methods of system science. Sustainable system design and sustainable design are interrelated and inclusive, but in the face of various complex and changeable problems in the real world, the overall systematic thinking will help to develop sustainable solutions, and promote the realization of sustainable development goals with the purpose of harmonious coexistence between people, people and nature, people and society.

Case study: Shanghai Urban Space Season 2021

Shanghai's biennial Urban Space Season has been held since 2015 under the theme of "Urban Renewal", "Connection", "Waterfront Space" and "15-Minute CLC" respectively. It aims to combine the display of space art with the practice of urban organic renewal, change the traditional static display into the dynamic interaction in public spaces, so as to explore more connotation and value of urban space. The most recent edition, the 2021 Urban Space Art Season, focused on the building of 15-minute CLC. Compared with the previous seasons, this one lay more stress on people's life, community building and urban ecology.

As an international city, Shanghai occupies a major position in China in terms of economy, culture and society. However, in recent years, due to the impact of urban development and expansion, traffic congestion, housing shortage, environmental pollution and the unacceptably far distance between homes and workplaces have become common urban problems. Cities with complex functions, livable environment, open and sharing surroundings, and local cultural characteristics will become people's vision of future cities. The highest measure of building a people's city is the sense of gain brought by the community life circle. It's imperative to build diversity and richness based on the unique culture and resources of the community and create a differentiated low-carbon and healthy proximate community lifestyle according to local conditions, so as to achieve convenient and shared space quality and open and intensive urban space pattern(Neuhaus, 2015). It is not difficult to see that this is consistent with the temporal urban guidelines of "Proximity, Mixity, Density, Ubiquity" proposed by Professor Carlos Moreno.

Systematic 15-minute CLC planning

Figure 1. 15-minute community life circle planning.

SUSAS2021 showcased the results of organizing living space with the time limit of 15 minutes in Shanghai in the past four

years, emphasizing the connection between the law of life and low-carbon behavior. Focusing on the concept of "livable, workable, travelable, education-friendly and health-friendly", it aimed to improve the quality of space and optimize sustainable ecosystems. The specific measures are as follows:
Livable: Built affordable and sustainable community housing supply systems, ensure that people from all walks of life could settle down in Shanghai, and supported shelters, livable ecology, whole-age care, smart living and resilient security; Increased public space, maintained and updated public facilities, so that citizens could enjoy high quality of life within a 15-minute radius.

Workable: Created more employment opportunities for community life circles within the time limit, reduced the threshold and cost of innovation and entrepreneurship, and provided employment opportunities and services; Effectively alleviated traffic congestion and work-family imbalance caused by long-distance commuting, reduced greenhouse gas emissions caused by traffic, and strove for energy saving and carbon reduction.

Travelable: Created colorful and ubiquitous community leisure space so that people could get close to nature; cultivated green and healthy travel and lifestyle; built distinctive community transportation networks that were slow-paced, friendly, and convenient to travel.

Education-friendly: Provided diverse learning systems, aesthetic classes and community education activities; Encouraged a green, low-carbon and sustainable lifestyle, and created a good learning atmosphere and promoted a lifelong learning philosophy.

Health-friendly: Provided a full life cycle of care within a 15-minute space, including hospitals, rescue stations, nursing homes, public living facilities and care gardens, reduced travel risks and helped reduce carbon emissions.

Figure 2. Key elements of the 15-minute community life circle planning in Shanghai.

The planning of community life circle is to meet people's basic daily needs within the range of walking distance, so as to reduce the number of people's long-distance trips and achieve the goal of reducing carbon emissions. From the perspective of service objects, the planning measures for the whole age group increase the inclusiveness of the project and contribute to social equity. In addition, systematic thinking plays an important role in the 15-minute CLC planning. The emphasis in the project is no longer a single transportation facility or community service planning, but a systematic consideration of the specific needs of people of all ages, both physical and spiritual, starting from public life. Systematic community life circle planning is not a simple addition of all elements. There is overlap and interaction between livable, workable, travelable, education-friendly and health-friendly. For example, the promotion of low carbon life to health, the attraction of public space for the healthy landscape, and so on. Unlike linear relations, systematic planning can promote the interaction between various elements to enhance the ability of self-organization and self-repair, and make it more adaptive.

Sustainable System Design

Figure 3. Community Meta-Box in the theme deduction area of SUSAS2021.

Figure 4. An ecological rain garden in Xinhua Community.

The sustainable system design centered on the 15-minute CLC consists of the key elements of energy, materials, water, ecology, society/economy and culture. The complete plan is to achieve the energy cycle, material cycle, water cycle, ecological cycle, social/economic cycle and cultural cycle, and the six key elements are related, thus forming a complete system. Among them, low-carbon travel, waste material regeneration, rainwater garden, solar power generation, and other measures are all committed to the principle of zero emissions in the community, transforming output (waste) into input (resources) to form a self-generating system. The

Figure 5. Cloud: The public art facilities in the theme deduction area of SUSAS2021.

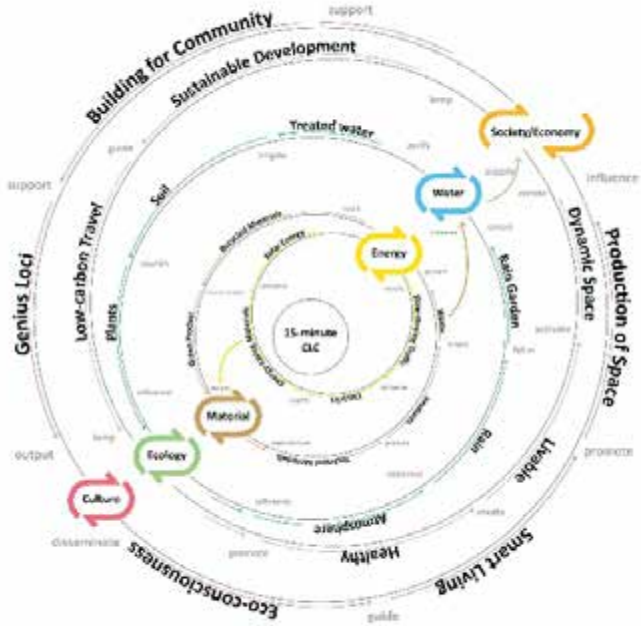

Figure 6. Eco-cycle system model about 15-minute community life circle.

main area of the system design is the local production and consumption system. In addition to the material resources involved, the social, economic and cultural aspects are realized by the participants in the local socio-economic activities. Therefore, the collaborative cooperation of community residents or other stakeholders can help promote the positive interaction between key elements and create new opportunities. Public participation is a key step in the sustainable system design of the 15-minute community life circle, and also an important factor in improving the cohesion and well-being of the community.

It has gradually become the international consensus in the post-epidemic era to regard community as the basic unit of a city and respond to urban problems as communities. To respond to global climate change and fulfill the commitment of the United Nations Climate Conference on net zero emissions, various countries and cities are actively exploring the road of climate adaptation for future urban development. This paper attempts to evaluate the climate adaptability and sustainable ecological effects of Shanghai based on specific urban practices from four dimensions of its urban renewal, shared community, low-carbon life and smart network platform, evaluating the key factors influencing climate change in practice and specific measures for net-zero emissions.

Urban renewal: In the process of building community life circle, the "acupuncture-like" renewal method of minimal design adjustment, actions and implementation cost is proposed; With a focus on the improvement of environmental quality, the existing community gray space was transformed

Figure 3. Spatial typologies: Formal learning space; Individual area; Group area; Webinar / 3600; Arcade / e-learning; Encounter area (Developed by B. Elizondo & D. Gamboa))

into ecological garden featuring carbon sequestration, abandoned factories were preserved and renovated into cultural industrial parks, preserving the cultural characteristics of the city and meanwhile allowing residents to enjoy a high-quality space environment in the adjacent space. Compared with traditional means of demolition and reconstruction, urban renewal with minimal intervention can ensure the goal of improving spatial quality, but at a lower cost. Also, it helps save resources and reduce wastage and carbon emissions. From environmental, economic and cultural perspectives, urban renewal with minimal intervention is more sustainable.

Shared community: Shared community is mainly reflected in sharing governance achievements, tapping into community needs, creating governance mechanisms and building community homes. In the practice of building diverse and shared communities, Shanghai encouraged community planners, social organizations, social workers, volunteers and local enterprises to participate in the joint construction of communities, with emphasis on the planning, construction and management of life circles to ensure localized and sustainable shared communities. At present, more than 180 community projects have been completed in Shanghai. The governance model of shared communities helps multiple stakeholders work together to build low-carbon communities, and share climate responsibility and governance outcomes.

Low-carbon life: low energy, low consumption, low cost lifestyle can start with saving electricity and gas, as well as recycling. On the one hand, as mentioned above, the theme interpretation area of SUSAS2021 is represented by Community Meta-Box, and the materials used are recycled plastic and recycled wood. Clean solar energy was used to power the pavilion, providing a green and low-carbon living place and a new perspective on the sustainable development of the space for the surrounding residents. During the art seasons, sustainable circle experience activities were organized to guide the public to participate in community ecological experience and ecological education in the form of game invitations. Public participation played the most persuasive role in low-carbon environmental protection. On the other hand, proximity to basic services helps to save time wasted on transport, reduce energy

and carbon emissions, and thus promote sustainable transport. The construction of "livable, workable, travelable, education-friendly and health-friendly" 15-minute CLC is conducive to the formation of sustainable ecological effect.

Intelligent network platform: The world is experiencing the fourth industrial revolution featuring ubiquitous information and communication technology (ICT). The proposal of the 15-minute city is considered timely(Allam, 2019). Shanghai explored smart application scenarios on the basis of a 15-minute CLC and took into consideration the community-built interactive scenarios from design, management and governance, ensuring the accessibility of basic amenities and sustainable development of urban space by means of technical support.

Discussion

Community is the basic unit of urban development and the "last kilometer" of multi-stakeholder participation. Life circle planning with a 15-minute radius emphasizes the connection between production, living space and behavior habits, effectively allocate public resources, improve service efficiency, inspire a new low-carbon lifestyle in the post-epidemic era, and enhance the climate adaptability of urban development and public life(Pozoukidou & Chatziyiannaki, 2021).

So far, the practice of "15-minute" CLC in Shanghai has made good progress. The development framework established by SUSAS2021 and the development model of multiple collaboration have begun to bear fruit, and the results of SUSAS2021 have been widely supported and recognized by the public. This practice verified the feasibility of building a sustainable ecosystem of 15-minute CLC, laying a good foundation for the future sustainable urban renewal and climate change adaptation. However, in terms of building sustainable urban system in the future, the current practice of Shanghai is still in the early stage. It is not difficult to find that there is no obvious evaluation standard for the quantification of practical achievements at present, and the development of public space and community construction lacks clear policy incentives. In the future, in the design and transformation of the overall functional zoning of the city, more emphasis should be placed on multiple and composite structural design on the basis of preserving the spatial characteristics, so that the construction of proximate and accessible life circle network can be truly realized, and a sustainable low-carbon urban development environment can be created.

In this study, the exploration of urban sustainable living circle is still in its early stage, but the development framework and practical results proposed are worthy of being applauded. As a relatively successful case of urban transformation, Shanghai's micro-renewal has received widespread attention and recognition from other cities. After SUSAS2021, a total of 52 cities jointly signed the document "15-minute community life circle" Shanghai initiative. It can be expected that in the future, more cities will join in low-carbon and sustainable urban construction and provide climate adaptation solutions for urban development in response to global climate change.

Conclusions

This paper mainly studies the promotion effect of "15-minute CLC" on the construction of sustainable urban ecosystem based on the proximity urban design scheme. Taking SUSAS2021 as an example, this paper studies its climate adaptability and sustainable ecological effects through specific renewal schemes, and points out the positive role of community planning to make it livable and resilient, so as to promote sustainability and reduce carbon emissions.

As the "15-minute CLC" has gained attention and been put into practice in many cities around the world, further research is necessary to demonstrate the differentiated solutions of different cities. In the face of the growing challenges posed by climate change, both rural and urban communities should contribute to future climate adaptation programs. How to establish a sustainable urban ecosystem to support the sustainable development of cities in the critical period of global urban development and transformation is a priority for researchers and urban decision-makers, and also the direction of human efforts to respond to climate change. Obviously, the planning practice of "15-minute CLC" is a solution that helps alleviate urban contradictions and enhance urban climate adaptability.

Research into proximate urban design or the 15-minute CLC will continue, and the concept will be enriched and improved as more cities and stakeholders join in. Let us work together to build sustainable urban ecosystems that are low-carbon, resilient, diverse, inclusive and equitable.

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The unified citizen engagement approach: a design-oriented framework for involving citizens in the energy transition

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Abstract

The paper describes the first implementation of the Unified Citizen Engagement Approach (UCEA), a newly developed design-oriented framework for citizen engagement in the energy transition. The preliminary testing and evaluation of several of its pathways in Groningen, the Netherlands, show that the role of design in the energy transition is not limited to the adoption of (co)design tools and methods. Instead, design should be integrated in the process in a more holistic way and on multiple levels, taking into account broader issues than energy, the maturity of local initiatives, and effective communication with stakeholders.

Author keywords

co-design, citizen engagement, energy transition, positive energy districts

Introduction

The transition from fossil-fuels to renewable energy sources has become increasingly urgent, not only in the context of reaching the climate goals, but also due to the recent rising costs in energy. Although the energy transition is often perceived to be the responsibility of (national) governments, regions or local governments such as municipalities, it is the citizens who play a pivotal role in the process, as in most cases they are the ones who will ultimately have to implement the appropriate sustainability measures in their homes, change their energy production and consumption patterns and bear any financial consequences (Kalkbrenner & Roosen, 2016; Lennon et al., 2020).

In several countries, such as in the Netherlands, the importance of local energy initiatives, consisting of similarly-minded citizens who have organised themselves in order to collectively address energy-related issues in their own neighbourhoods is acknowledged (Arentsen & Bellekom, 2014; Hasanov & Zuidema, 2018; Soares da Silva & Horlings, 2020). Oftentimes functioning as intermediaries, these initiatives act as repositories for knowledge and manage relations between stakeholders, while in some cases they can play an active role in the strategy formulation for the local energy transition of their district (Hargreaves et al., 2013).

Specifically, the citizen-centred perspective on the energy transition, has led to an interest in exploring the role of co-creation and co-design in the process (Ambole et al., 2019; Ryszawska et al., 2021; Sillak et al., 2021), as the stakeholders involved need to agree on a joint vision in order to successfully implement sustainable interventions, often consisting of (technically and logistically) complex, long-term projects that can have significant impact on a neighbourhood and its residents.

Citizen engagement approaches relating to energy transition are oftentimes designed to only address one actor or stakeholder, leaning towards either technological or social aspects. In the context of this study, the *Unified Citizen Engagement Approach* (UCEA) has been developed, , adopting a more integrated and designerly stance, by combining the perspectives of three main actors (the individual, the initiative and the municipality), and by mainly consisting of (co) design methods and tools.

This paper will discuss the preliminary findings of the testing of several 'pathways' that have been taken through the UCEA by local initiatives in the city of Groningen during the MAKING-CITY project during 2020-2022. The research provides a unique opportunity to evaluate this design-based citizen engagement approach from the local initiatives' perspective, by gaining insights into the implemented co-design tools, as well as into the strength of the model itself in practice.

Background

MAKING-CITY, a Horizon 2020 project funded by the European Commission, aims to demonstrate the possibilities of Positive Energy Districts (PEDs), which are districts that annually generate more (sustainable) energy than they consume (MAKING-CITY, 2023). Eight European cities participate in the project, with Groningen in the Netherlands designated as a pilot city, along with Oulu in Finland. As co-designing the PED together with local residents was one of the main tasks in MAKING-CITY, the project partners in Groningen developed the UCEA, which was based on some of the partners' existing approaches. These include the *Customer Journey to a Natural Gas-free Home* (De Koning et

al., 2020), the *Cooperative Approach* (Grunneger Power, 2023) and the *District Energy Approach* (Municipality of Groningen, 2019). In addition, the Hanze University of Applied Sciences (HUAS) conducted social research, which supported the UCEA's construction.

Co-design in citizen engagement approaches

In the Netherlands, the importance of citizen engagement in the energy transition, particularly through local energy initiatives, has been acknowledged since the past decade (Hisschemoller, 2012; Dóci & Vasileiadou, 2015). Therefore, several citizen engagement approaches have already been developed, such as the *Smart Energy Cities* (SEC) model (Smart Energy Cities, 2023), which integrates the technological and social routes. Other approaches focus on specific audiences, such as *Becoming Sustainable Together with Residents* (Kort et al., 2022), *Moving Together Locally* (Eerland et al., 2020), the *Toolkit Engaging Entrepreneurs in the Energy Transition* (Van Nijkerk et al., 2023) and the aforementioned *Customer Journey*, which focus on home owners associations, local initiatives, entrepreneurs and individual citizens, respectively. Examples of approaches which include multiple stakeholders

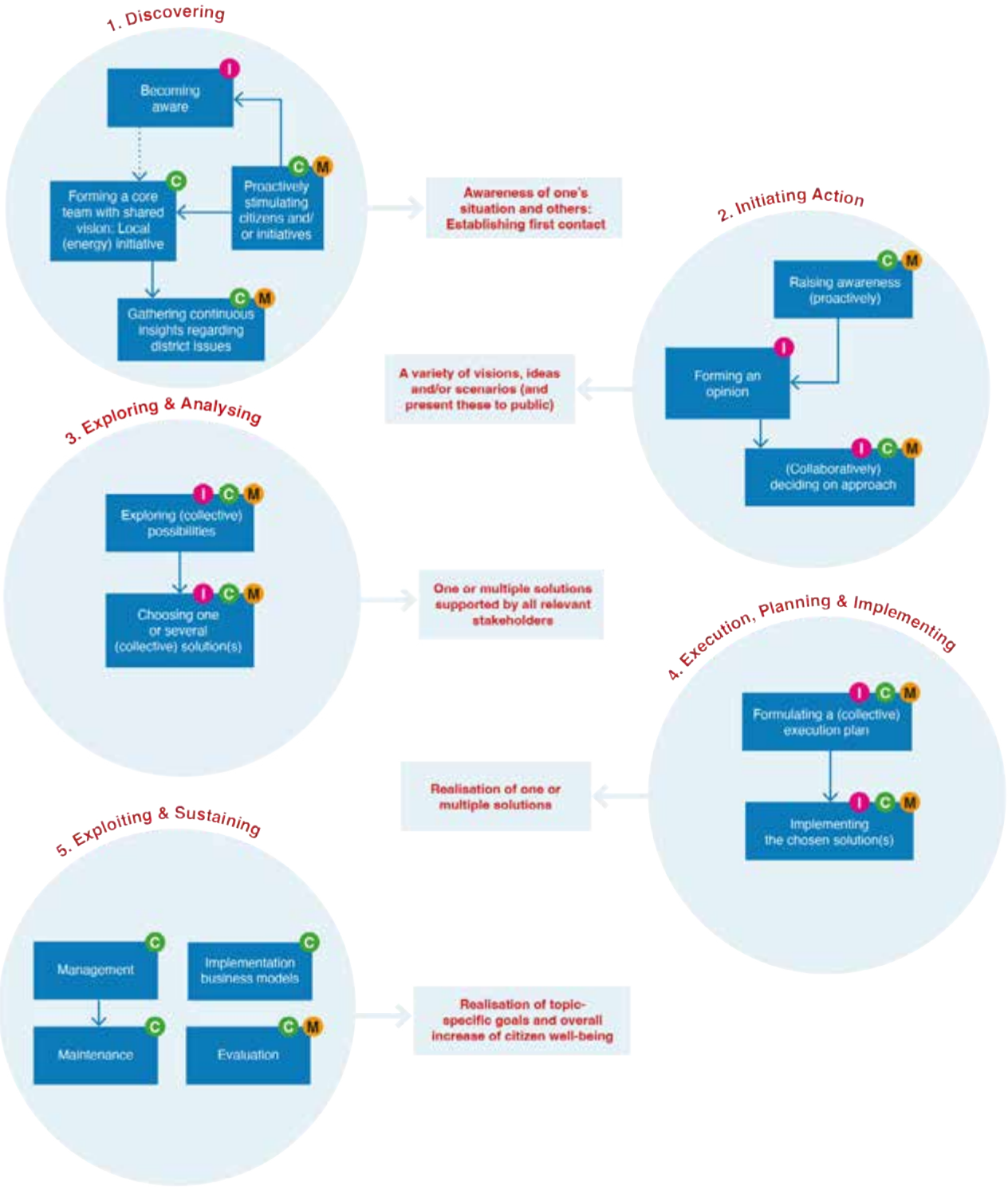

Figure 1. The five phases of the Unified Citizen Engagement Approach (UCEA), outlining actions for the three main actors: the (I)ndividual, the (C)ooperative or initiative, and the (M)unicipality.

include serious games such as the *WE-Energy Game* (Ouariachi, 2021) and *Energy Safari* (Ampatzidou & Gugerell, 2019).

Despite the increasing interest of involving a variety of stakeholders in the energy transition, implementing co-design in the process is currently far from being standard practice. In the citizen engagement approaches discussed above, for example, co-design is not an integral part of the process, or in some cases, is not included at all. Shortall et al. (2022) reviewed 28 recent EU-funded energy transition projects, discussing the extent of citizen participation alongside the associated methods and tools. Although the authors consider co-design as one of most inclusive forms of participation, their review shows in only six projects a form of co-design was used, with only three projects taking a (co)design philosophy as their departure point.

The UCEA aims to go one step further, by including multiple actors and integrating (co)design tools and methods in all of its phases as well as fostering the dynamic nature of the design process, which is reflected in its iterative approach.

The Unified Citizen Engagement Approach (UCEA)

The UCEA consists of five iterative phases, or spaces: 1) *Discovering*, (2) *Initiating Action*, (3) *Exploring & Analysing*, (4) *Executing, Planning & Implementing* and (5) *Exploiting & Sustaining*. Within each space, key activities are outlined for the (I)ndividual, the (C)ooperative or initiative and the (M) unicipality, supported by (co-design) tools that can be used by these actors to reach the objectives within the respective phase (see figure 1). In addition, each activity comes with associated (design) tools and methods (see table 1), which are aimed to help the actor move forward in the process.

The spaces can be initiated or accessed at any time, depending on the questions or needs of the respective actor(s). Activities by different actors can occur simultaneously, both within a phase and in multiple phases. Similarly, going back-and-forth between spaces is also possible, particularly in the first three spaces. This flexibility is inherent to the approach and was designed on purpose, since experience from the field has shown that citizen engagement often does not necessarily follow a linear path. For example, if an activity in a certain phase did not yield the expected result, an actor could choose to initiate an activity from another phase or even take a step back to a previous phase.

Table 1. Excerpt of list of tools & methods for UCEA Phase 1 (Discovering), listing the relevant actors

	Activity		
Tools	Raising awareness (proactively)	Forming an opinion	(Collaboratively) deciding on approach
Collective SWOT analy-sis		I C M	I C M
Design charrettes		I C M	I C M
Ecosystem mapping	C M	C M	C M
Fast idea generator		I C M	

Methodology

The development of the UCEA was preceded by an extensive social research phase conducted by a multidisciplinary research team in close collaboration with local citizen initiatives, which providing insight into various social aspects, such as social cohesion, sustainable behaviour and appropriate communication (Tjahja, 2022). These qualitative research studies, which were conducted during the development of the UCEA, informed the design process of the approach, and influenced the testing and evaluation process.

As it was not feasible within the scope of the project and the time span of the five UCEA phases to test the entire approach, since this would require several years and long-term commitment of stakeholders, a number of pathways through the model have been tested in three districts in Groningen: Hoogkerk, Oosterpark and Oosterpoort (see figure 2). The districts differ in terms of built environment, spatial development and sociodemographics, and the key criterion for selection was the willingness of the respective local neighbourhood initiatives to participate in the project.

All three districts started with the first phase of the UCEA, taking the perspective of the cooperative/initiative, as the pathways were designed in close collaboration with the collaborating local initiatives, considering their current progress, needs and respective local socio-economic context. In addition, each pathway consisted of activities spanning multiple phases, with some of the tools and methods being tested during co-creation events organised by the project partners in collaboration with the local initiatives. The tools were evaluated by means of surveys and interviews with some of the participating actors, such as key members of the initiatives and municipality representatives.

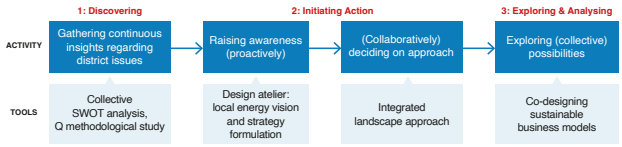

Figure 2. An example of one of the three pathways. In this case, the pathway tested in the district of Hoogkerk in Groningen (October 2021 – June 2022).

Findings

The main findings of the preliminary evaluation of the UCEA have been grouped in broader themes, which will be discussed separately in the following sections.

Broadening the focus

Both the social research studies, as well as the evaluation of the implemented UCEA path in Hoogkerk, show that co-creation events with residents should have a broader focus than only energy transition. Oftentimes, issues related to sustainable energy are intertwined with other (social) issues in the neighbourhood, such as (energy) poverty, social exclusion and safety. Addressing these issues separately is therefore not conducive, necessitating the adoption of a more comprehensive approach. In Hoogkerk, the implementation of the *integrated energy landscape approach* (De Boer & Zuidema, 2015; Picchi et al., 2019), in a number of participatory events, was particularly useful when co-designing a PED-district, as it takes into account the values assigned to the place by the local community.

Maturity and flexibility

The choice of tools and methods used in each stage of the UCEA process should be chosen carefully, as this decision depends on the level of development and readiness ('maturity') of the local initiative and community in relation to local energy transition. Moreover, taking into account the other two actors and trying to connect and potentially include them within suitable moments of the emergent pathway, can be of great importance. Flexibility is recommended when implementing these tools, as they may need to be modified to fit the needs of the initiative or other stakeholders, with some tools being more suitable for certain groups in particular phases or activities.

The evaluation of UCEA finds that while it is adaptable to different contexts, there are inherent restrictions when working with local citizen initiatives or cooperatives. The aforementioned maturity level of the initiative, lack or resources (time, manpower) and their own planning may restrict the types of tools that can be applied. Additionally, initiatives may not follow the same timeline as municipalities or researchers, and their pace should be respected when organizing activities or events.

Moreover, due to the long-term nature of the energy transition process and the variations in maturity of initiatives, it may not be possible to fully follow all five phases of the UCEA, and it is recommended to set up specific pathways instead. The UCEA should be used as a framework to support and guide the actors through the process, without enforcing a certain pace or deadlines, as there is a risk of initiatives abandoning the approach due to this. Additional tools and methods can be added as needed, but their value and impact on other actors and stakeholders should be considered as well as the added value they have over existing tools and how their input/output connects to the other tools in the UCEA.

The importance of a solid communication strategy

The purpose and goals of participatory events should be clearly communicated to both the organizers and attendees, and an explicit framework outlining the process should be used and followed during events. Additionally, the events should be held consistently and on a regular basis, as the outcomes of one event can be used as input for future events. It is also important to consider the number and types of participants, as they can have a significant impact on what in/output is generated. When communicating with the local community, it is important to tailor the strategy to take into account local perspectives on the energy transition. The social research studies conducted in the preliminary phase have shown that events are oftentimes geared towards specific groups, such as homeowners, while unintentionally excluding others, such as tenants, students and landlords. In addition, when using a certain tool or method, it is important to clearly explain the intentions and reasoning behind these decisions to the local community and municipality and to involve them in the process.

Discussion

The findings show in the energy transition is not limited to the usage of (co)design tools and methods with stakeholders, but can play different roles on different levels. First, the expansion of the scope to include broader societal issues than solely the energy transition, should also be reflected in the overall approach, necessitating the inclusion of holistic (co)design methods, such as the aforementioned integrated landscape approach. Consequently, suggested interventions based on these analyses will most likely have a broader (physical) impact on the neighbourhood as well. The inclusion of the municipality as an actor in the UCEA is therefore essential, as these interventions can have an impact on public space.

Second, in addition to co-designing with residents one specific events, such as neighbourhood gatherings or events, the energy transition process as a whole should be a joint effort from its inception, which is evidenced by the fact that the maturity of the initiatives will determine the scope, feasibility and impact of the proposed (design) interventions. Moreover, since input and output of certain tools, in some cases, can be dependent on one another, a careful consideration is needed to determine *which* tool to use *when* and which actions to undertake next. By coordinating the sequence of tools within a pathway in an effective way, a local initiative could, for example, also inspire the two others actors to contribute and encourage them to initiate action themselves.

Third, there is also a role for design in the communication activities surrounding the energy transition process in a neighbourhood, as how the interventions are communicated can potentially influence the awareness, perception, expectations, and ultimately, the degree of support and participation of local residents. The social research studies conducted have shown that communication is often aimed at particular audiences, such as homeowners with a relatively high income, while inadvertently excluding other groups, such as social tenants, students and migrants. A comprehensive communication strategy, for example, through *transmedia storytelling*, which entails systematically conveying a narrative through multiple channels, with each medium providing its own unique contribution (Jenkins, 2008), could be a suitable means to address this issue.

Conclusion

This preliminary evaluation of the UCEA has demonstrated that design can play a much broader role in the energy transition than traditionally envisioned. Furthermore, the inclusion of the three main actors enables fine-tuning of the process, which can have a positive effect on the effectiveness of the tools used as well as the eventual outcome. Although these initial results are promising, more research needs to be conducted to explore other pathways and test the strength of the of the approach itself by investigating the pathways' sequences as well as the tools associated with them. The complete framework as well as its development is described in the project deliverable *D3.11 New citizens' engagement strategies in Groningen* and can be found on the MAKING-CITY website (makingcity.eu).

Acknowledgments

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Designing for viral infection awareness through PLAYMUTATION

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Abstract

Media trust has been one of the greatest societal challenges given viral outbreaks within a new media landscape, amplifying fear-inducing measures, and information avoidance. Although some research has been carried out on the media (mis)use to inform about viral infections, there has been general lack of information on media design to create this awareness. The purpose of this paper is to contribute to establishing practices to develop virus epidemiologic-themed digital games to raise awareness for viral infections in young adults. Using a qualitative development research involving twenty-six informed individuals in microbiology and game design and thirty-four young adults aged between 18 and 35, a set of guidelines within the project PLAYMUTATION were proposed: (i) Validating the information on the transmission of the virus, measures to prevent and treat viral infections as a topic; (ii) Virtual modelling of the viruses physical interactions; and (iii) Showing implicitly the bio-psycho-social consequences, among others. This paper advances the knowledge of connectivity and creativity in times of conflict by simulating game-based scenarios that may prepare players for acting upon future health crises and outbreaks.

Author keywords

Digital Games; Viral Infections; Awareness Design; Changing Behaviors.

Introduction

The past few years have seen increasing animal and human infections worldwide, which heightened the need for information about pathogens, host-pathogens interactions, and their spread in the general population. Over the course of history, humans have been challenged to lead the eradicating these infections (e.g., smallpox), controlling them by massive vaccination (e.g., measles, mumps), or behavior change – e.g., HIV/AIDS awareness. However, human mobility, and misleading media discourses that may impact people's attitudes, fears and behaviors emphasize the urgent need to leverage science-society debates and digitally mediated health communication strategies to educate about microbial and virus infections and viral outbreaks. Fighting against misinformation and overabundance of information about viral outbreaks also sets a priority in youth education, being media design an important dimension to deal with uncertainty, and medium credibility (Knudsen, Dahlberg, Iversen, Johannesson, &Nygaard, 2022). This latter dimension also tends to be highly dependent on media use.

In fact, the use of media and, in specific, digital games may constitute great opportunities to raise awareness of viral infections and impact behavior change (Putri et al, 2021; Furstrand et al., 2020). In particular, digital games may be a suitable medium for simulating models of infection and dissemination of some pathogens – i.e., easily spread and disseminated airborne viral diseases, comprising a set of pathologies that can be caught by breathing when infected people cough, sneeze, or talk, spewing nasal and throat secretions into the air, beyond touching a contaminated surface that harbors these agents, followed by touching eyes, nose, or mouth that may also result in infection. Some examples of these airborne diseases include COVID-19, the common cold, the common flu, varicella, mumps, and measles. Moreover, games may foster collaborative problem-solving (Li, & Tsai, 2013), stimulate scientific curiosity, and learning about the virus's nature, transmission, and infection (Wang, & Huang, 2021; Lima et al., 2017; Jenson, Taylor, & de Castell, 2011).

In this sense, the aim of the ongoing PLAYMUTATION research project (https://playmutation.web.ua.pt/) is to: (i) Map the use of games in microbiology and media interventions in youngster's attitudes and behaviors relative to viral infections; (ii) Develop and validate the virus epidemiologic-themed digital game interventions (through gameplay and game-it-yourself initiatives); and (iii) Assess the youngsters' attitudes and behaviors relative to viral infections. This paper provides an overview of the game Mutation developed under this project and discuss the role of games to create awareness for health in times of crisis.

The paper is divided into three sections, including the introduction and conclusions: Section 'The Project PLAYMUTATION' presents the aim, approach, and context of the project. Then, the section 'The Digital game Mutation Madness' briefly describes some of the design and development decisions of the game. Finally, section 'Game Design for Situation Awareness

for Health in Times of Crisis' discusses the way this media enables the awareness about viral infections and preparedness in times of crisis.

The Project PLAYMUTATION

The PLAYMUTATION research project – Virus Epidemiologic-themed Digital Games and Youngsters' Attitudes to Viral Infections aims to analyze the use of digital games to inform about the evolution of viral genomes, transmission, and mutations, as well as to promote self-care and infection prevention in youngsters.

The research question that guides this project is "How can virus epidemiologic-themed digital games raise youngsters' awareness of viral infections?" and, as such, it is divided into three phases. For instance, the research begins with the map of the use of games in microbiology and media interventions in youngsters' attitudes and behaviors relative to viral infections (PHASE 1). Then, a virus epidemiologic-themed digital game is developed (PHASE 2), which will serve as the intervention to assess the youngsters' attitudes and behaviors (PHASE 3).

In a broader sense, qualitative research is followed to understand the main design components of virus disease-themed digital games to raise young adults' awareness of virus diseases. PLAYMUTATION began in March 2022 with the consultation of twenty-six informed individuals in microbiology and game design using a 3-round Delphi method to achieve a consensus relative to the requirements of the game, i.e., the informed individuals were asked about the top-leading actions for raising people's awareness of viral infections and rate the whole suggestions in the following rounds.

The game Mutation Madness was then developed within this project, taking the individuals' perspectives into account. The characteristics of the game are described below with the challenge of balancing players' engagement and learning goals beyond intertwining information accuracy and fiction.

After its development, thirty-four young adults aged between 18 and 35 tested and evaluated the game in terms of the player experience (i.e., surveyed about game learnability, clarity of the goal, reward motivation, perceived self-progress, intention of activity repetition, balancing gameplay, item use and sense of control, involvement) and learning and behavior (i.e., surveyed about ways to fight and prevent viral infections, virus characteristics, mutations, preparedness for viral outbreaks, change in perspective), positive and negative aspects, and areas of improvements.

This ongoing project also involves a second stage in which the participants build their own versions of the game Mutation Madness with accurate and validated data about viral infections. This later stage of the project is grounded in the fact that digital games can be used as a mean for fostering youngsters' self-expression in health crisis and communicate own bias and (mis) representations.

In brief, this research sets out to determine the main design components that Game-based Learning should have to learn microbiology, while generating awareness to viral outbreaks and epidemics. The use of games in citizen science and self-expression in the healthcare domain are presented as the major contributions of this project to Game UX design for health education and science learning.

Moreover, the contributions are aligned with the sustainable development goals of ensuring quality education and good health and well-being with the use of media for increasing knowledge in virus epidemics, and changing behaviors associated with pandemics.

The digital game Mutation Madness

The digital game Mutation Madness was developed under the project PLAYMUTATION, aiming to raise young adult's awareness for viral infections. This is a 3d third-person epidemiologic-themed shooter portraying a virologist's attempt to fight against different waves of virus and variants, using different in-game items.

Figure 1 illustrates the gameplay of the game Mutation Madness and acquisition of in-game items using genetic points.

Figure 1. Mutation Madness gameplay and acquisition of in-game items

Each game level corresponds to different city scenarios named after essential concepts relative to viral infections, e.g., Cell city in which virus multiply acting as intracellular parasites, and virus-inspired structure RNA Road and Spike Station as viral genomes, and spike proteins (Flint et al., 2015).

Beyond fighting viruses, the player must find the mystery boxes hidden in each level that unlock different pieces of information relative to the Mad Virus. Figure 2 shows the panel 'Virus Research' to complete with the characteristics of the virus such as its structure, family, distribution, modes of transmission, pathogenicity, symptoms, risk factors, and control measures.

Figure 2. The Virus Research Panel

» Disinfectant that refills the virologist weapon and this is particularly important given that it may inactivate viruses and reduce viral transmissions (Lin et al., 2020);

- Vaccine that acts as the player's shield within time-limit constraints. Vaccines induce immune responses and protect the individuals from viral infections. However, these may lose effectiveness given virus mutations (Louten, 2016);
- Paracetamol is used for the player to restore health-related wellbeing. Paracetamols are analgesic and antipyretic that may make the individual feel better during a viral infection and reduce the effects of its symptoms (France, 2022); and
- Antivirals that enable to deactivate nearby viruses, given its role in blocking the life cycle of the virus (e.g., attachment) and prevent its replication (Louten, 2016).

In a nutshell, the game Mutation Madness addresses the following educational content: Virus characteristics and behaviors; Prevention of viral infections; and Emergence of virus mutation and new variants.

Game Design for Situation Awareness for Health in Times of Crisis

A major contribution of the project PLAYMUTATION was the proposal of guidelines and practices to inform the process of designing and developing digital games to deal with health crisis scenarios.

When designing a digital platform that intends to generate awareness for a specific situation, one should consider the "perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (Endsley & Jones, 2004, p.13). As such, this is a three-stage process in terms of the user experience, i.e., perception of elements in the environment; analysis of the situation; and projection of future actions (Endsley & Jones, 2004).

Additional challenges are posed when analyzing, producing, and evaluating these artifacts with this purpose like ensuring information accuracy, updating, and putting it into context to prevent possible manipulations or misinformation especially when using a media that both fiction and facts are blended. Hence, the following recommendations are proposed:

- Ensure proximity between information sources and game developers during the initial phase corresponding to requirement analysis and initial validation.
- Carefully use the narrative to inform about the situation to not amplify fear-induced messages, panic, or conspiracy theories. Be aware of public policymaking and communication guidelines relative to crisis scenarios.
- Attend the individual's goal relative to health crisis situations – i.e., awareness of health data, goals interpretation, and prediction to achieve the goals.
- Enable role-playing of health crisis communicators and decision-makers to understand the implications of possible health policy-making and societal measures concerning healthcare crises.

In the specific case of the project PLAYMUTATION, the following recommendations arose either from the involvement of informed individuals and young adults who tested the game *Mutation Madness*: (i) Validating the information on the transmission of the virus, measures to prevent and treat viral infections as a topic; (ii) Virtual modelling of the viruses physical interactions; (iii) Showing implicitly the bio-psycho-social consequences; and (iv) Enabling players to spread the message of these activities in their social networks to increase the outreach. In terms of the game-based learning outcomes, most of the participants emphasized that the game allowed them to learn about the occurrence of virus mutations and possible ways to fight against viral infections.

Conclusion

This research set out to establishing practices to develop virus epidemiologic-themed digital games to raise awareness for viral infections in young adults. A three-phase qualitative development was, therefore, followed under the ongoing project PLAYMUTATION: 1. Surveying twenty-six informed individuals in microbiology and game design to identify the game requirements; 2. Development of the game 'Mutation Madness'; and 3. Evaluation of the game with thirty-four young adults aged between 18 and 35. Based on the results from the first- and third- phases, a set of guidelines were outlined, including the validation of the information on the transmission of the virus, measures to prevent and treat viral infections as a topic, virtual modelling of the viruses' physical interactions, among others.

In terms of the second-phase relative to the development of the digital game *Mutation Madness*, a game design awareness process was adopted in its development, incorporating associated stimuli to the representation of viruses, comprehension of the situation, future projection, and decision-making towards a set of actions and feedback, in which the learning content was transmitted implicitly. Beyond applying this process of designing for situation awareness to product design, there is also potential to be extended as the use of media within the city landscape. Participants have revealed that the game enabled to learn possible ways to fight and viral infections, followed with the characteristics of the viruses. Indeed, it demonstrated potential to raise knowledge about viral infections and their virus mutations and variants. Further work is being carried out in the projects PLAYMUTATION2 and YO-MEDIA: Youngsters' Media Literacy in Times of Crisis, in which game development ('Game-It-Yourself' initiatives) is being explored to foster youngsters' self-expression in health crisis and communicate (mis) representations. Games are expected to foster media trust by validating information with specialized individuals in relevant areas to the healthcare crisis, present clearly what results from fiction and reality, present different scenarios, and perspective-taking with possible actions to deal with the crisis.

Finally, it is worth emphasizing that this work advances the use of game design and development activities to self-express in times of crisis, being these contributions essential to understand the role of media development for increasing knowledge and preparedness in times of crisis.

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Gamifying the low impact customer solution design

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Abstract

The business requirements for environmental responsibility also cover the low environmental impacts for customer use process in addition to low production harm. The environmental impacts caused when the customer needs to search for, use and dispose of the business solution should also be decreased by sustainable business development. This paper describes the content and gamified learning solution for a Massive Open Online Course (MOOC) for small-scale businesses about low impact customer solution design. Since these businesses are unskilled in both user-driven design and service design, and the environmentally responsible customer behaviour tools are multifaceted, the creation of the learning material has applied gamified, step by step solutions. Gamified learning supports planning and problem solving for real-life contexts. Low impact customer solution tools such as canvases, design guidelines and ideation cards also point to game-based possibilities. The MOOC solution used canvas game-boards with stories and challenges to gradually build and interact with the customer solution. The navigation sections included the basics of dual responsibility business needs, a customer-driven approach, service design and communication. The basic canvases and tools included a dual loop for consumption-production systems analysis, customer personas for customer information role play and customer journeys for detailed solution design. The game setting tried to set boundaries to explore the complex systems content in a safe enough environment to promote engagement, self-confidence and control for the small-scale business managers. The MOOC-solution will be tested with small-scale business owners in the late spring and early autumn of 2023. The critical aspects in the material are comprehensibility, support for a customer-driven approach and a low impact customer solution design. The time use efficiency and usability for the busy business learners will be crucial features to follow and improve.

Author keywords

Sustainable service design; carbon handprint; gamified learning; Massive Open Online Course.

Introduction

Due to the threats of climate change and the drastic decline in biodiversity that relate to the abundance and overconsumption in developed countries and subsequent resource scarcity, the business requirements for environmental responsibility have shifted from merely reducing the environmental harm of production to including low environmental impact from the customer-user processes. Solutions to the ecological sustainability crisis require a reform of economic operation models including the low impact consumption patterns of everyday needs: accommodation, energy and water use, mobility, food and products and services. (Lettenmeier et al., 2019, p. 4-5). Around 70% of CO2 emissions in developed countries are caused by the daily consumption of residential households (Salo & Nissinen, 2017, p. 3-12). Calculations for staying within the 1.5-degree global temperature rise indicate that the environmental impacts of consumption in developed countries should be reduced by 70% by 2030 and 90% by 2050 (Lettenmeier et al., 2019, p. 45). Businesses should support consumers in this necessity of consumption behaviour change.

Many businesses have made efforts to lower their production carbon footprint or other production impacts. Attention is now also being focused on the environmental handprint which points to the climate benefits, or the emissions avoided when the customer is using a product, process, or service. This perspective also traces the positive future effects on emissions instead of focusing on the current negative ones (Sitra, Carbon Handprint). The Finnish Upright project has started to calculate the net impact of companies (Upright project) reducing the handprint from the footprint. The net calculations urge companies to pay attention to their handprint effects, the environmental impact during the consumption process of the solution.

A Massive Open Online Course (MOOC) is being developed for small-scale businesses about issues and tools suitable for the low impact customer behaviour design. It is being created in two overlapping projects focusing on responsible and effective service and product development in the LAB University of Applied Sciences in Finland. The MOOC content includes systems thinking, customer-driven design principles with customer personas and customer journey, and the design

for behaviour change tools. In addition to the business interviews, benchmarks and expert consulting, the material applies earlier gathered and tested collections of customer-driven design tools for environmentally responsible solutions. The array of materials includes qualitative user research-based design guidelines, service design tools and cross-disciplinary, multifaceted environmentally responsible customer behaviour tools (Kälviäinen, 2022; Kälviäinen, 2021; Kälviäinen, 2019). The complex support material for customer-driven development of the low environmental impact customer solutions makes the course content demanding for the business managers suffering from time scarcity. For these reasons the MOOC content has been developed considering the possibilities provided by gamified learning and step by step approaches in coaching the manager-learners.

The learning requirements leading to gamified MOOC idea

The MOOC development so far has consisted of 17 small-scale regional business manager interviews carried out in spring 2022. The businesses demonstrated a lack of customer-orientation but interest in customer understanding. Customer-orientation was interpreted in a narrow way and included aspects such as feedback surveys, or customer encounter feedback. There was a lack of customer studies and customers were not involved in the co-development of products or services. Service design theory suggests providing extended understanding about the pre-, during- and post-stages of the customer journey for the developing customer experience (Stickdorn et al., 2018, 112). Many businesses saw questions of environmental responsibility as big and challenging and experienced difficulties in environmental responsibility communications. There was intimidation around these issues, and in communication a fear of becoming accused of greenwashing.

The needs of these small-scale businesses in terms of the content, structure, and scope of the learning materials indicated that usable material should be easy to obtain from a digital platform and should contain targeted information from experts in the field. The businesses hoped for plain language usage, explanations of important concepts and examples from their own business fields. Practical, easy-to-use tasks to apply on a company-by-company basis were hoped for.

The drafting of the material and learning guidance further happened though business benchmarks in spring 2022 and a series of lectures and co-design training sessions during the spring and autumn 2022. The participant companies in the training sessions requested for memory lists and having practical examples of the solution parts. Additionally, needs for the course to be engaging, innovative, pleasurable, and encouraging were stated. This also meant variation in the material format including videoclips. It was also observed how some of the participating companies were advanced in their environmentally sustainable activities while some were beginners.

The requirements for the guidance for design, ease of use despite the complexity of the materials, needs for engagement and requests for special, business field applicable materials led the MOOC creation group to seek inspiration from gamified learning solutions. These seemed to offer support in coping with the systemic and applied learning demands. Results from gamified learning solutions compared to other non-traditional ones point to learning support for planning, problem solving, imagining real-life situations and creativity (Safapour et al., 2019, 284). Psychological tools for behavioural change have also been found to overlap with gamified learning in environmentally low impact solutions design and in other behaviour change demanding solutions (Kälviäinen, 2021; Bucher, 2020).

Gamified learning involves ways of applying game-oriented thinking to achieve learning engagement through stories, autonomy, meaningful content, challenges, interaction, feedback, and the feeling of achievement. A game setting can provide boundaries to explore content on complex systems in a safe enough environment to enhance self-confidence and control (Kapp, 2012, 15-16). The participating managers of the small-scale businesses hoped for engagement support among other pressing duties and when facing complex content. One support means was a meaningful storyline that interacted with their own business case and development goals. Autonomy, as well as variable levels of knowhow concerning environmentally sustainable business aspects, in addition to specific business needs were met through level-based solutions where the basic learning route was complemented by opportunities to go deeper into specific business or knowledge needs.

The grounds for using gamification rose also from the nature of the game type of tools at hand: canvases describing systems, visual process descriptions, design guidelines and ideation cards. The aim of the gamification was to apply the basic features of games such as game boards, a story, and a challenge so that they unfold gradually and support remembering, a sense of control, decision making, mastering and a sense of achievement. The idea of selecting a customer role persona for a gamer was applied to support the customer-driven perspective. It seemed important not to add other means of gamification to avoid any extra cognitive load.

To avoid cognitive load the whole material in the MOOC was divided into smaller sections, where the interaction for the learner's own business case could be built in small steps through tasks and supporting examples. This tutorial approach of giving first some simple tasks and repeating them by increasing the variation and effort level gradually also points to gamified solutions. Specific business examples were added to the tasks and further support was provided by videos in which selected experts from consultancies and businesses shared their own development perspectives, or the learner was shown how to use the canvas tools. Since in a service design process there are no right answers, memory list types of materials were used at the end of each section for the learners to check if they had considered the provided design instructions. The gamification development led also to ensure the content section titles were visible all the time so that the learners could navigate back when they needed to check information from the earlier sections. This feature is also important as it supports iteration in design thinking.

The section themes created were:

1. The environmental sustainability pressures for businesses and a presentation of the different types of customer groups for sustainable consumption. Tasks include an analysis of the current business situation and a selection of a baseline customer persona role.
2. A customer-driven approach for service solutions with the presentation of the customer journey tool, sustainable consumer trend information and research information about different motivational and behav-

ioural consumer segments. Condensed instructions to carry out qualitative customer research. The tasks include application of the customer journey into the learner's own business offering, its environmental consumption impact areas and developing the stereotyped customer persona into a more realistic business customer for the solution.

3 Service and product redesign instructions about how to avoid environmental consumption impacts, barriers and hindrances to this, and drivers for sustainable consumption. The basic customer journey canvas is elaborated in a form that integrates behaviour change psychology with the drivers for sustainable consumption. Tasks include rethinking the activities where customers produce environmental harm and redesigning the customer journey considering the behavioural psychology features of customer motivation, capabilities, and opportunities in the service moments of pre-, during and post service phases.

4 Communication about the solution with justified, transparent, understandable, and motivating way. The tasks include planning the suitable communication for the selected customer persona and creating a campaign to differentiate the solution in the markets.

The systemic development idea described as a double loop canvas

In addition to regional business interviews a benchmark analysis was conducted in the spring of 2022 scanning national Finnish and international product and service development solutions that support customers' environmentally responsible activities. A systemic double loop canvas was created by analysing these examples to support a modelling the low-impact consumption and production system (Figure 1). It describes the actions of the company and the customer in parallel demonstrating the possibilities and the consequences of dual responsibility for businesses.

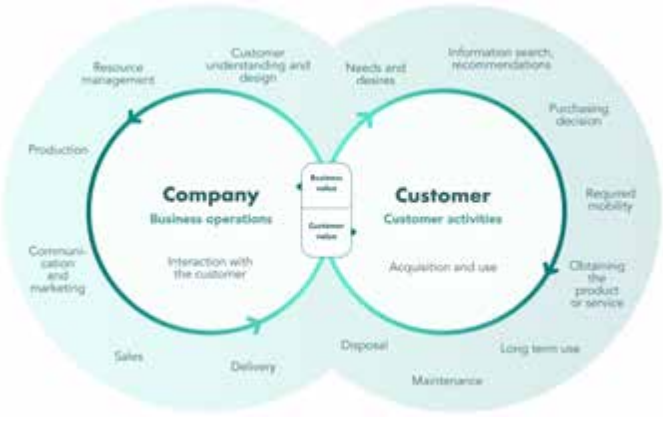

Figure 1. Double loop description of the consumption and production system (figure by Enna Eloranta and the project group 2022).

The idea in the new solution development is to consider first the customer-users, and to point the service moments when the solution can reduce the environmental impact of the customer. This indicates how to change the offering towards low consumption. The idea is to only then analyse the demands of low impact customer-orientated solutions on production. A comparable double loop is used in the United Nations' Sustainable Development goals number 12 Sustainable Consumption and Production pointing to the unsustainable patterns of consumption and production as root causes of the triple planetary crises of climate change, biodiversity loss and pollution (United Nations). The circular economy business solutions point to the need for systemic change in consumption-production systems where many of the solutions are based on services-based processes to reach the outcome of reducing the use of materials and keeping them in closed use circles. With product solutions these include sharing platforms, products as services and product lifecycle extensions. (Sitra & Deloitte 2022). With the consumption-production systems and circular economy solutions it is important to notice that a systemic change towards low, adequacy-based consumption models is necessary in addition to ensuring efficiency of these systems. (Bengtsson et al., 2018).

The advanced layers are provided with two triple loop canvases that make it possible to model the multi-level operations of co-working companies, distribution companies and platform companies offering recycling or customer peer-to-peer services. The loop canvases form the basic canvases or game boards that orientate the business learner to the learning content so that their own customer offerings and production form the starting point with an analysis of the current situation. The loop canvases also provide the vision for the learning so that the initial learning story provides a promise of returning to the production-distribution part of the loop when the customer-orientated design is completed. The loop models help businesses to build a system-based flow understanding of how their services and products offer different service moments and interactions with the possibilities to reduce the environmental impacts of customer use and how then these solution shifts change the related production-distribution activities.

According to the executed training sessions, the loop-based canvases seem to work well to concretize the current situation and in demonstrating the meaningful transformation possibilities within the limits of the current resource situation and collaboration possibilities of the small-scale businesses. The loops also help to change the business perspective from business-centred environmental sustainability to include the customer journey and customer value point of view and even to ask the big questions of adequacy-based consumption. This question is if the customer needs can be satisfied in totally new, low consumption ways.

Game roles from the customer-user perspective

An important notion in transformative design towards low-impact environmental consumption has been to consider how to help businesses meet these challenges of everyday consumption behaviour. A basic understanding of the user-driven development process should begin from an understanding of customer motivation and activities. The customer persona tools help to consider the consumption activities and journeys with the business offerings (Stickdorn et al., 2018, 41-42). The idea in the MOOC is to ask the business owners to put themselves in the roles of their customers and start the learning and solution creation process in the customer's shoes.

The customer section provides information of changing consumption trends. A change towards environmentally responsible desires and increasing consumers' expectations in terms of sustainable choices was clearly visible in 2022 (Ac-

centure Interactive, 2022; Euromonitor International, 2022; Greene & Korkman, 2022). Greene and Korkman (2022) illustrate the changes in the product relationships globally highlighting the consumption shift from the satisfaction of needs and desires to adequacy-based consumption, although still emphasizing the pleasure of consuming. It is relevant to notice the consistent findings in consumer research about the nature-positive attitudes of consumers towards environmental responsibility, but in practice evidence of the lack of responsible actions and behaviours (White & Habib, 2018, p. 9).

In Finland and internationally customer research has demonstrated that there are different types of consumer motivations and actions on the questions of environmental sustainability. Customers expect companies to support their own changing needs for low-impact consumption and to provide products and services based on their sustainability values. By combining information from several earlier studies, a chart of different consumer profiles was created to support the MOOC learner to see the solution from the customers' perspective (Kälviäinen 2022, p.80-103; Kaitosalmi et al., 2021; Salonen et al., 2014). In the first section of the material a four-fold field chart provides the learner with four rather stereotyped personas to represent some different types of sustainable consumers (Figure 2).

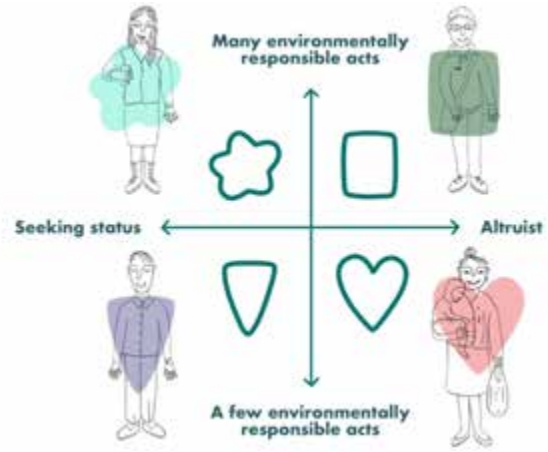

Figure 2. A four-fold field for different consumer profiles and consumer persona examples for environmentally sustainable consumption (figure by Enna Eloranta and the project group 2022).

In Figure 2 the upper parts' consumers perform many environmentally responsible acts and the lower parts' consumers do little. The left parts represent consumers who are concerned with themselves and their own status or image and the right parts those who care about the benefits for the close people or even for the whole planet. The provided stereotyped persona in the left upper corner is a young person who leads an eco-chic life using small, trend-based sustainable solutions. In the right upper corner is an adult student who is deeply committed to environmentally sustainable solutions. In the left lower corner is a technology orientated elderly man interested in status-related environmentally sustainable technology solutions, and in the lower right corner is a mother who seeks family benefits and does some environmentally sustainable acts connected to them.

For the learner, in the first learning section it is possible to select one persona closest to their own customer group to start up the customer-driven learning. The personas are also marked with symbols providing links in the following steps to practical examples concerning each persona. In the second customer-driven section the learner is guided to create a persona or personas that more accurately resemble their own realistic business customers. As a check list the stereotyped personas provide examples of how to create a customer persona and what could be important to find out as customer understanding for the different phases of the consumer journey.

The customer journey as the canvas and process for the design steps

The specific tool to design an offering that supports customers to reduce their environmental impact is a customer journey. This provides a system of service moments where the different possibilities to reduce the individual environmental burden can be designed. Already via the loop canvases in the first section the business managers can mirror their current customer journey against the phases of pre- (finding, choosing, accessing), during (learning to use and using) and post- (disposing, recommending) service. In the second section they are asked to move their offering mapping to a customer journey canvas (Stickdorn et al., 2018, 44-53). This analysis points out the environmental impact areas the customer journey entails in their business. In the third section they start to use relevant consumer advice on low environmental impact to design the new customer journey. The advice is presented from studies of consumer-based carbon emissions and as advice collections attached to a carbon footprint calculator (Salo & Nissinen, 2017; Impiö et al., 2020). The means to reduce emissions due to consumption include reductions of accommodation, mobility, food, and product related environmental impacts (Salo & Nissinen, 2017, p. 14–22). Many of these occur not only in the core service use but in the pre- and post-service use phases.

The gap between consumers' environmentally positive attitudes and less responsible choices and behaviour is influenced by the motivational consumer interests, the pressures of busy everyday life, emotional biases in decision-making, and the lack of necessary individual capabilities (Kälviäinen 2022, p. 155–162). The overflow of choice and marketing in the saturated markets make information about responsible solutions difficult to find and understand, and the messages may be contradictory and confusing (Kälviäinen 2022, p. 180-195). Consumers need service solutions that are interesting, easy to find and understand, are smoothly integrated into their daily lives, and offer suitable support, help and rewards in the required habit changes (Kälviäinen, 2022, p. 209–211). Behavioural psychology explains this using the COM-B model, where the factors of capabilities, opportunities, and motivation all come together supporting a person to behave in a certain way (Mitchie et al. 2011; Bucher, 2020, 116-122).

Figure 3 explains the consumer journey with COM-B factors where the required support for crossing the barriers and providing support can be embedded for a new, low impact customer journey covering the pre-, during-, and post-service stages. On customer journeys and the related service moments and touchpoints, it is possible to integrate interventions to the solutions to both overcome obstacles and utilize customer interests related to them (Kälviäinen, 2022, p. 6). The new customer journey should be made suitable for the customer persona created. Figure 3 is layered with the consumer profile symbols marked examples of service moments and touchpoints suitable for each customer type.

Figure 3. The customer journey with the COM-B model containing service moments and symbols for customer persona related examples (figure by Kälviäinen and the development team 2022).

Advanced level customer-driven tools for service moments and touchpoints are additionally offered based on psychological advice on decision making heuristics and biases that can be used to support behavioural change (Kälviäinen 2022, pp. 22-30; Lockton, 2018). The vast amount of these materials is edited to a minor range and offered in a form where advice is attached to suitable pre-, during- and post-service phases. The pre phase is important for raising interest and the last ones for the formation of new habits. The selection considers the need to build support for behavioural change as a process (Kälviäinen, 2021).

The feedback for the new solution design is offered in the form of guidelines for low impact, customer-driven solutions (Kälviäinen, 2022, pp. 217-219). These guidelines serve as memory cards to check if the solution fulfils the advice given. At the end of the design section the results are further transported to the initial loop canvas, where the consequences of the change in the customer journey can be applied to the production or distribution of the offering.

The fourth learning section for communication uses the achieved design solution as the basis. The step-by-step analysis reminds managers that the information about environmental impacts should be based on true actions and described as factual information. Some of the consumer segments will be interested in this. The customer-driven part for communication reviews the drivers and ways of informing the different types of customers with consumer profile symbols indicated examples. Finally, it proposes ways of carrying out campaigns for differentiation and provides examples of these.

Conclusion: The critical points of the learning material

The main content for the MOOC is challenging as it needs a combination of customer understanding, environmentally responsible possibilities for consumption, and the creation of customer journeys with the needs to encourage psychology-based behavioural change. It is especially challenging for small-scale businesses that struggle even with developing their production-centred environmentally sustainable responsibilities. To ensure the ease-of-use, and a smooth and functional whole the MOOC course will be tested together with a set of regional small-scale businesse managers before the launch in the autumn of 2023. Based on the results, the further development of the support material will be carried out during autumn 2023.

Considering the MOOC-material aims and learning with it, as the conclusion of the work so far, several critical perspectives can be stated. The requirements from the small-scale businesses suggested finding ways of supporting them in sufficiently easy ways despite the complexity of the challenge of the dual responsibility. The comprehensibility of the content has been tackled by trying to build up a step-by-step development story that would make sense from the business managers' point of view. The value for the business in it has been emphasised. Each of the steps is supported by visual canvases that are gradually built to be more complex and are in this way filled in during the development. Examples are offered to support understanding the content.

The, for many small-scale companies, challenging customer-driven attitude is supported by dedicated material, examples and tasks. In addition to basics of it, the low impact customer solutions provide a further challenge because they might require customers to do something they are partly reluctant or too lazy to do. The materials have tried to support the attitude change towards customer-orientation and provide for the customer information and examples attached to the customer personas in the learning and design process.

Support for low impact customer solution design has been the central focus of the learning material. The material has been tested with different types of companies participating during the compiling process. The viability of the material used comes partly from the fact that it contains materials from a long period of development and use with design students and company cases (Kälviäinen 2022). The independent setting in which business managers should be able to use the tools for redesign of their varying business offerings is a new one. These learners do not necessarily possess design skills, and it sets further demands for the usability of the material. The step-by-step redesign process and the usefulness of the different canvases, visualisations and supporting examples can only be verified when the materials are further mirrored against different companies and their customer profile needs.

Time issues for small-scale companies are also central. The editing of the material has considered how to keep the content short enough and further editing should be done on the points where the material and tasks prove to be too time consuming. The time perspective also includes basic usability and ease of navigation.

The aim of creating the learning material has been to support small-scale businesses to identify their own starting points and resources, and to take advantage of consumers' growing interest in environmentally responsible everyday life. The input of regional small-scale businesses in environmentally sustainable transitions is of importance. They are especially influential in local transformative processes, as their offerings typically support consumers in their everyday consumption habits. The support for the small-scale businesses' dual environmental responsibility is important, and it should be made easy and meaningful for them to use. Increasing their customer-driven environmental design expertise strengthens their force to activate the local green transitions for sustainable consumption.

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Connecting to the future; using serious games and scenario development for responsible design

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Abstract

Design is a medium that allows for storytelling, at the same time design can be inspired, informed, or improved by stories. In Design Education, past year's efforts have been made to let the content speak more vividly to the students. We introduce the Future Scenario Development Play and Design methodology as a process for Research through Design. Based on the Future Scenario Development Design methodology (Eggink & Albert de la Bruheze, 2015), this scenario development approach aims at exploring futures that are more than just a few years ahead of us. We expanded the method with a serious game and a general conceptual design phase. The scenario of a plausible future, broken into three-time horizons (5, 15, and 30 years), provides the requirements, opportunities, and constraints for the design. The serious game SES (Scenario Exploration System) (Bontoux & Bengtsson, 2016) provides a safe sandbox for the students to explore two contrasting future scenarios of their own making. Through this half-day experiential exploration students empathise with relevant stakeholders by taking up their role. This approach allows the students to stumble upon the intricacies of their scenarios and set their own creative constraints for the conceptual design phase to follow.

With a case study, based on the results of an Industrial Design Engineering Master course concerning the design of the "Future of Food", we will show how this Design of the Future methodology is able to explain the present and future interplay between society, culture and technology. We will dive deeper into how the experiences from the game sessions influenced the design phase and eventually the design concepts presented by the students.

From the results of the case study, we can conclude that our proposed method provides the students with an effective arsenal of tools to use in their design process while offering them a well-rounded experience through which to envision, empathise with, design and create for the future.

Author keywords

Scenario Exploration System; Serious Game; Scenario Development; Responsible Design; Futuring; Future Scenario Development Design methodology

Introduction

In an interconnected and ever-changing world organisations are called to overcome challenges in a fast-paced way. To be prepared for future challenges organisations need to have a level of informed foresight. As Anna Valtonen notes: "The arrival of COVID-19 implies that there will be an even greater need for us to be able to address uncertainty and align ourselves with even more radical transformations. What new practices emerge, and how design can contribute to these changes, is a discussion we have only just begun." (Valtonen, 2020, p.523). To form this new alignment, it is important not only to formulate potential future scenarios but also to succeed at understanding them vividly. This process is complex, data heavy and often-times tedious therefore a structured method can help (Daalhuizen, 2014). Especially for the novice designers that students are (Dorst & Reymen, 2004).

Design by its nature is future-oriented since we use design to envision and create things that do not exist yet. While at the same time, when a design becomes reality, it helps shape the future.

As Göransdotter has stated so eminently: "design is not only – or even primarily – about making things that take on material presence in our lives. Even more, design is about proposing that things could be otherwise. It is about proposing that we could do things differently" (Göransdotter, 2020, p.301). Design education therefore needs to prepare the new generation of designers for challenges in the future. Challenges such as the uncertainty that comes with discussing about the future and the difficulty to try and predict potential effects a design might have on a rapidly changing environment.

In this paper we propose the Future Scenario Development Design & Play methodology aimed at helping designers vividly explain the interplay between Society, Culture, Economy and Technology in the potential futures they create. To expand future scenarios to their full social, economic, and environmental implications we use a combination of scenario building, tangible exploration, and practical design. This method allows designers to interact with the envisioned futures and struggle with their challenges. In this paper we will argue that this helps in creating better/fairer/more responsible/more inclusive results and designs.

In addition to highlighting our methodology, we present a

case study, based on the results of an Industrial Design Engineering Master course concerning the theme "Future of Food".

SES & future studies

Since humanity's early times humans have learned through games and stories (Andreu-Cabrera, 2010). Even though both stories and games today are considered primarily forms of entertainment they can be powerful teaching tools. Serious games have been used in a variety of educational purposes such as mechanical engineering (Sousa, 2020), collaborative ideation (Sousa, 2021) and socio-ecological dynamics (Orduña, 2020). Methods for applying (serious) storytelling in education and design have also been introduced in recent years (Lugmayr, 2017).

The serious game used in this paper has its origins in policy making and collaboration. Created by the Joint Research centre of the European Commision, the Scenario Exploration system (SES) has been used "...to engage stakeholders with foresight scenarios created to support the EU policy-making process." (Boutoux & Bengtsson, 2016). We have made several changes to the game mechanics and philosophy to apply it in the design field while keeping in line with the role-playing and turn-based strategic character of the game.

The SES version we used in this course can be described as a way to explore focal issues in future scenarios. It is designed to help players engage in systemic thinking, discover and create alternative futures, and create novel engagements between stakeholders. In the context of this course, the SES was used as a role-playing serious game where the students/ designers had the opportunity to embody real stakeholders, discover blind spots in their future scenarios and consider the social, cultural and environmental consequences of their potential design.

At the same time the process of creating and playing a game added fun and enthusiasm in the course and allowed the students opportunities for serendipitous discoveries. We found out that students tended to empathise better with the futures they created and the people who would inhabit them, generating better insight into potential dynamics between stakeholders. Aspects such as counter-movements, friction between powers, unexpected events and social pressure were explored, painting a more realistic picture and helping them to avoid utopian/dystopian tropes.

Scenario Development Method

A scenario is a way to envision a possible and plausible future. By making different scenarios, designers can prepare for future events in an ever-changing environment (Göransdotter, 2020). The future is very uncertain, but for our design methodology it is not necessary that the future plays out in the way it is envisioned in a scenario. As Valtonen (2020) indicated, it is all about anticipating a possible future that might be radically different than our present day. A design for a certain scenario may have relevance for any kind of future. By tactically choosing scenarios, it is possible to capture, and design for, a wide spectrum of different futures.

To find these relevant, possible and plausible scenarios', a seven-step method was followed, building on the 6-step method in the Future Scenario Development Design methodology (Eggink & Albert de la Bruheze, 2015), which in its turn is an elaboration of the five-step explorative context scenario methodology (Eggink, Reinders & van der Meulen, 2009). In our continuous effort to improve the methodology. Some alterations were made in order to incorporate the Scenario Exploration System (Bontoux & Bengtsson, 2016) serious game. Together this forms the Future Scenario Development Play and Design methodology presented here see Table 1.

At the end of this process the final scenarios are presented in a visual way and one scenario is chosen to continue within the design phase. It is important to note here that the students were asked to come up with daring and thought-provoking scenarios within the confinements of their chosen focal issue and initial research.

Table 1. Future Scenario Development Play and Design methodology.

Step 1	Focal Issue	A confined theme that is relevant within the context of the given area of interest (in our case food).
Step 2	Actors & factors	An actor network of stakeholders involved in the focal issue categorised in: Policy, Business, Civil Society Organisations, Academia and Citizen groups. Relevant aspects are also outlined.
Step 3	Uncertain-ty/ Rele-vance ma-trix	A matrix mapping the actors and factors based on their uncertainty and relevance on a two-dimensional space. Items that are identified as both important and uncertain, are the building blocks for the different sce-narios.
Step 4	Strategic space	The two key long-term uncertainties are used to create a second two-dimensional space. For an example of a strategic space see Figure 1
Step 5	Scenario plots	Creation of three coherent and plausible scenarios are inspired by balanced developments and extremes in the strategic space.
Step 6	Scenario elaboration	Scenario Plots are fleshed out into full scenario narratives using the structure of three time horizons in the future, forming the basis for exploration.
Step 7	SES game session	Using materials from the 6 earlier steps an SES version is developed. Two contrasting scenarios are chosen to be explored in a 4-hour session.

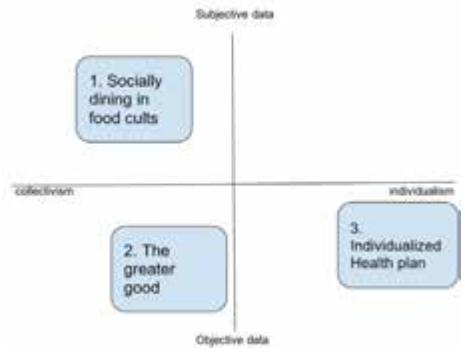

Figure 1. Strategic space example.

Game design//SES

We applied SES as a board game in order to encourage discussion and offer tangible representations of each action, resource and consequence. Yet playing a unique game for each team comes with an amount of necessary preparation. For the game/SES to be played, the outline scenarios of the game need to be created, player's roles as well as event dynamics need to be defined, and finally material needs to be printed.

Starting from the scenarios, these were adapted into three short 200-word stories representing the three time horizons and a short six-bullet summary for conciseness that could fit into cards. Next, four "explorers" (individuals leading existing organisations) were chosen to be played during the game by each of the players. Mostly, actors were chosen to represent a voice from the quadruple helix: Policymaker, Business, Civil Society Organization (CSO) and Academia. Each role has a different dynamic to play in the game, complementing each other from a broad perspective on dynamics at play in future societies. In addition, a large and existing group of individual citizens is chosen, to serve as the "public voice". One participant is assigned to express social judgement of the explorers' actions based on the biases of this group.

Finally, personas were developed for each of the 4 explorers forming a well-rounded character complete with personal information, values and professional goals. The personas were aimed at fostering empathy between the player(student) and explorer(character) as well as offering a framework based on which the player can interpret information and make decisions from the lens of the character. Using the U/I matrix, from the "important & certain region", six so-called mega trends were selected, factors that will be important in any future scenario. In addition, six what-if cards were defined, denoting large-scale events that could disrupt scenarios, to be used in case the game became stale. In addition, one student assistant was appointed for each session as a facilitator. Consecutively, 4-hour sessions were run see Figure 2. The goal of the games was to find the needs or wants of the future society and/or find an opportunity for design.

Directly after the game itself see Figure 3, a short facilitated reflective session was held per group. Making sure to summarise thoughts and get some discussion going about the long session. Events and actions taken in the game were reflected on, answering questions like: How diverse groups of people would feel during the scenario's playing out? Was this a desirable future? What could design do to influence this future, or the road towards it? In the final phase, it was up to the groups

Figure 3. SES game board at the end of a game.

themselves, using their design knowledge, to make a design set into this future.

Design Case: Future of Food

Food as a broad topic is interconnected with both nature and humanity. Therefore, on a macro level food supply also faces challenges from population increase and climate change, while on a micro level food relates to personal health, culture, lifestyle, and preferences. The future of food is therefore an excellent carrier for the investigation of the future interplay between Society, Culture, Economy, and Technology. A lot of the current and future challenges that food faces (climate change, migration, cultural shifts) are complicated issues calling for transdisciplinary collaboration aimed at transformational change.

The future of Food was investigated within the master course Create the Future. The course itself was set out as project-oriented education (Ponsen & Ruijter, 2002), arranged around the theme of Food. It lasted ten weeks and needed the workload of five European credits. The course was split into two sections: building, exploring and visual presentation of future scenarios, followed by development of design concepts within these future scenarios. Forty students took part in the course organised in eight groups, resulting in eight unique design examples from which we have selected the two examples presented here.

Design Example 1: Lokaal is Lekker (Local is Delicious)

The students chose to focus on the future of Nutrition and Health for adults in the Netherlands. The focal issue was then

Figure 2. SES game in process.

Figure 4. "Lokaal is Lekker" design.

formulated as: "How will our society evolve if global trade, mobility and large-scale food distribution becomes non-viable?".

Putting a lot of weight into availability of nutritional information, legislation, marketing, food availability and environmental factors, the students chose one of the four scenarios they developed in the course as their future context. This scenario is characterised by increased general population health and improved wealth equality in the context of a highly regulated market and full transition to local produce. In this future context a stock market crash has limited global trade and caused imported food prices to rise drastically. As a result, population growth and migration slow down while food supply becomes local. The envisioned scenario was also altered during the SES game. While an environmental crisis destabilised national food production, a community-spirit emerged from the collaboration among the explorers.

The students designed the structure of a Community-"Supermarket"-Greenhouse complex (see Figure 4 aimed at helping local communities with food independence in seven steps: Preservation of food and agricultural knowledge via a *Museum*, a *Greenhouse* for local and seasonal food, a *Community* area for collaboration and learning, *Educational* programs with experts, a *Restaurant* for tasting and gathering, a *Supermarket* offering the locally grown crops and *Delivery* for citizens with restricted mobility.

The complex aspires to be self-sustaining by integrating with the infrastructure of the community and reusing resources (such as compost, sewage and rainwater). While at the same time applying old and traditional agricultural methods such as crop rotation to preserve soil fertility.

Design Example 2: Food Delivery / Kitchen of the Future

The students chose to focus on the future of food distribution and delivery in the Netherlands. Based on the growing trend and normalisation of food delivery, attached to health and environmental challenges, the students formulated their focal issue as: "How will our society evolve if food delivery will be the norm instead of an exception?".

They chose one of the four scenarios they developed in the course as their future context. In this scenario, today's platform economy, where restaurants offer meals through a delivery platform, becomes the norm. Positioning themselves as a commodity for every family, these restaurants minimise end-consumer cooking effort while trying to preserve family-style dinners by offering family meal options. Citizens, in this scenario, put emphasis on convenience and are universally accepting of this new system. Everyday food has been industrialised, minimising food waste and optimising efficiency. At the same time cooking ability is decreased within the younger generations and is treated as a niche hobby.

Figure 5. design of "Kitchen of the Future"

The future scenario was altered during the SES session when the need for strict food quality and nutritional standards regulation became clear. At the same time, the social aspect of cooking itself and not just eating was highlighted, prompting the students to envision alternatives for the cooking experience in VR as well as in cooking seminars, similar to today's sewing or woodworking seminars.

The students designed a food delivery system along with a living space arrangement considering emission minimization, preservation of food quality in the supply chain and social structures Figure 5.

Discussion

While envisioning the future it is easy to fall into our own biases and overlook social and environmental side-effects of a design. For us to think about the future and have future-oriented discussions in a structured and informed way futuring methods are needed, despite the level of complexity and uncertainty they force us to accept. An explorative process can therefore be beneficial to fully utilise future predictions, and in that regard, we succeeded in introducing this new method to students. We managed to get them some preliminary experience with futuring methods and by extension, role-playing and explorative methods at large, so that they can apply it when they are called to design for our future.

One remaining challenge is for the students to fully immerse themselves in the scenarios, which would be advantageous to help them empathise more with the situations at hand and the people involved. Not all groups achieved a satisfactory level of immersion. Compared to other methods, like day in the life scenarios, it helped them to look at all aspects of the theme. Students depended on their teammates to embody their characters fully, therefore some teams lacked the right degree of dynamics in their play. Of course, this kind of method requires practice, and it was apparent that students who already had some role-playing experience were easier to adapt and embody their characters. Interestingly even a small amount of experience appeared to be sufficient. When the second scenario was played (about 1,5h of play) students appeared more motivated and immersed. A break in between the two time horizons, with some discussions about the flow of the game, may have facilitated this improvement.

From a practical perspective, the course had been quite intensive on academic staff resources, as for every SES session a facilitator needs to be hired for a 4-hour session plus preparation. To lessen the burden on the resources, we would like to try expanding the teams to 6 students and allow the students to self-moderate their own sessions.

In the Design Phase, students focused on a need they discovered in their scenarios after the exploration phase. In our opinion a lot more can be done with addressing the responsibility of Designers regarding their creation (Eggink et al., 2020). A design is at risk of becoming one-sided, especially when real (future) stakeholders do not exist yet (Dorrestijn, Van der Voort & Verbeek, 2014), and tools to understand the influence on people can be quite suitable. An example of such a tool that fits this method well is the Product Impact Tool (PIT), that looks at different modi of influence of designs on people (Dorrestijn & Eggink, 2014; Raub, Dorrestijn & Eggink, 2018). In addition,

there is value in looking at the social implications of introducing such a technology, to establish some kind of dialogue with future societies. A tool that would be well suited for this is Constructive Technology Assessment (CTA) (Rip, Misa & Schot, 1995; Kuhlmann, 2012). In future research, we would like to explore how together these tools can add to the Future Design & Play method to allow for a more comprehensive way for responsible future design.

Conclusion

Futuring projects are complicated and uncertain yet they are needed for us to think about the future and have future-oriented discussions. An explorative matter is necessary, and in that regard, we succeeded in introducing this new method to students.

Linking the previous six-step scenario method to the SES tool, creates a powerful way to envision the future and at the same time empathise with the stakeholders in the envisioned future situations. It allows for designing propositions that can be relevant for the future, even if the future does not play out as in the scenario. This allows designers to prepare for many futures.

The method worked to make scenarios more tangible, stretched the students' thinking and helped understanding the possibilities and uncertainties they will inevitably face.

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About utopias, apocalypses, respawning and zombies and how understanding images of space and time may inform design for sustainable behaviour

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Abstract

This paper presents justification for, and experimentation with an artistic method designed to help designers better understand how people imagine time, and connect this consciously or subconsciously to their norms, values and intentions which ultimately shape their behaviour. Four monologues were created, put on video, and a pilot experiment suggest high potential for further development of this artistic method, extending the designer's toolbox to identify points of interventions when designing for sustainable behaviour.

Author keywords

Sustainable behaviour; narratives; temporality; artistic research; performative research.

Introduction

Fuelled by a desire to expand the toolkit of design researchers beyond conventional approaches in design for sustainable behaviour, an interdisciplinary 3-year project 'Narrating Sustainability' was initiated early 2022. This project brought together researchers from design, psychology and literature studies. Internally funded with three full time researchers and three supervising professors, the project allows for, and sets out to explore interdisciplinary avenues of inquiry which may challenge more conventional disciplinary approaches. The aim of this paper is to introduce our motivations and rationale for using unconventional methods of inquiry, and provides one example of doing so.

Background

Design research is occupied with equipping designers with tools to understand complex contexts, in order to identify opportunities for interventions which can change undesirable situations into desirable ones. It draws on a range of disciplines from engineering, social, business and natural sciences as well as the humanities (e.g., Lockton et al. 2010, Zachrisson & Boks, 2012). In the past 15 years, design research has increasingly focused on sustainable behaviour and practices, applying psychological and sociological understanding of what enables or prevents users from behaving in sustainable ways, in exploration of solution spaces and design of interventions. Behaviour is shaped by normative, habitual, intentional and situational processes (Klöckner & Blöbaum, 2012), and design interventions have mostly been focused on the situational and habitual context, as these are most likely to provide concrete, hands-on and well-defined design challenges. For example, to support reducing food waste, design interventions are typically aimed at providing recipes for leftovers, designing appropriate storage units, designing apps for more conscious food purchases, and so on. However, research demonstrates quite clearly that norms and values heavily influence our intentions to behave responsibly and to make use of opportunities which facilitate interventions such as these (Pahl et al., 2014; Slovic, 2020). As Paul Slovic, preeminent researcher of risk perception in the public, has said, the strongest predictor of what someone perceives as a meaningful risk is the extent to which it stirs up emotions in them—not any quantitative markers of the extremity of said risk. In his words, "the public is influenced by worldviews, political ideologies, and values." This makes it likely (and environmental research bears out) that people often intend to act in environmentally friendly ways, but then do not always act in accordance with these beliefs. That is, they may theoretically agree that climate risk is great enough to motivate action, but in their daily life, the perception of this risk remains theoretical, and therefore does not motivate environmentally sustainable behaviours. Indeed, this constellation of norms, values, and emotions surrounding them are well-known to have impacts on human behaviour, especially when it relates to controversial, politicized topics (Kahan et al., 2012). Yet, uncovering norms and values, in particular when elements of awkwardness, embarrassment and even shame may play a role, is understudied in design research (Trondsen & Boks, 2022). Sustainability design studies in particular could benefit from such research, as it is subject to narratives about who and what is responsible, which informs and is informed by norms and values (Fausey et al., 2010). For instance, while the belief-action gap has been widely researched in environmental studies, the role of the aforementioned values, norms, and worldviews (including specific social desirability biases

which may limit the extent to which participants are able or willing to be frank about such values) has not been addressed to a large extent, in particular not in design research. In this study we intend to adhere to norms and values that we think we can or at least should be able to manage, in particular the ways we all justify non-politically correct, or unpopular opinions or actions with narrative explanations that ease the cognitive dissonance mentioned by Festinger. Festinger's famous dissonance theory (1962), has led later scholars to urge for "application of belief-system theory," via a "self-confrontation strategy to make inconsistences between values a person holds and their behaviour visible" (Grube et al., 1994, qtd. In Klöckner 2022, p. 6). Festinger famously theorized that most people will find some sort of way to bridge the gap between their actions and their beliefs, if they are misaligned. Pairing his findings with those of narratology, we theorize that people most likely use brief, aphoristic narratives to justify or explain away moments when they are doing something that does not align with their beliefs, or which may be seen as shameful or unpopular by others. We also theorize that people draw from the logic in infrastructures around them to develop these aphoristic narratives (of which, more directly). Aphorisms are short statements which attempt to package a general truth in a brief statement. Work in management theory has confirmed that a two-fold process of reflection and cognitive reframing can affect how people consider their own motivations for tasks or behaviours (Hewett, 2023). For instance, we may know it is best to sort plastics for recycling or to avoid buying unnecessary clothing items or air travel tickets. But nearly everyone at some point does not properly sort recyclable goods and does indulge in unnecessary purchases. Per Festinger, people will seek to resolve these dissonances. People may say, for instance, 'one contaminated recycling load does not affect so much', or 'no one can live without any indulgences', and consciously or subconsciously justify taking that sun-and-beach filled holiday after all.

As stated, researching norms, values, and behavioural intentions which may modulate the efficacy of sustainability design solutions, has received little attention in design research; the question whether design research can contribute to redesigning norms, values and resulting intentions seems more distant from common design research and practice – perhaps for obvious reasons. Yet, per Hewett 2023, it is the same tool of narrative which individuals appear to use to adjust their behaviours and beliefs, and find greater determination to change such behaviours. Admittedly, both the complexity and the morality connected to such topics adds a layer of complexity to any research design initiative, because not only is it hard to make change or receptiveness to information happen, but also because researchers may be limited by participants' Social Desirability Bias, or other elements of shame or embarrassment, "should-ought" thinking that may limit self-report-based investigations. Thus, while there are many limiting factors to sustainable behaviour, one that has been largely ignored so far, are the norms and values that make it difficult for people to admit—even to themselves—how they actually think, feel, or believe information regarding climate change, sustainability, and the future. This prevents change-makers such as design researchers to become informed about essential parts of behaviour-influencing factors, which compromises ideation and testing of design interventions. In short: if users will not admit that they 'cheat', are lazy, or cannot be bothered, and neither can articulate why, or why they think it is OK, designers will be ill- or even misinformed and misled when designing for sustainable behaviour.

Less conventional approaches towards user insights

Partly inspired by acknowledgement that conventional user-centred design methods may not provide a full picture, designers have in the past decade stepped away from solely using conventional product and service design, and more recently explored approaches including design futuring, design fiction (Hebrok & Mainsah, 2022), design activism (Julier, 2013), speculative design (Dunne & Raby, 2013), (norm-) critical design, and norm-creative design. (But how to see narratives explicitly as both an element of the toolbox and/or as part of solution spaces is still ill-explored. Literature (both within and outside design research) reports on many physical and digital experiments where narratives are used to create awareness, reflection and action. Such experiments contribute to expanding design for sustainable behaviour research and thereby extend the designer's toolbox by using narratives about sustainability to enable, facilitate, nudge, tempt and seduce towards desirable behaviour. But they mostly conceptualize narratives as an instrumental tool for changing behaviour, instead of an existing, given phenomenon which may have influenced more static worldviews or zeitgeists, which are in fact (as research verifies) quite difficult to shift. They may, for instance, change over time and not through a single design intervention. Thus, we argue that such impacts need to be studied as a determining, independent variable. Another common research design modality is asking participants to imagine a future they want, or to imagine the future differently. Our rationale would see such interventions as short-sighted because they do not consider that the imagination is necessarily an extrapolative force, expanding upon that what we have already been given or exposed to, and thus unlikely to bear fruitful new ideas or truly cosmologically innovative imaginings. Indeed, Cultivation Theory, long used as a standard in media studies, holds that "exposure to media messages over time fosters homogenous attitudes and beliefs about the world among frequent viewers," lending credence to the notion that asking participants to imagine futures is somewhat circular reasoning (Giacacardi, et al., 2016).

Zooming in on the temporal element in sustainability narratives

If behaviours and values are impacted by our world views, these same are impacted—indeed, limited in many ways—by the worldviews we are surrounded with in media and society. Indeed, media studies scholars, a derivative field of narrative and literary studies agree that media is a form of collective memory, and a means of renegotiating or re-shaping cultural memories (Gambarato, et al., 2022). Narrative theory would suggest, in addition, that the possible futures we can imagine are shaped greatly by the possible futures we have been shown in media. We then decided to focus on the concept of time and temporality, since imagining is, first and foremost, always a temporal exercise—whether imagining the future, or re-imagining one's past, or even imagining a completely random series of events, one is necessarily envisioning a timeline different than the one actually inhabited. Risk-analysis, too,

involves imaging consequences and outcomes in a future space based on present conditions. Since sustainability, even at an etymological level, indicates a concern with the feasibility of a set of conditions to continue safely over time—a question of risk which involves extrapolative (e.g., future imagining) considerations, we opted to explore the interaction of narratives about time upon sustainability beliefs.

Studies of climate change focusing on addressing the belief-actions gap widely acknowledge the problematics of time as a complicating factor in communicating the urgency of a problem, which is, by definition, slowly evolving—at least as far as the scalability of the human extrapolative imagination is concerned. Thus, how people perceive time plays an important role in influencing individuals' attitudes and behaviours towards climate change and other sustainability issues (Milfont et al., 2012). Perhaps the most often-mentioned temporal dimension of climate change is its extension into the future. That is, while impacts are already happening, the most significant and far-reaching impacts of climate change lie in the future, creating a distance between our lives now and these future climate change impacts (Pahl et al., 2014). This is considered to be the primary hinderance to pro-environmental behaviours in the here and now (Gifford et al., 2009). The way this distance is perceived and framed in individuals' minds is likely to vary across people (Pitt and Casasanto, 2021; Nicholson-Cole, 2005), and it can be presumed that few consciously understand how images of past, present and future affect their behaviour. Moreover, even fewer will consciously understand how they end up with such images in their heads. Researchers themselves lack specific understandings of how timescapes are constructed as spatiotemporal cognitive models (Pitt and Casasanto, 2021).

From a Design for Sustainable Behaviour perspective, it would be valuable to obtain insights on how these images come about and how they, consciously or subconsciously, affect everyday choices people make. Preliminary work has explored how individual differences in media exposure impacts pro-environmental beliefs and behaviour through interaction with the variable of future-oriented thinking (Nicholson-Cole, 2005). Because semi-structured interview design alone is subject to demand characteristic bias and social desirability bias, we believe it would be useful to study how media influence could be used to allow participants a face-saving means of pivoting or shifting their environmental beliefs. Per the scholars cited above, this would theoretically allow participants the chance to reflect upon and change spaces of cognitive dissonance causing a belief-action gap in their sustainable behaviours, and which may be embarrassing to admit or perhaps even unrecognized. This, we propose, would be foregrounded on an initial study design which further explores the correlation between such media consumption and belief formation in the first place. With such insights, designers could create interventions that potentially unlock thought and value patterns in users' minds, and thus open up for design strategies which stimulate sustainable behaviour or avoid unsustainable ones.

Introducing our experimental approach

This article proposes an approach which explores if and how explicit visualisations and interpretations of how 'time works' can make people realise how their own conscious and, so far, subconscious perceptions of time and space affect their beliefs and the choices they make. What if people subconsciously believe that utopian or dystopian futures, or futures based on disconnected, alternative realities are unavoidable and behave accordingly? If a utopian future is to happen anyway, but to be preceded by an apocalyptic event, why would one behave sustainably now? What if the popular video game notion of respawning subconsciously enables people to believe in the infinite restorability of the coral reefs, rainforests, and the ozone layer, and belief that any climate crisis can be "fixed" by starting over from a safe back-up? These questions are explored by linking a typology of space and time interpretations to personas which will help people to identify their mental models of space and time and how they affect their behaviour in relation to everyday choices and their effect on sustainability. Using a conventional design research approach would imply using for example interviews, focus groups, cultural probes and diary studies to probe and identify temporality aspects of sustainability narratives 'that people think are out there and may have an impact on them'. Then, it may be followed by developing personas to help respondents recognize which one they identify with and what temporal understanding of the world they have in relation to sustainability challenges. But because of the above explained expected lack of imaginative capabilities, we wanted to approach the problem from a more performative, artistic, and retro-engineered perspective. We decided to ask, not what participants can imagine on their own, but to enable them to reflect on how their imaginative processes may have already been shaped by the imaginative possibilities afforded by the media diet around them. So, rather than asking participants to draw on their own, by-definition limited imaginative capacity, or extracting new imaginative possibilities from already marginalized groups, we sought an approach which allowed experimentation with exploring, as others have sought to do, how scalar (in temporal, spatial, and personal realms) imaginaries are limited by narrative affordances in the environment, which we hypothesize make up a large proportion of the cultural zeitgeist which people are influenced by and add influence to. We hypothesize that streaming media today, which has become a nearly ubiquitous pipeline of TikTok filters, binge-worthy fantasy-scapes, and competing narratives of "fake news", must have an effect on what, how, and how far people can take their imaginings. So, in seeking an ethical means of testing these narrative bounds at their limits, and find out what humans are capable of imagining (or are limited in their imagination), we turned to a readily available reality-pushing-but-hegemonic discourse: science fiction and fantasy tales on streaming media.

Developing monologues of temporality

So, instead of using conventional user research to collect potential ingredients for 'sci-fi and fantasy-based narratives of temporality in relation to sustainability crises', we used a more artistic approach to create these. Using our expertise in media studies, social narratives and sustainability research, we co-wrote four different monologues, and recorded videos with the same actor speaking out these monologues in an informal kitchen setting: The Matrix video, The Star Trek video, The Groundhog Day video, and The Zombie video, each incorporating two different ingredients: aspects of temporality, and emotions (Figure 1).

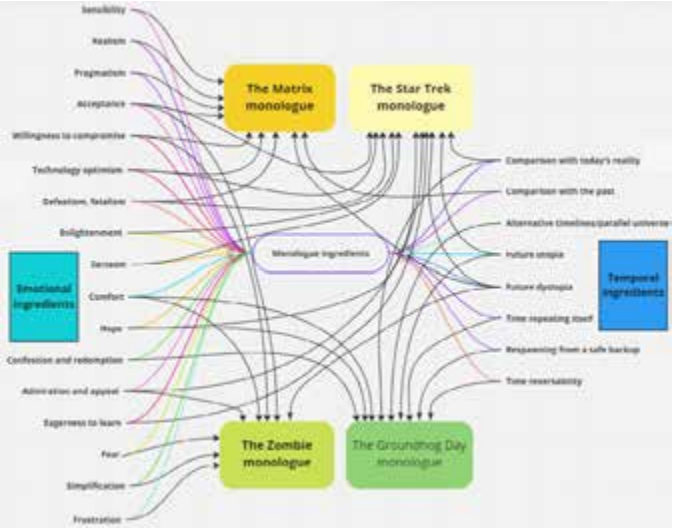

Figure 1. Emotional and temporal ingredients for our four monologues

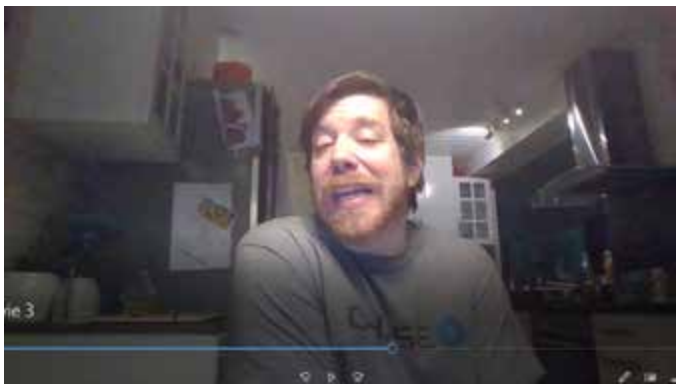

Figure 2. Still from a video

Each monologue also contained an element of self-criticism, like *'I know I probably sound weird'*, a fallacy or element of cognitive dissonance *'I know it doesn't make sense, but still, if you think about it...'*, as well as a comment in the vein of *'I think many people think like me'*. Dramaturgical clues in the scripts helped the actor to act in the exact intended informal style, resulting in 4 videos in which an 'average Joe' casually yet somewhat embarrassed 'admits' his personal views, and reflects a bit on what other might think of that (Figure 2). A questionnaire was developed to measure the impact of the videos on the audience, and to assess the validity of this sort of research design. Thus, the questions asked about how participants felt during and after viewing the videos, and framed quantitatively and qualitatively in tandem, for each question. Next, In a pilot experiment, a small sample (n=12) of master students in the Department's Sustainability Transitions course were shown the 4 videos and then asked to fill out the questionnaire. The results revealed several interesting avenues for further study and further iteration of our research design. Very few differences were seen between discourse analysis of qualitative versus quantitative responses in the survey. Similar levels of irritation or frustration were shown in response to each video, as was true for feelings of solidarity (i.e., feeling agreement with the perspective shown), vicarious embarrassment for the speaker, and reassurance. The main difference in reactions was shown in terms of what opinions viewers felt recognition in relation to (i.e., having seen others with these opinions), which was quite high for two of the videos. The Matrix-inspired video, which emphasized a future-scape in which alternate reality technologies provide simulated satisfaction with life but also emphasized trust in such technology to help us accepting effects of climate change. The second video which was highly rated as a "recognizable" perspective involved influence from video games such as Minecraft, and partly inspired by the movie Groundhog Day. This video emphasized the notion that we can redeem the errors of the past with "do-overs," much like respawning or reloading from save points in video games, where an element of forgiveness or a clean slate is built into platform modalities.

While viewers did not rank The Matrix video as indicative of their own beliefs the majority of the time, instead labelling this a view they had seen in others, they also frequently labelled it as "what would be best for the planet," and "what would be best for mankind," as well as "what would be most moral (according to your own values)". This may suggest that while viewers do not necessarily consciously recognize their own beliefs in a narrative (and are instead more likely to say "others" have that belief, or that it is familiar but not personally held) they nevertheless reveal subconscious alignment with these beliefs, but a lack of awareness that they themselves ascribe to it. This is shown by the divergence in "solidarity" (I have felt this way) responses with the "this would be best for..." series of responses. Intriguingly, this majority selection of The Matrix video as the top choice in the "this would be best for..." series itself diverged only when participants were asked what they felt would be personally best for them and their families, in which case they chose The Star Trek narrative about working together to build utopias. At the very least, this suggests further cognitive dissonance and directions for further research, as there seems to be a distancing of what participants feel is their personally held belief and what they deem to be the most positive narrative for them.

Conclusions

Our pilot experiment suggests that exposing respondents to these videos allows for new ways of inquiry which may uncover new insights relevant for Design for Sustainable Behaviour. Colleagues and friends from a wide variety of disciplinary backgrounds also enthusiastically responded to the videos. They saw immediately the potential of having an anonymous person articulate narratives and using this to evoke responses and reflections from respondents, once they are shown these videos. They intuitively seem to "get" that these videos addressed a wide variety of research design "blind spots" necessitated by the norms of each of our disciplines. Seeing another person 'somewhat inarticulately' articulate thoughts and opinions, which may or may not reflect an informant's own responses, may contribute to probing and understanding how people create images of how 'things work', and where those images come from. Supported by these positive responses, we see several future research opportunities, including:

- Using larger sample sizes to allow for statistically significant results based on analysis of both qualitative and quantitative responses to the survey.
- Creating new sets of monologues addressing other elements of sustainability narratives beyond the time aspect, and/or focused on specific themes such as climate crises, resource efficiency or consumerism. Pending further investigation, monologues such as

these could be an increasingly large "toolbox" for designers to implement in exploration of a range of topics.

- Experimentation with different formats of exposing respondents to monologues, such as using social media, public interventions and/or theatre settings), and with different forms of collecting feedback (surveys, interviews, group discussions).
- Using larger sample sizes would allow us to better assess this homogeneity of variance and parse out the relationships between self-recognition or lack thereof in viewers.

It is our hope (and expectation) that our unconventional, partly artistic and performative research design may, once refined, extend the (design) researcher's toolbox and reveal new possibilities to identify intervention points towards designing for sustainable behaviour.

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Digital Futures/Hybrid Reality

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Introduction

> 'The danger isn't that AI destroys us. It's that it drives us insane'
>
> — Jaron Lanier [1]

While our preparations were running, generative AI systems such as ChatGPT and Dall-E suddenly headlined and underlined a new era of fear and hope. As the quote above of a prevalent virtual reality pioneer underlines, this requires a critical mindset with a passion for innovation. The Metaverse, 3D printing, artificial intelligence, and similar phenomena are re-shaping the role of the designer: a novel skillset and attitude is required to convert these digital capabilities into valuable tools and methods. This might require defining types of cyber-physical or augmented craftmanship, not forgetting about sustainability, social inclusion, and aesthetics. Furthermore, how can we ensure that the human (both collective and individual) stays in the driver seat, while political and economic agendas complicate a true human-centered design in times of industry 4.0, algorithms, distributed data, fuzzy intellectual property, and so forth.

For this track we received over 167 proposals that, after a double-blind review, resulted in 37 high-quality papers and 11 posters. These contributions go beyond the technical, to envision the capabilities of software/hardware as a meta-medium, with specific applications for the creative industry, and to frame the educational/ethical challenges in case studies and reflections.

The section ***new crafts and craftspeople***, revolves around the intersection of craft and digital immersive technologies, exploring hybrid workflows and production processes for creating augmented textile artefacts and fashion-tech products. The papers discuss learning experiences and experiments in digital fabrication, as well as the design of hybrid workflows and business models to engage with Industry 4.0 technologies in craft production.

Research through design in the cyber-physical era deals addresses the integration of technology with music-making and human-computer interaction in designerly ways, exploring physical interactions and sensory experiences in the design of digital products, and rethinking traditional paradigms of disability and the body in relation to technology.

The section entitled ***redefining the role of designers***, explores the intersection of computational thinking, design, and fabrication in creating augmented and accessible museums. The papers cover a range of topics such as co-creating 3D materials with synesthetic AI, speculating futures in an age of nostalgia, and the use of cabinets of curiosities to explore collections and tokens in the postcolonial context. The papers highlight the potential for technology to enhance the museum experience and promote inclusivity, while also addressing the challenges and complexities of curating collections and representing diverse histories.

The section ***usability and performance of innovations*** addresses the importance of evaluating and asessing new designs, with an increasing role of technology in enhancing learning, work, and shopping experiences.

Design for and with extended reality focuses on the intersection of immersive technologies, creativity, and materiality. This includes applications such as virtual reality and the metaverse, for creative expression and communication. The papers explore how these technologies can be used to assist in ceramic creation, stimulate storytelling and communication competencies, and introduce the concept of material experience in virtual environments. Additionally, the theme also touches upon the purpose of furniture in the metaverse.

The section ***design for and with digital fabrication*** provides new insights towards design methods and techniques in the field of additive manufacturing (AM). The papers also highlight the importance of knowledge transfer and collaboration in advancing the commercialisation of AM. Additionally, there is a focus on the use of new materials and technologies in the design process, such as electronic textiles and circular design materials. Finally, the papers address the impact of automation and technology on traditional craft practices.

1 https://www.theguardian.com/technology/2023/mar/23/tech-guru-jaron-lanier-the-danger-isnt-that-ai-destroys-us-its-that-it-drives-us-insane

The digital on an urban scale covers exploration and design of urban spaces in the context of technological advancements, particularly in the realm of smart cities and extended reality. They examine the relationship between technology and urban environments, exploring concepts such as data activation, engagement, and the use of 5G technology to create smart product-service systems. The papers also address the need to rethink traditional notions of urban planning and design, to create more flexible and adaptable urban spaces that can respond to the changing needs of communities.

The section ***technology-driven design education*** covers new insights in the integration of technology into design education, specifically AI and virtual reality, as well as the need for collaboration and interaction in the design process. The papers also touch on the evolving role of designers in a technology-driven world.

Finally, the common themes of the section ***digital fashion*** are sustainable fashion, the use of digital technology in fashion, and the evolution of fashion into the virtual space of the metaverse. The papers explore the potential of digital twins, media technologies, NFTs, and direct-to-avatar retail experiences to improve sustainability, design knowledge, and customer engagement in fashion. They also discuss the challenges and opportunities of deconstructing materiality in fashion and creating new forms of value and expression in the metaverse.

Apart from these academic papers, we hosted workshops, posters, and this time also a curated collection of lecture/performances featuring cyber-physical artworks. We Thank the authors and reviewers for their hard work and hope that this set offers a new chapter to Cumulus, to provide a guide to move from traditional design and heritage to critical integration and convergence.

Fashion craftsmanship 4.0: learning experience about industry 4.0 technologies for hybrid digital fashion-tech products, processes, and business model design

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Abstract

The European fashion craftsmanship sector is renowned worldwide for its excellence and competitive value in producing tangible and intangible cultural heritage (ICH) in creative practices and material artifacts. However, the competition of mass production at lower costs and the increasing jobs digitalization threatens the survival of fashion craftsmanship knowledge. In this context, Industry 4.0 (I4.0) technologies could become a trigger to transform fashion craftsmanship by hybridizing workflows via new tools, gestures, and creative acts. Due to a technological and socio-cultural divide between the old and future generations of fashion craftspeople, new educational models are necessary to update the skills and imagination of future fashion professionals towards the revival of crafts ICH while accounting for holistic multidimensional sustainability. Therefore, the paper presents an interdisciplinary challenge-based learning experience conducted at Politecnico di Milano and University of Borås, combining a design and business management methodological approach to deliver Fashion-Tech proofs of concepts (covering product, service, process, and business model innovations). Delivered proofs of concepts demonstrate the potential of I4.0 technologies to preserve cultural diversity and local heritage, improve multiple dimensions of sustainability, and empower creativity and connectivity between different stakeholders. New products, services, processes, and business ecosystems of hybrid fashion craftsmanship can contribute to interdisciplinary learning spaces where different users/stakeholders connect and engage in co-creation and co-learning activities. Besides, the developed educational model can be applied to training fashion craftspeople 4.0.

Author keywords

digital design; digital fabrication; fashion craftsmanship 4.0; education for Fashion-Tech; sustainability.

Introduction

The technological and socio-cultural divide between old and future fashion craftspeople is nowadays impacting the lack of generational turnover and the preservation of intangible cultural heritage (ICH) in the Italian and European fashion craft sectors. The meaningful application of Industry 4.0 (I4.0) technologies via new educational models could bridge this gap by enabling digital literacy, the connection of stakeholders, and the pursuit of environmental, political, cultural, and socio-economic sustainability. The paper presents the results of an interdisciplinary learning experience and discusses the implications of training future professionals in the hybrid (i.e., analogue/digital) fashion craftsmanship sector, focusing on creativity and collaboration.

Literature review

Traditional and future fashion craftsmanship at risk of extinction

The European fashion craftsmanship sector is recognized for its quality, creativity, and competitive economic value in producing cultural content embedded into creative practices and material products. European (e.g., Italy, France, Germany, Spain, Portugal) fashion micro-enterprises of craft-based high-end personal goods (e.g., textile and clothing, jewellery, eyewear, and leather goods accessories) represent 74% of the global value of these products (EC, 2023a). In particular, the EU textile and clothing craft sector employs 1.5 million people and produces a turnover of €147 billion (Euratex, 2022); meanwhile, about 36K enterprises generating a turnover of €48 billion and employing around 435K people produce leather crafts (EC, 2023c). Fashion craftspeople inherit and preserve the knowledge, expertise, and skills of crafting unique and excellent artefacts as Intangible Cultural Heritage (ICH), being custodians of traditional expertise situated in specific territories and communities (UNESCO, 2003). However, the competition of global mass production at lower costs, the delocalization of manufacturing to places with cheaper hand labour, and the spreading digitalization are forecasted to cause a shortage of traditional fashion and textile artisanal experts across the operational, technical, managerial, creative and scientific sectors (ETP, 2016). Passing the tacit artisanal knowledge through the familiar entourage and on-the-job learning practices inside workshops further

reduces the number of available expert craftspeople in the fashion sector. For example, in 2013, Confartigianato Imprese predicted an unexpected death of Italian craft entrepreneurs, specifically in the sector of design, fashion, and personal luxury items (e.g., leather, footwear, clothing, and jewellery), thus impacting the decrease of 'Made in Italy' economy by 9.1% (Bonfanti et al., 2015). Since the fashion craftsmanship sector is a significant asset for economic, cultural, social, and environmental sustainability, the European Commission primarily focuses on revitalizing European urban and rural areas by nearshoring the craftsmanship processes toward a feasible and resilient governance of a post-emergency society (EC, 2023b).

Exploiting digital technologies toward fashion craftsmanship 4.0

To stay competitive against mass globalization and production, small and local artisanal enterprises could exploit I4.0 technologies to develop highly customized products through on-demand production at fair and competitive prices on the market, while increasing product uniqueness and quality. In addition, they can become a trigger for encouraging new generations of artisans' to produce new crafts through new workflows aided by I4.0 technologies, thus hybridizing traditional practices towards a systemic paradigm change in the fashion ecosystem (McCullough, 2015; Bertola and Teunisen, 2018). I4.0 technologies could also help digitize traditional fashion crafts gestures and processes, translating the intangible fashion knowledge into teaching materials to incentivize mutual learning between humans and technologies, thus nurturing the future generation of fashion professionals in old craft sectors (Casciani and Vandi, 2022). Besides, studies demonstrate that I4.0 technologies define new relationships between artisans and technologies, particularly in assisting or augmenting daily manufacturing tasks toward operators' health, well-being, and safety (Burden, Donovan, Caldwell, Teixeira, 2022). However, the digital transformation in Italian fashion crafts enterprises is still far from a mature reach, with 9.5% in the eyewear sector, 5.8% in jewellery, 14.2% in the clothing and apparel sector, 8.4% in textile, 1.6% in footwear (Digital Manufacturing Lab, 2018). The main constraints for this limited adoption from Italian and European fashion crafts enterprises are the inadequate knowledge about I4.0 technologies' opportunities which is related to a different business strategy and culture of the enterprise, the lack of internal/external competences, constrained financial resources, and the difficulty in identifying the right partner to drive the digital transition (Digital Manufacturing Lab, 2018; Kusters et al., 2017). Adopting I4.0 technologies represents a complex challenge for the present craftspeople with limited digital skills across engineering, design, and business management domains (Jimeno-Morenilla et al., 2021). The advantages of embracing digital technologies in fashion craft-based workflows rely on boosting products' quality and exclusivity, improving working conditions, increasing productivity and efficiency, and reaching sustainability. From a cultural perspective, digital technologies could help revive the crafts communities and maintain cultural diversity and local identity (Brown and Vacca, 2022). Despite this, craftspeople face sociocultural barriers toward I4.0 technologies in terms of expectations, reluctance to use, perceived lower quality of implemented crafting processes, and fear of the complete automation of work towards the disappearance of artisanal practices and job loss (Mosca and La Rosa, 2019).

Training future fashion hybrid craftspeople

The shortage of craftspeople and associated skills and knowledge in the fashion sector is expected by 2030 (ETP 2022) due to a huge turnover of employees after the retirement of highly specialized artisans. Besides, fashion craftspeople face the challenge of adapting their workflows to respond to the green and digital economy transition, with the conflicting demand of focusing on retaining existing competencies, and attracting new talents (ETP, 2022). Hand-based craftsmanship has lost its attractiveness and safety with a consequent decrease in interest by a younger generation of professionals. However, research has forecasted a future scenario of fashion industries in 2030 focused on the Renaissance of the Crafts regarding production, employment, required skills, and competences (Skills 4 Smart TCLF Industries 2030, 2022).

The intergenerational technological and socio-cultural gap between old and new fashion craftspeople should be mitigated to preserve and transmit the fashion craftsmanship ICH through digital literacy provision to the older generation of artisans, meanwhile incentivizing the interest of the younger generation to hand-based craftsmanship hybridized with the use of I4.0 technologies. New educational models aim to achieve the aforementioned objective and to drive the digital transformation and sustainability of the European fashion eco-system, preserving both specialised traditional skills while advancing the new ones relevant to the digital evolution of the sector (Bertola and Vandi, 2021; Digital Education Action Plan (2021-2027), 2021; Unesco, 2017). Besides, new educational models should also foster the encounter of traditional and future craftspeople, supporting collaboration and peer-to-peer learning and education. In this direction, a series of piloted learning experiences (LE) have already suggested that innovative proof of concepts of sustainable Fashion-Tech solutions could be enhanced by the use of a challenge-based learning (CBL) approach, by combining design and business model perspectives (Casciani et. al, 2020; Casciani and Colombi, 2022; Ma, 2022;). In the CBL approach, students face real-life and multidimensional problems involving social, cultural, economic, technological, and environmental dimensions and are encouraged to formulate their solution by collaborating with different stakeholders involved/affected by the process or solution, thus allowing the connection between students, teaching staff, professionals, technologists, researchers, and artisans (Nichols and Cator, 2009; Nichols et al. 2016). Due to the complexity of the real-world challenges, the CBL approach supports the connection of knowledge among different disciplines, resulting in sharing common glossaries, and perspectives toward the synergistic integration and modification of disciplinary contributions. Hence, education is crucial to maintain, and valorise fashion craftsmanship ICH by cultivating and nurturing future fashion professionals that combine digital skills while preserving the traditional material and manufacturing competences.

Methodology

The paper presents an international and interdisciplinary LE conducted by Politecnico di Milano and University of Borås collaborating to train the hybrid fashion professionals of the future with soft skills, technical/digital, and subject-specific skills while boosting integration between the human, so-

cio-cultural, and economic perspectives. The LE focused on the implementation of the more operative I4.0 technologies such as 3D printing (3DP), 3D scanning (3DS), laser cutting (LC), collaborative robotics (CR), virtual and augmented reality (VR/AR) in the design of new craft products/systems of products, new hybrid digital crafting processes, and new business models that also account for a multidimensional perspective of sustainability. By coupling design-driven and business management innovation perspectives inside an interdisciplinary action-oriented pedagogical approach, we aimed to encourage a positive and culturally meaningful paradigmatic shift, bringing students closer to crafts and craftspeople and preserving and enhancing traditional practices through digital transformation. The combination of design and business model innovation education is crucial to support the possibility of achieving a real and fruitful digital transition in the fashion craftsmanship sector (Jin & Shin, 2021). Focusing on the comparison between pre- and post-course skills self-assessments, derived from the answers from the questionnaire and by the analysis of the LE results such as proof of concepts and group project reports, the paper aims to discuss the impact of the piloted educational models for the fashion crafts' digital transformation towards sustainability. In particular, this study intends sustainability as a holistic multidimensional concept entailing environmental, economic, social, and cultural dimensions (Fletcher, 2014; UCLG, 2010; British Council, 2020).

LE design: developing collaboration, toolkit, and educational methodology

Growing interdisciplinary Fashion-Tech partnerships

The LE has been offered to 21 international and interdisciplinary students (76% female, 19% male, 5% non-binary gender) from graphic design (5%), product design (21%), fashion design (52%), architecture and landscape (10.5%), and business management (10.5%). They worked in 5 interdisciplinary groups mentored by 2 academic researchers/teaching staff from the involved Universities and 2 professional tutors from a Fashion-Tech start-up focusing on digital transformation, and non-standard fabrication technologies (Materea). The company participated actively in the LE design, delivered technology-focused lectures as expert trainers, and mentored students during the CBL phase. Students were asked to select one between five different applications of the fashion craftsmanship sectors (jewellery, textile and clothing, small and medium accessories in leather, footwear, and eyewear) since these sectors are at the forefront of Italian fashion craftsmanship (Bonfanti et al. 2015). Students were expected to focus on specific historical craftsmanship expertise and techniques with no geographical boundaries. However, being asked to include the craftspeople of the selected applications in the research and design processes, many focused on the Italian geographical context because most students were based in Italy. However, the LE allowed for a broader geographical scope/context to account for international students' interests and competences. In particular, some students focused on fashion craftsmanship in the Far East and Asia. Students have developed solutions such as low-fidelity prototypes, visualizations of workflows, and mock-ups of designed solutions, tools, and software. These outputs were shown to the stakeholders to test and provide a reality-check of the proposed proofs of concepts (PoC). Craftspeople were surveyed (7) and interviewed/observed (11) during their activities and were confronted with the hybridized crafted processes. Targeted final consumers were interviewed (12) and surveyed (78) to define needs and feedback in relation to the proposed hybridized crafted solutions.

Setting connected learning workspaces

The LE was delivered through 13 digital lectures divided into an initial theoretical part (DISCOVER), providing basic knowledge on design, methodology, engineering, and business management topics, and followed by a CBL part (DESIGN). It was aided by a system of educational tools providing an individual personalised learning path, such as Fashion-Tech Open Educational Resources (OER, 2022), and digital collaborative visual boards structured on MIRO to aid the communication, interdisciplinary exchange, collaboration on design activities and project management, toward a sharing of disciplinary glossary and methodologies, and asynchronous and synchronous interactions. OERs were focused on levelling the knowledge for students of different backgrounds to easily drive the CBL. Collaborative visual spaces were useful to both set up the activities, control the progress through the course timeline, and set a fruitful partnership between the instructors and learners as co-researchers/designers of the solutions during mentoring activities.

Joining design and business-driven innovation methods toward sustainability

To conduct a digital LE, a user-centred design approach combined with principles of design for sustainability/circularity and sustainable/circular business model (BM) innovation perspective was decided (Fig.1). User research aimed to understand craftspeople workflow, activities, tools, materials, needs, and challenges in integrating I4.0 technologies. This was complemented with final customer research to delimit main market segments for hybrid fashion craft. In addition, students focused on sustainability strategy, starting from the project groups' vision, mission, and core sustainability values formulation and then connecting it to specific Sustainable Development Goals (SDGs). Subsequently, the hybrid systems of product, process, and business model concept ideas were conceived, integrating research of available digital technologies adaptable in the fashion craft sector. Simultaneously running the product, process, and business model conceptualization stages aimed to facilitate the systemic interdisciplinary approach toward sustainability within the project teams. According to students' reports and evaluations, this allowed for a number of iterations and simultaneous adjustments of ideas that were detailed and visualized with low-fidelity mock-ups to be tested and validated with users (artisans + customers), thus providing a further design iteration (Fig.1).

LE results: hybridizing fashion craftsmanship practice through education

Hybridizing crafts system of products, processes, services, and business models

Implementing I4.0 technologies in students' solutions of hybrid systems of products, services, processes, and business models influenced the redefinition of fashion design, production,

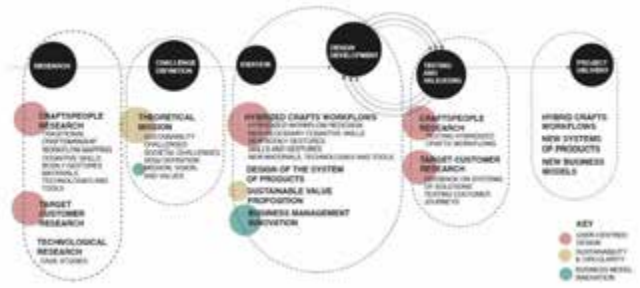

Figure 1. LE workflow from research to project delivery, blending design, and BM education

and consumption logic by challenging existing unsustainable models while attempting to preserve fashion craft ICH (Fig.2).

Students have developed 5 proof of concepts (PoCs) focusing on purely hand-based craft sectors (e.g., jacquard crocheting, stringing beads, hat weaving) and hybrid sectors already using technologies in some parts of the manufacturing processes (e.g., eyeglasses and dress shoemaking). In the latter, they focused on niche artisanal products, still very traditional and based on manual workflows.

PoC1 aims to preserve the jacquard crochet legacy by customizing the design of bags and small accessories, empowering international artisans with digital technologies to parametrize the design phases and augmented tools with sensors that amplify and extend their gestures. An online configurator allows product customization, and direct connection between artisans and customers, aiming to promote awareness of the crafts' tradition amongst the general public. PoC2 develops personalized advanced modular and long-lasting Italian dress shoes, augmenting traditional workflows of perfect fit and personalization with 3D scanning and Virtual Reality (VR) try-on technologies on a digital online configurator. The repetitive and cyclical activities of material cutting are aided through 3D printing and laser cutting, while the assembly is through collaborative robots. PoC3 develops 3D-printed interlocking beads made from recycled filaments, improving the efficiency and operability of international craftspeople during the beads stringing process, while allowing beads customization via simplified parametric digital configurator and VR try-on. PoC4 focuses on customized headwear weaving, combining the precision and speed of laser cutting with the uniqueness of traditional Vietnamese crafts techniques, thus promoting local economic development and customer personalization via head scanning and an online configurator. PoC5 creates a digital platform to connect a network of artisans able to offer sustainable and fully traceable glasses made of recyclable materials, thus offering a service of disassembly, repair and renovation throughout Italy, to extend the life cycle of glasses while allowing a customized artisanal work through face scanning, digital design, and fabrication.

Similar solutions are already present in the activities of researchers and design practitioners working on creative experimentation and co-creative practices, investigating the interaction between humans and robots (Ugur, 2020; Performative robotic micro-factories, 2021), humans and digital fabrication (Pistofidou & Olmos, 2019; Morpurgo, 2017) to design hybrid crafts workflows and new solutions. Several examples exist in using online configurators for on-demand design and purchase of fashion products (Nervous Systems, 2023; Nike by you, 2023) and craftspeople networking platforms (Italian Artisan, 2023) strenghtening alliances to better reach the market. Interesting processes and solutions for highly manual-based craft sectors such as knitting (Rosner & Ryokai, 2010), crocheting (Smith et al. 2015), embroidering (Flanagan & Fraietta, 2019), and beading (Nicholas et al. 2022) have already explored the possibilities of using I4.0 technologies for detecting, archiving, and teaching traditional crafts expertise, meanwhile creating more accessible data to be passed to future professionals.

Embedding multidimensional values of BM innovation and sustainability

Interweaving traditional artisanal processes with technologies toward multidimensional sustainability dimensions, the

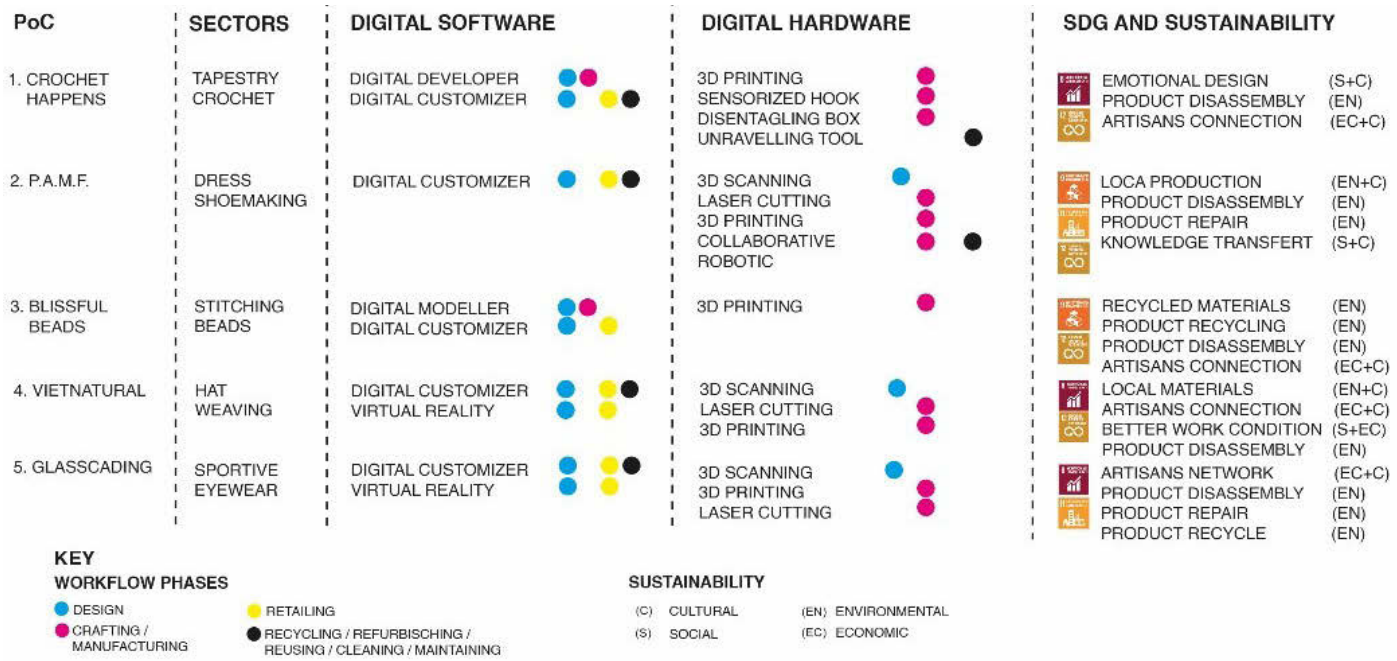

Figure 2. Hybrid sustainable fashion-tech solutions PoCs

PoC	CUSTOMER VALUE PROPOSITION	MARKET APPROACH	VALUE CREATION APPROACH	VALUE CAPTURE / REVENUES	BUSINESS MODEL TYPE
1. CROCHET HAPPENS	customizable crochet bags for self-expression, emotional durability, responsible consumption based on products uniqueness and process transparency	**narrow differentiation** (focus on limited range of customer segments and product differentiation)	. direct interaction of artisans with customers via customization and transparency services on digital platform allowing to follow production process in real-time; . increased efficiency of complex artisanal tapestry crochet process by enabling simpler, and less wasteful on-demand production	. Product sales via digital and physical channels where price is calculated based on degree of customization; . repairing service and online advertisement fees	**Limited product and market portfolio model** (providing some range of customization options of the products for specific customer segments) **to slow resource use by extending product lifespan.**
2. P.A.M.F.	Hyper-personalized (on individual measurements) dress shoes with focus on high quality long-lasting performance and emotional durability enabled by caring and upgrading services to meet different seasonal, functional and aesthetic customer needs	**Broad differentiation/ mass customization** (focus on broad customer base and product differentiation)	. On-demand local personalized production where customer is involved in value co-creation during production and use phase (via post-sales upgrading services); . digital technologies augment traditional artisanal process allowing for better working conditions, improved productivity and customer service	. Product sales via digital and physical channels where price is calculated based on degree of customization; . repairing service and online advertisement fees	**Extended product and market portfolio model** (providing broad range of customization options of products and services for broad customer base) **to slow resource use by extending product lifespan.**
3. BLISSFUL BEADS	Customizable beads and jewelry designs with focus on creativity, self-expression and sustainability (e.g., by using post-consumer and recyclable materials as input resources)	**Narrow differentiation** (focus on one specific customer segment and product differentiation)	Users engagement in co-design and artisanal workshops activities, quicker, easier, more creative and cost-efficient beads production and jewelry assembly process	Physical and digital product sales enabled by virtualization of design process, workshop fees	**Extended product portfolio model** (wide range of customized beads/jewelry designs for one specific customer segment) **to close resource loop by using post-consumer and recyclable materials as input resources.**
4. VIETNATURAL	Custom-tailored headwear enabling self-expression, uniqueness and sustainability (e.g., by supporting crafts sector, enabling less wasteful production and promoting use of bio-based input materials)	**Narrow differentiation** (focus on limited range of customer segments and product differentiation)	On-demand local personalized/customized production, 3D design file sent directly to manufacturer, digital platform connecting artisans, designers and customers enables more simple, faster and less wasteful artisanal production	Physical product sales (hats and repair kits), customization fee, repairing service fee	**Limited product and market portfolio model** (providing some range of customization options of the products for specific customer segments) **to slow resource use by extending product lifespan.**
5. GLASSCADING	Custom-tailored high quality sustainable glasses from fully traceable materials including the product renovation services during the use phase	**Narrow differentiation** (focus on limited range of customer segments and product differentiation)	Product and accompanying renovation services (e.g. maintenance, repair) are provided by the network of artisans connected virtually together and with customers via digital platform, artisanal process is enabled by knowledge-sharing, digital upskilling (education on use of digital technologies, e.g. laser cutting), improved flexibility and lower cost in production and services provision due to use of complementary resources/capacities	Subscriptions	**Limited product and market portfolio model** (providing some range of customization options of the product and services for specific customer segments) **to slow resource use by expanding product lifespan.**

Figure 3. Business models typology of PoCs

solutions encompass different types of value creation: (i) emotional values via increased transparency and storytelling about craft processes, products, and artisans themselves; (ii) cultural value of preserving and spreading the craft ICH; (iii) sustainability/circularity improvements extending product use, and offering repair and recycling services; (iv) increased efficiency, visibility and thus competitiveness of small artisans and their products/services in the mainstream fashion market; (v) customization/self-expression opportunities for to final customers' engaged in co-creation with artisans/designers; (vi) connectivity enabled by technological tools. To monetize the developed hybrid craft solutions, the suggested business models focus on combining products and market portfolio models (e.g., different customized product offerings target different market segments) while aiming to slow resource use and close material loops. These models are acknowledged as part of the digital transformation of creative industries (Feng 2020). Traditional revenue streams based on product sales are complemented by customization, repair, and after-sales support services, whereas one of the suggested business models is subscription-based. More details on the BM typology of PoCs are presented in Figure 3.

Encoding hybrid crafts workflows in new workshops through augmented tools

All projects configured new sustainable and hybrid manufacturing workflows reflected in the design of customised digital software, augmented tools and hardware, workbenches, and spaces to conduct and streamline hybrid crafts activities, representing the affinity between craftspeople and their work environment/material organisation (Oxman, 2007). They supported the design, manufacturing, selling, and repairing phases, establishing a good encounter and negotiation between hand and digital dematerialized activities. The proposed tangible tools augmented with technologies were designed to offer the artisans functional performances, strengthening manufacturing activities in terms of dexterity, process simplification, and gestural digitalization to record crafts activities and encode them to assist craft planning and training. Tools ranged from the

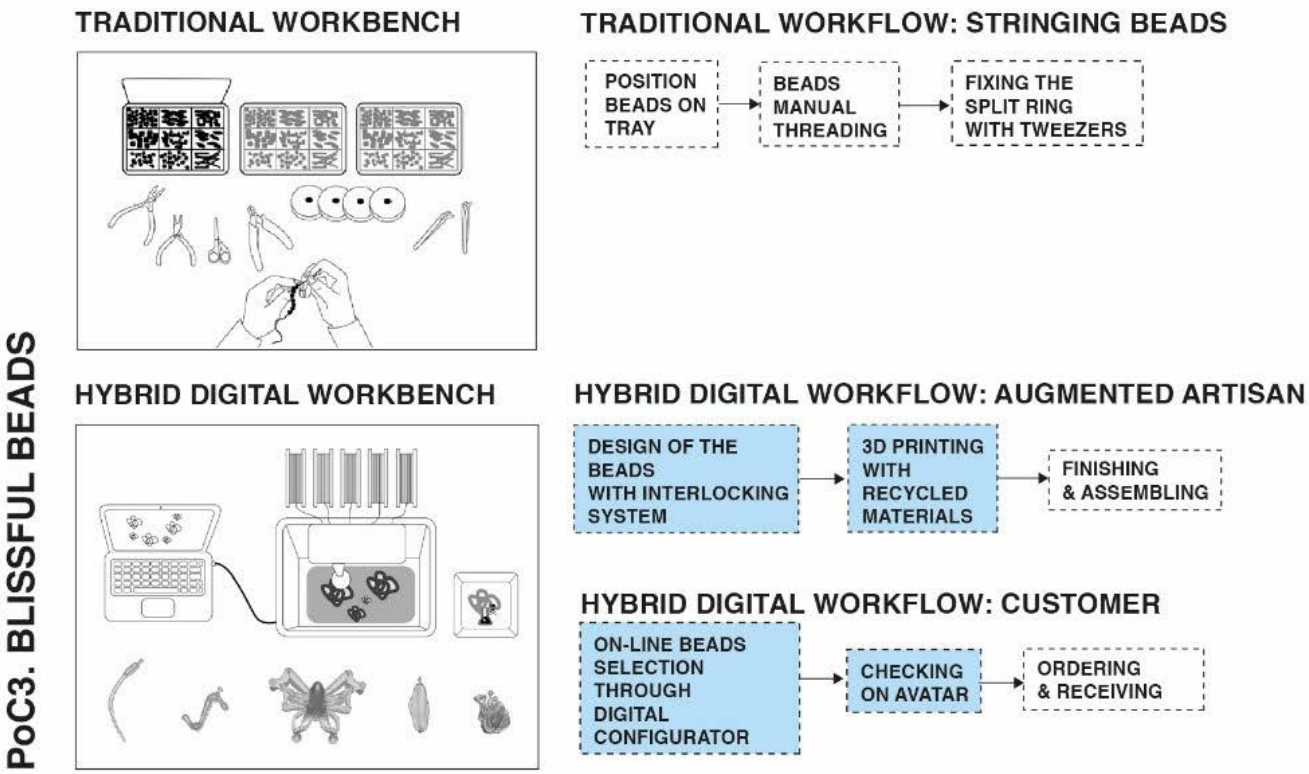

Figure 4. Example of comparison of traditional / hybrid digital workflows and workbench / tools.
PoC3 Blissful beads courtesy of Bachmann B., Xuan G., Lombardi B., Melodia E., Wang B.

smallest integration of sensors and actuators in augmented hooks for enhanced jacquard crocheting (PoC1) to the customization of CR hand-effectors for aiding cyclic assembly and cleaning stages (PoC2). Almost all PoCs equipped the artisans with customised digital parametric software with more intuitive interfaces to simplify artisan-computer interactions. The software is aimed to streamline digital 3D modelling toward digital fabrication (PoC3), develop and engineer made-to-measure craft productions, create networking platforms among artisans in the same sector (PoC4), and aid the configuration of customised craft artefacts by the final consumer. An example of traditional and hybrid workflows, workbenches, and designed solutions is reported in Figure 4. Both digital tools and software were designed to be connected in real-time, aiding both hybrid craft practices and on-demand retail channels, allowing streamlined automation from the design to the crafting of products, thus contributing to the empowerment of craftspeople overproduction.

Connecting stakeholders in the hybrid fashion crafts

Almost all the developed PoC aimed to shorten the distance between stakeholders. Thanks to co-design practices allowed by digital configurators, final customers can access fashion ICH, by watching the workflow progresses of hybrid crafting of their customised products, thus unveiling the complexity, meaning, uniqueness, and beauty of fashion crafts. Therefore, digital technologies enhance the emotional values of craft products, promoting long-lasting connections between users and products, thus contributing to more responsible consumption practices, including extended product use, repair, and recycling. From the artisans' perspective, all PoCs aim to link them with the global fashion markets by preserving their local communities and ICH.

Evolving from multidisciplinary to interdisciplinary skillsets

Students ranked soft skills acquired during the course as 3.75 (based on the Likert scale of 1-5) with particular appreciation of creativity and innovation, collaboration/teamwork, problem-solving, and critical thinking based on sustainability and interdisciplinarity considerations. They rated 4 and above subject-specific skills: fashion-tech design process and methodology, user-centred research, craftsmanship digitalization, and sustainability-oriented business model development. According to students' evaluation, mentoring activities provided: directive guidelines on how to improve the solutions (75%), inspiration and motivation to identify creative solutions (16.7%), contribution to joint co-production of knowledge/ideas in the group projects (33.3%), space for critically and independently reflecting on what improvements are needed (41.6%). Based on students' reflections in group reports, the focus on the design-driven approach complemented by business model thinking toward hybrid crafts innovation was perceived as challenging but beneficial. The business model innovation approach allowed the development of a critical stance on the economic viability of hybrid design of fashion crafts, enabling students reflection on how to attractively frame the value proposition, develop possible revenue streams and consider important partners/collaborations for intended value creation.

Conclusions

By demonstrating new educational models based on interdisciplinary, CBL, and systemic approaches (Bertola and Teunissen, 2018; Pal, 2017), this paper argues that education is a crucial lever to help fashion craftsmanship to stay competitive on the market and preserve its tangible and intangible cultural heritage while promoting sustainability and circularity. Higher education Institutions (HEIs) can drive new learn-

ing experiences based on complementary employment of design, and BM approaches, facilitating industry/multi-stakeholder collaboration and educating future fashion professionals to drive the digital transition towards sustainable hybrid fashion craft solutions.

CBL approach empowers the creation of networks of stakeholders involved/affected by the designed solutions, bridging and bonding the actual craftspeople with the new generation of hybrid fashion professionals across design, technology, and business domains. However, it is crucial to enable stakeholders' involvement at the early stage of research and design for early validations and iterations. According to recent literature, students should develop communication and negotiation skills through visualisations and low-fidelity prototypes to enhance the engagement of the involved stakeholders and craftspeople throughout the process (Mayer et al., 2022).

As demonstrated by delivered PoCs, I4.0 technologies integration in craft workflows offers opportunities for co-designing, co-crafting, and co-learning activities between artisans-students, artisan-technologies, and artisans-customers. If I4.0 technologies were used to make the craft knowledge transfer more engaging, traditional craftspeople still retain fear and doubts about the security of collected gestural data meanwhile crafting (Muller, 2019). Additional reflections on the role of artisans, designers, and computers/machines/robots gaining agency in crafting products are thus necessary to understand the evolution of creative leadership (Stevens, 2020).

The possibilities of exploring interwoven human-machine systems offered by the presented LE have nurtured students' inspirations and skills to design craft artefacts with more complex geometries and augmented precision, while improving its uniqueness through the design of pre-determined configurable parameters, thus impacting aesthetic languages and the hyper-customization of the output (Fig. 4). Provided with design and business joint training, students have gathered an understanding of traditional craft workflows, skills, and ICH, and proposed purposeful integration of technologies to increase the entanglement of traditional and digital crafts processes towards the future competitive and sustainable hybrid fashion craftsmanship sector.

However, the limitations of this kind of LE are related to the limited time to improve and develop high-fidelity prototypes to be tested iteratively with both fashion-tech professionals and traditional craftspeople inside their workshops. Therefore, a follow-up of this LE could be developing a residency model where students could develop functional prototypes and test them directly through on-field study research, and learning-by-doing activities. This Residency approach could amplify, extend and strengthen the implications of digital technologies in transforming fashion craft professional skills while retaining ICH, and in the change of creative processes, workflows, and tools toward more sustainable and meaningful fashion solutions.

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Crafting hybrid workflows for the design of augmented textile artefacts

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Abstract

In the textile field, digital crafting is a relatively unexplored domain that requires further investigation in relation to the tools of the field and the aesthetic consequences of their use on the design. Computer software such as SDS-ONE APEX4 and computerised flat-bed knitting machines made by Shima Seiki are examples of the digitisation of analogue textile processes, and make use of digitally controlled material-fabrication methods. In adopting an exploratory approach to textile digitisation, this research aims to: i) explore methods of digital craftsmanship with a focus on textile materials and tools for the design of smart textiles, and ii) test the aesthetic possibilities of sketching smart textile artefacts using a hybrid workflow.

This paper presents a hybrid workflow composed of methods emerging from the synergy between experiential knowledge of materials and experiments with digital media. One category of experiments addressed the material level. By utilising digital tools for the virtual sampling of colour-changing smart materials, two changes in textiles were explored: from white to coloured in response to UV light, and from bright to dark in light-emitting yarns being recharged by UV light. The different timings of the colour changes and dimming of the smart yarns were documented and digitised, resulting in a library of colour swatches of gradients based on dynamic material behaviour. The swatches were combined with multi-layered textile structures, digital textures, and simulations of smart and conventional yarns to design the surface of textiles using the knit and weave design software SDS-ONE APEX4. In the sketches, every pixel represented a knit stitch or meeting of a warp and weft thread, providing information about material, structure, and colour at a specific point in time. Another category of experiments addressed the relationship between material and form; the colours swatches were further mapped on three-dimensional objects in Blender software to generate new forms and explore how dynamic surface effects influence the perception of form.

The experiments presented in this case study suggest that digitising a process that is based on the physical behaviour of yarns and textile structures offers an alternative medium for exploring smart materials more sustainably, expanding physical experimentation into the digital. This hybrid process enables designers to move between software packages and collaborate across professional knowledge domains, with the potential to develop cross-disciplinary and more sustainable material practices.

Author keywords

Digital crafting; hybrid workflows; smart textile design; sustainable material practices.

Introduction

Digital craftsmanship in the field of textile design has generally been linked to industrial manufacturing processes; it requires work with digital machines that necessitate field-specific technical knowledge of yarn behaviour, textile structures, and programming textile-specific closed-source software. Digital textile environments and manufacturing tools have typically been developed to increase production efficiency, and are optimised for work with conventional materials, rather than being seen as parts of exploratory processes. From this perspective, the design process is technologically assisted and seen as a linear workflow moving smoothly from idea to material production as part of a bottom-up process.

Thus, in the textile field, experimental approaches to digital crafting are forming an emerging design space that requires further investigation in relation to the tools used by practitioners and the aesthetic consequences of their use on the design (Clarke & Harris, 2012).

State of the art

Today, the knowledge of the textile designer has expanded beyond the traditional domain of experimental analogue processes to include digitisation and advanced manufacturing using industrial machines. Thus, digital craftsmanship has begun to make use of exploratory processes that use digital modelling software and digitally controlled fabrication technologies to imagine new material concepts (Harris, 2012). Similar to the 3D-printing technologies used in product and architectural design, computer software such as SDS-ONE APEX4 and computerised flat-bed knitting machines made by Shima Seiki are examples of the digitisation of analogue textile processes, and make use of digitally controlled material-fabrication methods (Taylor & Townsend, 2014). In contrast to conventional digital form-modelling environments used in product design and architecture, the forming process used in SDS-ONE APEX4 relates strictly to textile materiality; the design process requires knowledge of knitting and weav-

ing in terms of yarn structures and qualities, and allows the geometrical principles of forming using textile methodology to be expanded upon.

Recent research in the textile field has exemplified how analogue and digital knowledge in the textile domain can interact in the design process to open up a greater degree of creativity for textile practitioners. The 'Responsive Knit' research project (Scott, 2018) introduces a new perspective on using analogue knowledge of structural textile behaviour to design a new workflow by exploring shape-changing materials that react to moisture. Informed by knowledge of analogue processes, the result exemplifies how the textile hierarchy of fibre, yarn, and knitted structures can be implemented in a digital material workflow to fabricate new materials inspired by biomimicry. Another research project explores the link between analogue and digital textile knowledge by developing methods for power knitting that are suitable for the design and manufacturing of soft robotics. The workflows include exploration of tendon placement, methods of shaping, and studies of anisotropic textures. The artefacts produced represent an experimental way of exploring the possibilities of digital knitting technology to combine textile qualities with actuation systems, resulting in complex shapes that are able to exhibit smart behaviour such as shape-changing (Albaugh et al., 2019). Similarly, the responsive textile installation *Lumen* (Sabin, 2019) uses a digital form-finding workflow based on the use of architectural tools such as Rhino, Grasshopper, and Kangaroo to fabricate a tensioned, knitted canopy. The knitting strategy used to create the installation was based on the whole-garment method developed for Shima Seiki machines, and uses digitally designed knitted tubular shapes. The diverse range of colours of the UV-reactive yarns is directly embedded in the knitting process, as the striped pattern follows the weft direction of the knitted cones.

Revisiting the role of experimental knowledge and analogue processes in digital workflows, Woolley and Huddleston emphasise the importance of craft in their own process: "For the craftsperson, the retention of some element of direct physical proximity is vital because physical contact underpins the interplay between perception, skill, knowledge and creativity on which practice depends" (2016, p.93). Although digitisation is strongly present in the textile field, the creativity that is the result of the experiential freedom of analogue processes – relating to e.g. knowledge of tactile qualities and material behaviour – is still present, and can be used in a meaningful way to inform digital designs with regard to new material concepts.

Aim and method

Adopting an exploratory approach towards textile digitisation, this research aims to: i) explore new methods of digital craftsmanship with a focus on textile materials and tools for the design of smart textiles, and ii) test the aesthetic possibilities of sketching smart textile artefacts using a hybrid workflow. Two types of light-responsive changes were explored in physical and a digital space: colour change from white to coloured in response to UV light, and colour change from bright to dark in light-emitting yarns being recharged by UV light. This was undertaken in order to establish a hybrid workflow of methods emerging from the synergy between experiential knowledge of materials and experiments with digital media.

Previously, Kooroshnia(2014) developed a method for creating two-phase patterns for print design by mixing glow-in-the-dark and conventional pigments for a coloured pattern in daylight and a pattern of gradation of light in darkness. Her research further stresses the need for new tools that allow for simulation of the effects of the pattern to aid the design process. In this case study, the gradation of colour and lightness is approached from the perspective of the textile structure, by embedding UV-reactive yarns into knit structures. Knit software SDS-ONE APEX4 and 3D-modelling software Blender were used to simulate and visualise the changes in colour and lightness, in parallel with physical experimenting feeding into the digital process by documenting and making knit experiments. In the workflow presented in this case study, three variables for designing UV-responsive colour changing textiles were identified: i. the placement of the UV-reactive yarn, ii. the choice and proportions of materials and iii. shape of the knit (Table 1).

Table 1. The design variables for UV-responsive colour changing knits

Design variable	Function in the design process	Type of sketching
Placement of UV-reactive yarn	Defines the surface texture or pattern of the knit in its coloured or light-emitting states	Hand- and machine-knitting, SDS-One APEX4: Design 64
Choice and Proportions of materials	Defines the texture, tactile properties and behaviour of the knit, and how visible the changes in colour and brightness are	Hand- and machine-knitting, SDS-One APEX4: Design 64
Shape of the knit	Defines what parts of the 3D shape are subjected to UV-light for colour change, or visible when emitting light.	Hand- and machine-knitting, Rhino 3d, Blender and Adobe Photoshop

Experiments

The first experiments addressed the material level. Changes were explored and mapped in UV-reactive yarns to translate their properties into a digital form for further experiments. When the yarns were placed in either sunlight or a dark room, it was noted that both the colour-changing and light-emitting yarns had different reaction times and intensities of colour or light. In order to understand how the expression of the textile might change over time when using these yarns and how, and for how long, the different yarns either change colour or emit light, the changes were documented and translated into digital colour charts. The glow-in-the-dark yarn samples were recharged outside, then placed in a dark space and documented at regular intervals for 3.5 hours, after which time all of them had stopped glowing. Colour charts showing the brightness of the yarns at specific points in time were made. Similar documenting was undertaken of the colour changes in the UV-reactive colour-changing yarns by taking the samples outside and documenting the changes at regular intervals until no further changes occurred (2 minutes after they had been placed outside). The yarns were taken inside, and the changes were documented until they had returned to their original colours. A series of colour charts showing the colours at specific points in time was made, showing when there were notable changes in the colour palette (i.e. a colour appearing or disappearing; Fig. 1).

Figure 1. Colour charts mapping the changes over time in the brightness of the glow-in-the-dark yarns (left) and colours of the colour-changing yarns (right).

The colour charts were then used to produce several series of gradients (Fig. 1). In the gradients, every pixel represented a knit stitch or the meeting of a warp and weft thread, providing information about material, structure, and colour at specific points in time. Two series gradients of the glow-in-the-dark yarns were made, visualising how the expression of textiles changed over 3.5 hours, i.e. the time taken for the yarns to go from fully recharged to no longer emitting light (Fig. 1). The colour charts for the UV-reactive colour-changing yarns were also used to create gradients to explore how the colours changed over the 34-minute period during which the yarns changed from white to coloured and back to white (Fig. 1). However, the UV-reactive colour changing yarns have a range of different colours, and they appear and disappear at different rates, unlike the glow-in-the-dark yarns, which primarily change in the intensity and duration of light. This gave the resulting gradient a striped expression.

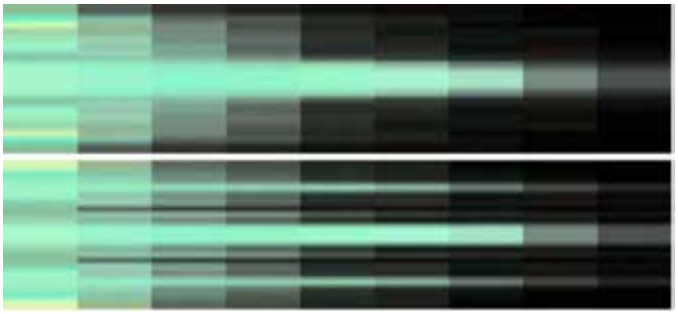

Figure 2. Two gradients showing changes in the colour of the light being emitted by glow-in-the-dark yarns over a 3.5-hour period: from bright to dark (above) and contrasting stripes (below).

Samples were knitted out using Dubied hand-knitting machine. Experiments combined a white single-jersey structure with floats in the colour-changing and glow-in-the-dark yarns, organised in a gradient from the most intense and longest-lasting to the lightest, fastest-dimming colour or glow. Different proportions in the placing and materials in the floats were tested, and one in which the distance between the floats was gradually increased as the gradient progressed from more to less reactive yarns produced a clear gradient in a dark room. The colour effect, however, was not particularly visible. To make the colour changes more visible, two threads of colour-changing yarn were plated together with a thicker white wool in a single-jersey structure (Fig. 3). The glow-in-the-dark yarn floats were organised as a striped pattern that mixed brighter and dimmer glowing yarns, creating a fabric with two different faces with contrasting changes.

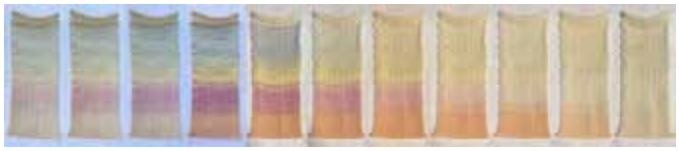

Figure 3. A gradient in UV-responsive colour changing yarns over a 55-minutes period first outside (images 1-4 from left), then inside (images 5-11 from the left). Single jersey with plating and floats on the reverse side.

In order to be able to digitally sketch changes in colour and amount of light emitted in a medium connected to textile materiality, the colour charts were transferred into the knit and weave software SDS-ONE APEX4. Exact shades of each colour chart, depicting the colours of the yarns at a specific point in time, were input as their own custom colourway. This made it possible to see how the expression of the textile would change over time by viewing it in relation to different colourways (Fig. 4). The software allows yarns that have similar sizes, weights, and textures to the physical UV-reactive yarns to be chosen, making it possible to translate the properties of these yarns into digital form and combine the changes in colour and amount of light emitted with textile structures, materials, and textures. Thus, it was possible to simulate what the textiles would look like at different stages of change.

Figure 4. SDS-ONE APEX4 simulation using the colourways of colours of the UV-reactive colour-changing yarns over a period of 34 minutes. Single-jersey structure with plating.

Two simulations were undertaken used knitted gradients with ten colourways to cover all of the increments in the colour changes of the yarns over a period of 34 minutes. The first simulation was undertaken using a single-jersey structure with a single thread of the colour-changing yarns. The second simulation was also a single-jersey structure but for this the colour-changing yarns were plated on a thicker wool yarn (Fig. 4). This created a heavier, denser fabric similar to one of the experiments undertaken using the hand-knitting machines (Fig. 3). The gradients of both experimental results were striped.

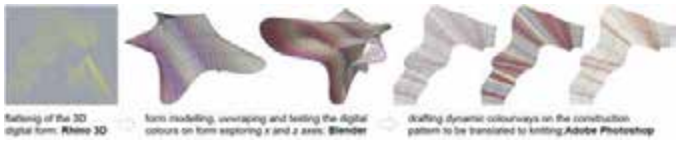

Figure 5. An example of flattened surface patterns prepared for knit construction; a simulation of a dynamic colour gradient created by applying colour gradients on the form in Rhino 3D.

In order to test the impact of different colours on form, an organic form was generated using Rhino 3D and Grasshopper (Fig. 5). These software packages allow three-dimensional objects to be flattened, which is necessary to translate the digital form to the physical knitting process. The form of the construction pattern was used to plan the sequence of colours and select yarns in terms of their quality when designing the knit forms. The same construction pattern could then be translated in the knitting software and fabricated using a partial knitting technique which allows direct shaping in the machine. Digital colour samples in the Blender software were mapped on the object to explore the effect of dynamic colour and texture on perception of form. The sizes of the stripes and direction of colour gradation and contrast were important to consider when planning colour placement on the form to emphasize its curvature and helped to plan the succession of colours on the construction pattern to be translated to the knitting program.

Conclusion

Smart materials react to various stimuli, which means that the designer needs to understand the textile's expression in multiple stages and consider how placement, heat, and light, for example, can influence the changes in expression that can occur. Three-dimensional modelling software packages such as Rhino 3D and Blender facilitate exploration of smart materials and changeable expressions in different contexts, as they allow parameters such as colour, form, space, and intensity and direction of light to be tweaked. Thus, the workflow presented in this paper explored the relationship between analogue and digital craftsmanship with a focus on colour, textile construction methods, and proposing tools for designing smart-textile artefacts. Similar to the research of Scott and Albaugh et al., it was found that navigating between various digital software packages allows the designer to fabricate and flexibly include dynamic variables, design variations, and smart-material agency in customised workflows for knitting design. In a comparable way, the hybrid workflow used in the creation of *Lumen* (Sabin, 2019) demonstrates that digital form-finding can be influenced by the limitations of the chosen knitting technique, and that such processes can be accurately translated into knitting technology. In addition, this research expands on these previous works by exploring the digitalization of smart colourways and their application on 3D forming process for knitting. Software packages such as SDS-ONE APEX4, which simulate conventional materials, allow the development of alternative workflows that are customised by the designer to function with colour-changing yarns, allowing changes in colour over time to be planned, predicted, and visualised directly on textile structures and digital artefacts. To further develop the method, the accuracy of colour expressions could be improved by documenting changes in yarn samples in a more controlled manner by using a colour scanner.

Generally, the introduction of digital sampling and form-finding supports the development of sustainable textile practices by reducing the need for material testing and consumption. However, software packages such as SDS-ONE APEX4, as well as Scotweave, TexGen, and Blender, should not be seen purely as means of recreating smart yarns in digital form in order for them to then be produced as physical textiles. Instead, they can be approached as alternative ways of working with smart materials and customised workflows, allowing the designer to develop sustainable and innovative practices relating to the Industry 5.0 model (Xu et al. 2021): they can facilitate exploration of values, expressions, materials, structures, and scenarios that might not yet be possible, or relevant, to realise in physical form.

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Distance: digital immersive technologies and craft engagement

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Abstract

The DISTANCE project (digital immersive technologies and craft engagement) is a novel practice-led experiment in the use of immersive technology to enable dispersed craft practitioners to apply their haptic skills and material knowledge in a digital immersive space, learning from peers through remote collaboration. Craft practice is rooted in tactile interpretation of materials expressed through tacit, haptic processes (Ray, 2009). In this paper we ask; what role can haptic crafts skills play in a virtual studio environment? The paper reflects on the interaction between different craft disciplines and thus how different kinds of tacit knowledge impact on the act of creation in an immersive space (McCullough, 2004). How does a VR studio relate to a material studio practice (Corazzo, 2019)? Conversely, what are the drawbacks of such places in terms of collaboration when craft practices are rooted in material knowledge and haptic skill? Through a series of semi-structured workshops, practitioners shared their experiences of working alone and collaboratively within immersive space and discussed the unique challenges and opportunities of integrating and sharing haptic-driven creative processes and experiences with digital space. Thematic analysis of workshop discussions, interpreted by both craft and HCI experts, are presented alongside analysis of the work produced. This paper describes the role that haptic skills can play within immersive environments for craft practitioners and discusses current challenges to be addressed and opportunities for future work in hybrid digital-physical spaces. The paper also reflects on the role a virtual studio space can play as a shared learning environment. What are the barriers to adopting a virtual studio practice using VR? How does a VR studio connect to a physical making place? It is becoming increasingly important for creative practitioners to gain digital skills and competencies, both for creative production and for collaboration (Palani, 2022, Helgason *et al*, 2023). While the Covid pandemic meant that many more activities were conducted online or through digital means, this technological transformation has been underway for many years already (Cavalheiro *et al*, 2020). In the United Kingdom, the term "CreaTech" has been coined to describe the emergence and importance of this intersection where digital and data skills meet creativity (Bahkshi *et al*, 2019). Finally, the paper reflects on what role a virtual studio can play in supporting a sustainable craft practice: how does a virtual creative place that offers limitless options in terms of scale, material exploration, unhindered by physical limitations impact physical making practices?

Keywords

Metaverse; VR; digital fabrication; craftsmanship; haptic; remote collaboration; data driven innovation

Introduction

The DISTANCE project (digital immersive technologies and craft engagement) took place during the UK COVID-19 lockdown of 2021 and is a novel practice-led experiment in the use of Virtual Reality (VR) to enable physically dispersed craft practitioners to apply their haptic skills and material knowledge in a digital immersive space, learning from peers through remote collaboration. Here we consider craft practice as both a skill and process (Adamson, 2007, p. 3), as a way of doing things, rooted in a tactile interpretation of *materials* expressed through tacit, haptic processes (Ray, 2009) and embodied in both manual and mental skills (Pye, 1968). The craft practitioners involved in this project are referred to as makers throughout this paper.

The pilot DISTANCE I took place online between February and April 2021 involving six makers in three partnerships, whilst the DISTANCE II roll-out phase took place from June 2021-January 2022 and engaged with eight craft makers and three collaborations. The project was developed and managed by the makers collective, Applied Arts Scotland (AAS), who sourced the funding and resourced a technical expert to support the project. Each maker was loaned a VR set (Oculus) over a period of three months (phase I) or eight months (phase II): each headset was set up and preloaded with the software required and supplied with a set of tailored instructions with regular technical and peer support sessions across the period, thus making the 'threshold' lower than if makers would have undertaken on their own. The collective journey of the maker participants was important in this project. Each craft maker had a different material expertise which ranged from product design, weaving and knitting, ceramics and glass, silversmithing and jewellery making. It is notable that the group had diverse and uneven prior digital production

skills which ranged from novices to proficient digital fabricators using 3D modelling and 3D printing. This paper describes the impact VR had on this diverse group of craft makers and how this technology was adapted to individual as well as collaborative making practices. The paper thus reflects on the interaction between different craft disciplines and what different tacit knowledge bears on creating in an immersive space. Conversely, what are the drawbacks of such places when craft practices are rooted in material knowledge and haptic skill? This paper also explores the role that haptic skills can play within immersive environments for craft practitioners (referred to as makers throughout) and discusses current challenges to be addressed and opportunities for future work in hybrid digital-physical spaces. Finally, this paper sums up the role VR can play in future craft practices and outlines further scope for study.

This paper has been based on data gathered 1) by active participation as makers by three of the authors, 2) from a series of semi-structured workshops facilitated by AAS in which the fourteen practitioners shared their experiences of working alone and collaboratively within the immersive space, and discussed the unique challenges and opportunities of integrating and sharing haptic-driven creative processes and experiences with digital space and 3) additional thematic analysis of workshop discussions, informed by both theory and practice. We use the terms immersive space and digital space throughout this paper as overlapping terms, since the project relied on shared non-physical spaces that were occupied as immersive spaces within VR headsets and/or as supporting digital spaces where work created could be supplemented, edited and curated, with the makers moving back-and-forth between these dimensions as needed.

Distance project: digital pivot

The DISTANCE project was developed for and by craft makers through AAS. DISTANCE I was financed by Creative Informatics, a four-year R&D project funded by the UK Arts and Humanities Research Council (AHRC), to support Data Driven Innovation (DDI) in the creative industries in Edinburgh and the South of Scotland region whilst DISTANCE II was funded by Creative Scotland with further plans for an international rollout. It is this cascading effect of small R&D interventions which deserves attention as well as the innovative collaboration developed in this project.

During the period of global lockdown of 2020/21, the cultural and creative sector became a proving ground for data driven innovation. The shift towards digital technologies was significantly accelerated by the global pandemic, condensing five years digital adaptation into two months (UNESCO, 2020; Baig *et al*, 2020). The swift digital pivot of the creative industries in the wake of the pandemic highlighted possibilities in the use of online spaces for not only disseminating creative work, but to connect, share, collaborate and create. Access to physical spaces for creative production was made difficult or impossible during lockdown, halting not only production of works but also limiting scope for research and development for creative practitioners who routinely rely on access to physical spaces and specialist equipment to create work. Whilst the use of online platforms enabled creatives to connect digitally in a virtual space, the DISTANCE project brought an added dimension by exploring how craft practitioners might be able to collaborate and create together in a virtual three-dimensional space, remotely.

The recent democratisation of VR through a marked decrease in the purchase price of VR headsets has enabled more creatives to explore this technology. However, this has coincided with the adoption of the software (e.g. Tiltbrush, owned by Google) and hardware (e.g. Oculus Quest, owned by the Facebook company Meta) by tech giants. VR technology is evolving rapidly which makes this risky for sole practitioners to experiment with as the technology may no longer be supported in the near future, making their investment of time and capital obsolete. The large tech companies are proving critical in both lowering access thresholds and potentially providing stability longer term. It also, however, opens ethical debates: an Oculus Quest at the time required a mandatory Facebook integration and is thus linked to a personal Facebook account (at time of writing requires an Oculus account) with known issues around data tracking (Bujlow *et al*, 2017). The DISTANCE project circumvented this by setting up a project Facebook account thereby avoiding linking to individuals' accounts which was shared across multiple headsets. With changes linked to the transition from Facebook to Meta, this approach is no longer possible.

The loan model of the VR headset fits within a sharing economy model where the upfront costs of technical equipment, including software is taken on by a third party, in this case AAS on behalf of its members. The sharing economy grew from DDI in the economy using digitised platforms (Belk, 2014) including Libraries of Things (Ameli, 2017). This sharing model supports not only a change in consumer behaviour by reducing resources (Edinburgh Tool Library, 2020), but critically also supports access to tools and specialist equipment for marginalised groups, those on lower incomes or with lesser means to invest in technology (Hamari *et al*, 2016: Hellwig *et al*, 2015) and fits with AAS' ethos of supporting sustainable making practices of and for its members.

The DISTANCE project was a collective learning project which occurred within a safe and trusted peer-led space that enhanced risk taking and exploration within digital space (Jaramillo *et al*, 2019). It evidenced that working remotely collaboratively can take place in both synchronous and asynchronous ways: collaborators could work on joint projects in shared digital space at separate times or they could work on it together, at the same time, in the same digital space. This enabled those with non-normative working patterns to fit around caring responsibilities or enabled those for whom travel was perhaps difficult for health reasons or with career responsibilities elsewhere, to be flexible in their collaboration. Regular scheduled sharing sessions meant that issues - technical or creative- were shared and addressed in near-real time.

Skills

Learning to use and understand this new technology required completely new skills, both haptic skills in terms of acquiring the tactile skills of handling the handsets and headset but also the mental challenge of different ways of working and thinking. Learning these skills did not come naturally to all the makers: some were "struggling" or "frustrated" with

the technology, with a reluctance to fully engage with the VR experience: "always more interested in the real world" whilst for some the physical experience of wearing a VR headset for a prolonged time confronted them with nausea and headaches, thus limiting their time in VR. Others, however, took to it easily. All makers were transferring existing skills into VR: from drawing to making skills such as weaving or throwing ceramics. It was notable that the more experimental adopters of the technology were willing to abandon their tacit knowledge of making and materials to play and explore.

The rationale for the makers to opt into DISTANCE ranged from simply wanting to explore this new technology as part of their ongoing professional development "to challenge myself" or "take me out of my comfort zone". All makers specifically explored how experimentation in a virtual environment would inform their analogue practice. Some makers who had prior experience of working with digital technology had specific aims in mind: "Discover and exploit the main advantages that working in VR with [Gravity Sketch] GS-VR has over other 3D modelling programmes". This mix of knowledge proved valuable to the collective learning experience during both the online collaborative sessions and the formal workshop exchanges facilitated by AAS. Access to the technical expert proved a key asset in the success of the DISTANCE project and enabled the makers to explore and solve practical problems, often relating to how to integrate their analogue practice into their VR. This maker led approach to making proved an equally fruitful learning experience for the technical expert as different questions emerged from maker queries than perhaps VR content developers might ask.

Whilst there are other technologies that enable remote collaboration, through file sharing of digital drawings for example, VR enabled creation and collaboration in a three-dimensional virtual space both in real time and asynchronous time. But unlike other creative technology, such as CAD, the immersive virtual reality tools offered a *playfulness* perhaps hitherto not experienced but which belies its origin in the gaming industry: "When I am in the headset I am not on the clock – I am playing". It was clear that the ability to play and experiment with this technology with low financial risk (headsets loan) did require an extensive investment of time to develop the necessary skills required: "Being able to deal with new stuff needs time to be digested and help each other". Furthermore, VR enabled craft makers to explore making without the usual physical boundaries of a material practice: no gravity, scale limitations, mess or carbon footprint of materials (acknowledging of course the digital carbon footprint): "immersive technology allows you to break the rules". This "limitlessness" was considered both an opportunity and a barrier when constraints can be useful as a framework to work against. Transferring haptic skills to a virtual environment required a fundamental understanding of what haptic skills each maker possessed: what were the actions which constitute their daily making practice? And how did these actions translate into bodily movement? Transferring these haptic skills to a VR hand controller with little haptic feedback proved challenging. The tactile setting in the hand controller enabled the weaver to successfully receive haptic feedback on the use of virtual materials in VR: "that feedback 'rumble' really supports the feeling of touching something". This was, however, not experienced by the other makers.

Augmented craftsmanship

The COVID-19 pandemic highlighted the need for digital literacy as more activities migrated to online, but this shift was part of a longstanding process. This digital transformation trend is disruptive, and it is changing the way that designers and artists create and distribute their work and influencing how audiences and clients access these creative outputs (Cavalheiro, 2020). Consequently, acquiring and improving digital skills is becoming more necessary for creative practitioners (Helgason *et al*, 2023). Digital technologies have pushed craft practice to new boundaries, enabling new ways of making work and creating new visual vocabularies (Cutler, 2012; Shillito, 2013) and VR is another in the toolbox. The exploration of material qualities in VR relied on the capacity of the software to mimic materials in a three-dimensional virtual world. Some materials were easily translated. Others, such as the drape of fabric, the fluidity of thread or the transparency of glass, required more exploration and experimentation with a limited palette. A weaver tried to emulate the woven textile. Only once the actual weaving action was abandoned and instead images of prior constructed woven fabric were imported, did the ability to construct or disregard components quickly become apparent. The ability to repeat knitted samples in an exploratory fashion would not be possible in real life without physically knitting them: "Gravitysketch helped me to visualise the things that are possible in real life". Furthermore, being able to walk around the constructed assemblages at different scales enabled her to envision her work on a scale hitherto not possible. The scalability in VR proved a key asset to most makers and supported the element of play. The liberty to "play" required a change of mindset. A potter consciously had to "forget" his tacit and material knowledge so as not to preclude experimentation in VR as the experiment "won't' work" in the analogue studio. A furniture designer was "making all these things that I cannot make in reality". A glass maker was experimenting with fluid 3D forms "that would be almost impossible to make at this scale and in this form as it defies gravity". In other words, experiments in VR might not be easily translatable in studio production: one maker felt a "responsibility to make work that is not possible in any other way". The experimentation in Gravitysketch had a freedom of expression that was "mindblowing", not easily found in material practice. It was noted by several makers that whilst tacit knowledge is critical for designing objects and products which will "live in the real world", this inherent knowledge can stymie the playfulness to which VR lends itself and which proved valuable for exploration and experimentation. For some makers, the playfulness generated in VR space was then taken back into the physical studio, generating a shift in process.

The interaction between the virtual and analogue proved to require some flexibility of mind. Some makers found the amount of time required "disproportionate to the results" to create something in VR "to then bring it back out into the real space to then make it". Those most adapted were those who had an ability to "start with nothing". One potter produced a multifaceted form in VR. This was translated into a 3D printed form from which a negative multi-part casting mould was made from which a ceramics form was slipcast and fired. The use of VR and 3D printing "took four steps out of the mould making process" so here too VR facilitated both time and ma-

terial saving contributions. This 3D object was brought back into the virtual environment by minting it as bitcoin. These different processes, outputs and learning were presented as an exhibition in a 3D environment, Frame V, that could be viewed and navigated via web browser on any compatible device, including immersive versions in the VR headset (Fig 1.)

Figure 1. Frame V digital immersive exhibition space of DISTANCE II, Applied Arts Scotland, with work by Chris Donnelly showcasing glaze testing of 3D printed form created in VR created slipcast and glazed before being turned back into digital through NFT mining. Source: https://framevr.io/distancechrisgallery. With kind permission from the artist.

The space included the opportunity to embed film, audio and 360-degree photo collages alongside 3D models, and for the viewer to take self-directed virtual walk-abouts. Linked spaces exhibited the work of individual makers and collaborative groups. This offered "a guided tour of everything that is possible in a virtual space" in terms of making practices. Furthermore, social media supported these collaborations to be shared and enabled immediate feedback on the processes and work made. This exploration between the virtual and analogue revealed different opportunities to interact with the initial form and transform it into different immaterial and material iterations, each with their constituent feedback to the maker (Spence et al, 2020 & 2022). The ability to import analogue works through photography and film into VR which could then be manipulated, 3D printed or made in the studio and then brought back in the VR made some makers question: "What is reality? Am I looking at x in VR or in VR looking at x?".

Conclusion

In DISTANCE the VR studio became not only a site of individual experimentation but a shared learning environment. Once basic VR skills were acquired, the virtual studio offered a creative place that offered limitless options in terms of scale, and material exploration, unhindered by physical or financial limitations, it enabled a certain amount of risk taking and exploration that would be prohibitive if executed in real terms. It is notable that the pandemic gave unprecedented "licence to play" as other commitments and responsibilities had temporarily been removed. Both the socially and environmental *inclusivity* of the technology make this a potential *sustainable* option. This is however, potentially offset by the rapid changes in software development, making investment in soon-to-be-obsolete hard- and software a non-viable option for creatives for whom training in new technology requires an upfront investment of time, even when hardware costs can be shared through a loan model. Furthermore, obsolete hardware, unless recycled in closed loop, wastes materials and resources. The barriers to adopting a virtual studio practice using VR were either physical (nausea and headaches), limited time to experiment and learn the necessary skills, inability to let go of innate material knowledge to facilitate playful learning and experimental making, and the limited material palette in the existing software. Conversely, the tacit knowledge of the makers can be used to arguably improve the experience of the tool itself. The facilitating factors were access to R&D funding, access to specialist equipment (sharing economy model), expert advice and support and an extended period within which to experiment. The funded R&D interventions are highlighting DDI in the creative industries that are worth paying attention to and are a model that deserves investment going forward. It is also worth reflecting on the value of a community of practice in a physical studio space, where *haptic* skills are paramount. If we consider the community of practice to be composed of shared experience, expertise and meaning (Jaramillo *et al*, 2019), then VR can replicate much of the intellectual and emotional aspects of experience, expertise and meaning but still falls short of the physical, at least whilst the VR studio is limited to a headset. A question going forward might be how immersive technology can integrate the embodied experience of making when the current focus is mostly audio and visual senses rather than haptic ones. However, technology is developing fast to include resistance and feedback loops to make the sensory experience more complete. What might this mean for material practices such as craft, design and architecture, where embodied material and haptic knowledge are fundamental to learning and acquiring skills? And what implication would this have on the 'playfulness' of VR?

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Notions of hybrid craft production: conversations and small-scale experiments in digital fabrication

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Abstract

Since the advent of 3-D printing as a form of additive manufacturing technology in the early 1980s, digital fabrication has made many inroads in craft and production. The 'digital fabrication revolution' (Gershenfeld 2012) has also presented us with opportunities for hybrid craft production, or situating craft practices at the intersection of traditional and digital modes of production. In spite of the burgeoning opportunities, there is still hesitation amongst traditional craftsmen and makers when it comes to adopting or integrating digital modes of production into their workflow. With contemporary Singapore and evolving ideas of 'craft' as the backdrop, this research unpacks possibilities for production through conversations with local craftsmen engaged in traditional and digital fabrication. The conversations primarily revolve around two pottery artists (with an emphasis on functional ware) and a makerspace located in a public library. The conversations and experiments reveal three key observations. First, notions of expediency and precision can play a role in how we come to appreciate and appraise 'skill' or more specifically 'hand skills'. This has implications for how we understand 'direct experience' (McCullough 2018; Cardoso 2018) in the context of craft objects. Second, when assessing quality, conversations around 'failure' reveal differing opinions about benchmarking and quality control between artists engaged in traditional pottery and digital fabrication respectively. Third, asking more open-ended questions about what a 'tool' is and how we can shape our own tools and workflows will reveal more opportunities for hybrid craft production. Lastly, through the aforementioned research, two potential barriers to entry were identified in the form of economic barriers, and time and education barriers.

Author keywords

hybrid craft production, digital fabrication, workmanship

Introduction

Since the advent of 3-D printing as a form of additive manufacturing technology in the early 1980s, digital fabrication has opened possibilities for makers and manufacturers alike. One can gain a sense of the techno-optimism via Neil Gershenfeld's (director of MIT's Center for Bits and Atoms) (2012) proclamation of this technological phenomenon as the "digital fabrication revolution". Chris Anderson, a former editor-in-chief of Wired magazine, elaborated on what this meant for individuals and communities by tracing the boom of the 'maker movement' and 'makerspaces' in his 2013 book, 'Makers: The New Industrial Revolution'.

3-D printing presents us with opportunities for hybrid craft production, or situating craft practices at the intersection of traditional and digital modes of production. At a time of "postdisciplinary flux", we can observe that the "categories of making are increasingly intermingled and hybridised" (Adamson 2013). While the market potential of 3-D printing for industrial manufacturers has been growing, this paper is more interested in the possibilities afforded to individuals, from "mass personalisation" (Deloitte 2015) to the boom of the "makerspace phenomenon" (Sherlock 2021). In particular, we are interested in individuals who consider themselves to be hobbyists, enthusiasts or amateurs in the realms of traditional and digital crafts.

The "hybridization of traditional and digital processes" (Treadaway 2016) can be found in a range of disciplines, from ceramics to textiles. However, in spite of the burgeoning opportunities, there is still hesitation amongst traditional makers in Singapore when it comes to adopting or integrating digital modes of production into their workflow. Various researchers working at the crossroads of computational methods and traditional craft have provided inspiration for this research, including Zoran's 'hybrid reassemblage' (in the context of "digital fabrication to restore broken ceramic objects") and Zheng and Nitsche's 'crafter-designer collaboration' model (discussed against the backdrop of a collaboration between design technologist Clement Zheng and ceramic artist Amy Roberson leading to experiments involving pottery and interaction design).

Singapore as context

Sherlock (2021) stated in her survey of the makerspace phenomenon covering San Francisco, Berlin and Calgary in Canada, that the "critical discourse around what is being made and why is often lacking". The same could be said of the digital

craft scene in Singapore, especially when looking for opportunities to rethink traditional crafts. In this spirit, we began our inquiry with one guiding question: how will digital fabrication tools open possibilities for hybrid craft production? In attempting to answer the aforementioned question, we conducted interviewees and studio tours with three research participants based in Singapore. In this spirit, one aim of this research was to explore the receptivity of craftsmen largely engaged in hand work to integrating digital fabrication into their workflow.

The criteria for selecting research participants was twofold: [1] craftsmen that made functional household craft objects, or, [2] craftsmen that employed either traditional, digital (such as 3-D printing) or hybrid craft production methods. The interviews enriched our appreciation for the role(s) played by traditional and digital craftsmen and possibilities for hybrid craft production.

Three craftsmen

Before we dive into our findings, it would help to better understand the profiles of our three research participants: Jolyn Ong, Goh Sing Hong and Muhammad Ismadi.

Ong is a hobbyist and pottery artist who has spent three years honing her skills in ceramics, with the goal of opening a pottery cafe one day, one that allowed patrons to find peace and relaxation. At age 25, she took up pottery classes at Toa Payoh Community Centre in Singapore before practising at shared studios and self-learning through online tutorials. Ong's motivation is driven by the endless wealth of knowledge that ceramics craft has to offer, which she believes could take her a lifetime to learn.

Goh is one of the youngest pottery artists in Singapore and spent two years learning ceramics at various studios, including Mud Rock Ceramics, Common Touch Craft and Ves Studio, before continuing her practice at her home-based studio and developing her own style. During this learning journey, she realised that she had a few decent pieces to sell and began marketing her wares through Instagram.

Muhammad is a maker coach at MakeIT at Tampines, a makerspace that is part of a National Library Board (NLB) initiative, and specialises in digital tools such as 3-D printing technologies. With a background in applied physics, Muhammad spent three years building a 3-D printer from scratch using scrap materials in 2013, a time when 3-D printers were not as affordable to the public. As a maker who now owns multiple consumer 3-D printers, he finds joy in DIY projects and customising everyday objects like wearables (e.g. watch straps).

'Direct experience' and making

Architectural professor McCullough took a production-based approach when he located the essence of craft in the digital realm as one that is based on the "direct experience, personal vision and mastery of a medium" of a maker (McCullough qtd. in Cardoso 2018), while Cardoso (2018) argued that the direct experience is not limited to makers, as it "stands alongside the experience of users" and that it is a 'collective' and 'open-ended' process.

When asked about their preferences regarding pottery craft, Ong shared that she has never been swayed by user or consumer preferences, explaining that "the whole point I'm doing ceramics is so I listen to myself". Rather than trying to find a fixed style, Ong envisions having dynamic styles that will speak of her different personalities and preferences that she has as a pottery artist. On the other hand, Goh is clear about her own style, as she is particularly interested in curvy forms and describes her style as "wacky". While a style can be perceived in her works, Goh mentions that consumer preferences such as cups being more popular as compared to vases tends to influence her production decisions when planning upcoming collections.

Despite having different tastes and preferences in their practice, both Ong and Goh highlight the importance of making artefacts by hand, and do not see a need to incorporate digital fabrication technologies such as CAD (computer-aided design) modelling and 3-D printing into their production process at this moment. After some years of practice, they have both learned techniques such as handbuilding and wheel-throwing to create pottery with their hands and therefore, the need to incorporate digital processes did not arise.

While Ong and Goh emphasised 'direct experience' (McCullough) and making things by hand, Muhammad explored using a 3-D printer as a tool to make his artefacts, rather than building or sculpting them *only* with his hands. Utilising the materials readily available in his makerspace, such as wax, concrete and air clay, he experimented with various casting techniques while relying on 3-D printed moulds. His casting experiments were an attempt to expand his palette of materials beyond plastics commonly associated with 3-D printing.

Immediacy and production

Pottery is a relatively long process, from hand-building or wheel-throwing, to glazing and firing. Ong and Goh mainly practiced the wheel-throwing technique to create their forms [see Table 2].

Table 2. Steps for making pottery, as shared by Ong and Goh

	Step	Description
1	Sketching Ideas	Drawing inspiration from online sources, and sketching ideas on paper.
2	Wheel-Throwing	Execute ideas on the wheel-throwing machine by perfecting the clay forms while ensuring that measurements are consistent. Perfecting the form alone takes a lot of practice (in order to get even thickness and reduce cracks during the firing process later on). It is important to note that the clay will shrink by 20% during the firing process, thus they have to compensate by making their items bigger than the finished size at this stage.
3	Glazing	The next two steps (glazing and firing) have to be done carefully as they are irreversible. Glazing itself is a whole different art form. If the compounds are inaccurate, it will affect the results during the firing phase.
4	Firing	Lastly, the glazed item is brought into the kiln to fire at above 1000°C. Once the clay is fired, it can no longer be recycled again.

Ong (2022) shared her opinion on the tedium of pottery:

> *A lot of people think a simple mug on the table is something you can get in a day, but it is not. If you are into the knowledge of it, you realise a piece of mug, bowl, or plate takes a month. The drying process, trimming it whilst it is just dry enough but not too dry... all these little things that you have to take note of adds to the whole length of the duration of making.*

To illustrate the point further, the final steps are irreversible—once a pottery piece is fired, the clay can no longer be recycled and the potter will have to destroy the piece or start over again. In comparison, Muhammad shared his experience with 3-D printing, while making a smartwatch strap from scratch [see Table 3].

Table 3. Steps for making a smartwatch strap, as shared by Muhammad

	Step	Description
1	3-D Modelling	Create a 3-D model of the strap using TinkerCAD, a 3D-modelling software.
2	Preparing for 3-D Printing	Convert the 3-D model file (.stl) into a 3-D printable format (.gx) using FlashPrint.
3	3-D Printing	During the 3D Printing process, several iterations can be made based on the measurements and prototypes in order to get the strap size and fitting right.

While pottery has irreversible steps (especially after glazing and firing), digital fabrication allows multiple iterations even after the initial 3-D printing. It is also clear that 3-D Printing is not an instantaneous process that allows you to see results or output immediately. Unless one downloads ready-to-print 3-D files from open-source portals such as Thingiverse.com, 3-D modelling requires time to refine and render; the step of 3-D modelling being a crucial one.

Quality benchmarking and defining 'failures'

When analysing how different craftsmen benchmark their craft pieces, it would help to understand how they define a 'good' or 'failed' piece. For Ong, she still considers herself an amateur and student after three years of practice, as she is constantly trying to hone her skills to the reach the level of a master ceramist before launching her own collection. On the other hand, Goh launched her first collection after about a year of practice. When asked how they each defined a failed ceramic piece, Goh described pieces that were "too thick, heavy, uneven [the opening is off centre], random holes" while Ong focussed on "cracks, patchy glazes".

To Ong, uneven forms can be seen as expressions of 'wabi-sabi', or the idea of intentional imperfections, and that the beauty of ceramics is that "there is no right, bad, good or wrong art". Goh believes that as a pottery artist, it is necessary to experience failures, while Ong thinks that "there's no such thing as failures, just lessons in pottery". For example, Ong usually slices her failed pieces in half to analyse what went wrong before recycling the clay. Both Ong and Goh agree that it was only after making progress over time, that they began to see their initial pieces as failed attempts. While different craftsmen have differing ideas of a good quality craft object, and the definition of failure is also equally subjective or deeply personal.

While Ong and Goh mainly described failures in terms of the physical characteristics of pottery pieces such as uneven forms and cracks, Muhammad experiences failures either during or after the 3-D printing process (e.g. during a casting process). With digital fabrication, iterations originate from the 3-D modelling process leading to an existing 3-D file that allows repeatability.

Possibilities for hybrid craft production

When presented with the possibilities of incorporating 3-D Printing into her process, Ong saw an opportunity to make a chuck using 3-D printing. A chuck is a tool that Ong often used to help trim her vases with narrow or uneven rims during the wheel-throwing process. Currently, Ong has been making chucks out of clay, but believes that there might be an opportunity to make her own tools using 3-D printing. Rather than relying solely on hand skills to achieve a certain form, pottery artists can make use of additional jigs when working with unusual or complex geometries.

Muhammad, on the other hand, has been experimenting with building his own tools since 2013. Rather than wait for 3-D printing to become more affordable and widespread, Muhammad spent three years experimenting and building his own first 3-D printer in 2013. Later, he purchased a Creality Ender-3 Pro, a beginner-friendly and relatively affordable 3-D printer suitable for makers. Muhammad prefers the Ender over competing models due to its flexibility. He is able to customise or upgrade different parts on his own, and print custom parts if required.

Many digital craftsmen have been experimenting with building their own 3-D printers for ceramics in recent years. Ong added that she thinks it is "quite exciting" and that she "will personally try it, in future" and she "might even include it if [she sees] some value in it... [and she sees herself] selling 3D printed ceramics because it's a series that is interesting and people might be interested". Digital fabrication can be used in a 'tool-making role', in addition to directly fabricating of end products (Jorgensen qtd. in Zoran et al. 2015).

Barriers to entry

Having discussed the potential for hybrid craft production, we cannot overlook barriers to entry.

Firstly, there is an economic barrier as pottery is considered an expensive craft to learn. Although Ong was keen on learning ceramics from a young age, she was only able to commit to learning pottery after having a stable personal income at the age of 25. Goh mentioned she is one of the youngest potters in her studios, where most potters are aged 30 and above. An average five-week pottery course can cost between SGD300 to 400 (USD 226 to 302) and Goh mentioned that she bought a second-hand wheel-throwing machine for around SGD300 (USD 226). On the other hand, the makerspaces (MakeIT) at public libraries in Singapore offers free usage of 3-D Printers to public users (age 13 and above), as long as they have a registered National Library Board account and completed a free three-hour starter course. In addition, visitors can receive guidance from maker coaches.

Secondly, there are also time and education barriers. When Ong and Goh first began learning pottery, they had to attend at least five physical lessons in order to learn the fundamentals of clay. Goh spent three weeks learning hand-building and two weeks on wheel-throwing, while Ong spent ten weeks learning wheel-throwing. With the basic skills acquired, they were then able to progress to self-practice or self-learning via online video tutorials. On the other hand, there are many free online resources that encourage self-learning about digital fabrication. For example, there are free 3-D modelling softwares such as TinkerCAD.com and Blender and many websites share user-generated content such as digital design files hosted on Thingiverse.com. In addition, studio space and overheads are a concern. While pottery artists who do not own a wheel-throwing machine have to rent spaces in pottery studios, one can do 3-D modelling relatively inexpensively.

Conclusion

In Gershenfeld's (2012) words, "personalisation, producing products for a market of one person" is what makes digital fabrication a 'killer app'. By being directly involved in the process of making, craftsmen can develop an emotional and personal attachment to the product as they feel less alienated in the course of making (physical or digital). Digital fabrication will not replace traditional crafts but opens opportunities for hybrid craft production, and new paths for customisation and personalisation in the today's consumer and craft landscape. While much attention has been given to 3-D printing for industry, the craft scene in Singapore can also reap benefits from advances made in additive manufacturing.

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Digital synesthesia in product design. Building a vocabulary of physical interactions for a sensible quantified self

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Abstract

The paper explores the possibilities of presenting quantitative information in qualitative, expressive, engaging, and entertaining ways. To do so, experiments focus on a range of sporting activities, where numeric performance data tends to be prevalent, but there is also an aspect of self-awareness and community that can benefit from a connection enriched by carefully expressed data. In this context, through three design workshops, we examine the sensory and semiotic quality of the interactions, leveraging outputs in the form of haptic actuators, as well as subtle uses of lighting and kinematics. The exercises challenged participants to transform raw data into novel sensorial experiences through commonly available hardware (sensors and actuators) and software, constituting a meta-medium to be valorized with the same agility as conventional materials, albeit with an obviously shifting set of skills. Based on the scientific literature and experimental results, this contribution offers a mapping of possible values between individual and shared experiences, working towards a new vocabulary of tactile and kinetic experiences that may be useful for the creative industries.

Author keywords

sensorial quality; haptics; kinematic objects; experimentations.

Introduction

The boundaries between digital and physical reality are becoming increasingly blurred, paving the way for new forms of hybrid interactions and opening up new meanings in perception. While eXtended Reality strives for a socially interconnected "metaverse" via VR and MR visors, this contribution tackles with interactions that often bypass the visual channel in order to connect people to (or through) data in more sensory ways, considering also haptic actuators (a growing communication channel, Zannoni et al., 2021).

In many fields of application, including those outside of sports, tracking and monitoring technologies have entered the daily lives of people through various wearable devices for observing the physical, mental, and emotional states of individuals (Mukhopadhyay, 2015). This phenomenon of self-tracking via technological devices relates to the concept of the Quantified Self (QS) (Wolf et al., 2010), and can be considered a cultural movement dedicated to the collection of body data with the goal of assessing and improving one's own physical, mental, and emotional performance. But going beyond the technical possibilities, the QS phenomenon has generated debate around its sociological and ethical implications in terms of privacy (Thuraisingham et al., 2018) and equality (Lupton, 2015). In fact, while measuring specific body parameters offers objective data for evaluation and personal improvement, it also implies the continuous confrontation of a user's health and performance indicators with extraneous standards that may be above (or below) their realistic possibilities, leading to a potentially conflictual relationship between the QS and the sensitivity (Qualified Self?) of the users.

In contrast to human behaviour, which is based on perceptions and sensations, the data-driven approach to the self is capable of reconfiguring actions and responses that rely on objective measurements of data from devices, enacting a manipulation that "could result in loss of human free agency and autonomy and even deceptions of humans" (Stephanidis et al., 2019). As stated by Wiener (1950), technology has the power of influencing and changing human key values and behaviours, which is becoming increasingly evident in this era of rapid technological advancement and permeation in human society. This leads the research towards a more symbiotic relationship (Licklider, 1960) between devices and people, close to the concept of Human-Computer Confluence (Ferscha, 2016) and Human-Computer Integration (HCInt) (Farooq & Grudin, 2016; Mueller et al., 2020), leading to data-based communication through new forms of sensing, blurring the barriers between the physical body and the digital self.

Computational Thinking and sensorial interactions

This work is based on the assumption that Computational Thinking (the ability to define a step-by-step solution to complex problems; Wing, 2006) acquired through the practice of Learning by Doing (Bruce & Bloch, 2012) should be a part of every student's curriculum in order to better understand technology and develop a proactive approach to using technology for improving everyday life. The relevance of Computational Thinking (CT) is widely recognised and it is taught at various levels of general education or STEM-focused, from el-

ementary schools to universities (Sabitzer et al., 2014; Mannila, 2014; García-Peñalvo & Cruz-Benito, 2016).
At the elementary school level, for example, an innovative education approach grounded in project-based teaching is proposed by Lyu (2021),tackling the children's problem solving skills while assisted by the teachers. Another didactic approach by Rossano (2020), consists of teaching middle school students the basics of Arduino and coding through simple exercises and applying the newly acquired knowledge to real-life situations, like the management of a wooden rail crossing model. At the high school level, Yin (2022) uses a didactic process with four steps to show how using Arduino-based activities can improve CT and engineering learning.

On the level of higher education for the Design Profession, the ambitions of a CT-focused course can be more advanced, not only teaching but also inquiring about the possibility of turning digital, quantitative data into qualitative, sensorial feedback, and evaluating whether these can become an actual framework. Beyond innovative functionalities, Design has a particular responsibility for finding appropriate semantic associations. New sensory qualities and gestures may follow analogue metaphors or pure abstraction, based on the intrinsic nature of the information being communicated or controlled. This paper presents the findings of a series of workshops, carried out with students of (industrial/product) design, with the goal of experimenting with such new sensory qualities.

In particular, the general theme of sports has been chosen, as this provides wide opportunities for experimentation. Physical activity is already one of the main targets of self-tracking, and sports are mostly quantitative, measurable, while also including various layers of social interactions between players, trainers, and fans. Indeed, past research works have shown interesting experimental augmentations of sporting activities, both within the boundaries of existing sports and reinventing them altogether. An interesting example by Hribernik (2022) developed a haptic feedback interface specifically for water sports, which pose obvious challenges, in order to effectively communicate data during a physical activity session. Another take on the haptic approach is tackled in the creation of a superhuman sport, "DubHap," with the intention to redesign existing sports and adapt them to the new era (Chernyshov et al., 2018). With a design-driven approach, technology can also help to invent completely new "superhuman sports" for the AR/VR and sensing gloves, engaging citizens through a series of "ideathons" (participative design workshops) in order to pull in ideas, such as interacting with a virtual energy projectile that can only be sensed and not seen (Orikasa et al., 2017).
Taking inspiration from the above mentioned research, our workshops' participants started experimenting with isolated sensorial aspects of various sports, then proposed smart objects that highlight a range of possibilities, analysed in the last section of the paper.

Workshop structure

The workshop format, called "Smart Design Pills", has been developed for design students in the third BSc year, therefore with a solid background of creative exercises, modelling and presentation skills, but without any knowledge of interactive hardware & software prototyping or coding. The programme comprises three workshops that cover the fundamentals of prototyping, beginning with the simplest actuator and gradually increasing difficulty: LEDs and light signals are the theme for the first workshop, "Shiny Rhythms"; vibrating signals and tactile perceptions are studied during the second workshop, "Touching Signals"; while movement and kinetics are explored through the third workshop, "and Yet it Moves."

Each workshop is three weeks long and begins with an introductory exercise focused on computational thinking skills without digital hardware and software, by substituting and simulating the sensors/actuators with readily available tools and materials: the phone's flash and vibration motor are used for role playing, cardboard and clay for stop motion animation. Later during the first week, students learn about the sensors, actuators, and code necessary for the workshop, as well as studying relevant case studies of smart objects. The second step concentrates on defining a concept and developing a rough prototype of the group's interactive product in view of the third and final step, which is committed to creating a final prototype while also taking aesthetic factors into account.

For the purposes of this course, students were divided into 17 groups of two or three, and each was assigned a random sport. Numerous factors were considered in order to create a collection as diverse as possible, including the potential need for equipment, the degree of interaction (individual or team-based), and the settings in which the sports could be practised (gyms, particular outdoor settings, settings irrelevant to the practice). Based on their technical characteristics, the sports were divided into six macro-groups (water sports, balance sports, ball sports, racket sports, urban sports, and martial arts) to facilitate planning and review processes and the sharing of useful information between groups within the same macro-group.

Workshop 1 - "Shiny Rhythms," was based on the use of light signals via white LEDs. A couple of evocative images were selected for each sport, specifically drawing from visual, kinetic, and acoustic aspects, as inspiration or reference. The students were required to recreate each of these concepts using an animated light signal that included timing, rhythm, and intensity as variables, with the aid of particular apps that allowed them to control and modify the values. Sketches, notes, and illustrative graphs showing the intensity of the signal over time were required to document the brainstorming and design phases. Afterward, a brief video showcasing the three final performances had to be created.

Students were then asked to apply the knowledge they had acquired to a product that would incorporate the use of LEDs into their assigned sports activities as the actual exercise for the first workshop, proceeding in the three weeks process as described above. The final goal was to elaborate digital signals into a light performance that could visually express the qualities of the sport.

Workshop 2 - "Touching Signals", focused on experimenting with the perception of haptic signals using vibrating actuators. The materials provided for the introductive exercise were an illustration of the emotion spectrum (Plutchik, Robert, 1980) as well as a map of emotions perceived by the human body (Nummenmaa et al., 2013) that helped them identify the areas of the body where sensors and actuators should be placed. The introductory activity focused on the representation of a designated emotion through vibrating sequences. The purpose of the activity was to find haptic feedback for conveying information that is typically processed through visual or auditory channels during the training processes, athletic performance, and communication with other participants (fans, teammates,

coach). The actual three weeks long activity of this workshop requested the students to design a product that incorporated haptic actuators in sports activities.

Workshop 3 - "And Yet it Moves", requested to design a kinetic smart object capable of interacting with the athletes, the audience, or the sporting environment. To familiarise students with the concept of movement, they were asked to identify some key aspects of sport (e.g., strength, coordination, acceleration) and represent them through a stop-motion video, using clay. Subsequently, they were asked to focus on three categories (objects for training, for sport execution, and for communication), elaborating a concept for each situation, rough prototyping and physically simulating the interaction of their products. Based on the findings from this exercise, students designed the project for the third workshop.

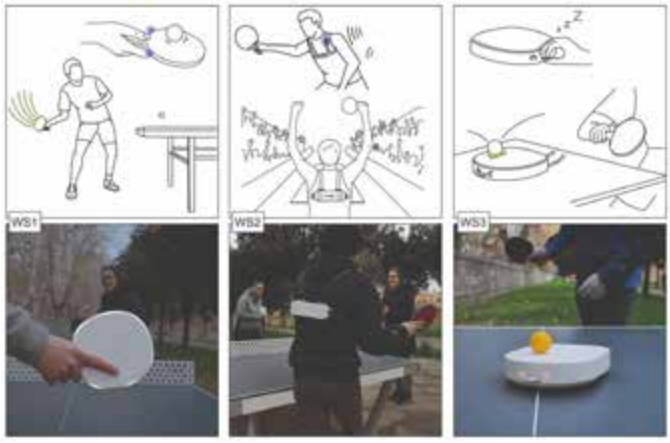

Figure 1. Top row: a storyboard for each project; bottom row: the prototypes resulted from the workshops.
Designed by: Barberis Lorenzo, Ciubotaru Gabriel Cosmin, Guarnieri Elena.

Results can be illustrated through the projects of the table tennis group (FIgure 1). The interactive table tennis racket designed for the first workshop features built-in LED lights that react to the ball's stroke through a shock sensor and the racket's movement through an accelerometer, providing a visually appealing indicator for the most spectacular (quickest, strongest) moves during the game. The product from the second workshop is a wearable harness for the player, equipped with vibration actuators on each shoulder. Each vibrating actuator responds to the audience's cheers on its respective side, giving the player haptic feedback on their surroundings without distraction from the game. Training the player with a small wheeled robot is the aim of the final movement-themed project. The robot is designed to run in random directions and it must be hit with the ball to raise the speed and therefore difficulty.

Interactive approaches

The 51 interactive projects developed across the three workshops lend themselves to a categorisation that can identify various aspects along which the projects are diversified. Prior to analysing our case studies, it's worth noting that past research has examined and theorised on qualitative design values in a variety of ways. Some of the methodologies that emerged from the research have been applied to the projects as a first step to approaching a more fitting system of values for this subject. Among the pioneers of Design for IoT, Rose (2014) categorised projects according to 7 possible characteristics: Glanceability (43% of the 51 projects fall under this characteristic), Gestureability (41%), Affordability (59%), Wearability (47%), Indestructibility (43%), Usability (56%), Loveability (33%). According to Rose, designing a product that exhibits all seven characteristics is quite difficult. In fact, only 10% of the 51 projects displayed one or two of the traits; around 30% displayed three or four; barely 15% displayed five out of seven; and only 4.5% presented six out of the seven characteristics. On the other hand, a more generic categorization such as the well-known "three levels of design" (Norman, 2004) - Reflective, Behavioural and Visceral - may be (even more) useful to better understand the product.

Beyond pre-existing categories, the traits of each student project were analysed separately, thus identifying a set of connotation parameters that were common to all of the projects. Each parameter presents two dualistic and mutually exclusive values: one that leans on a "personal" and "closed" aspect and one on a "shared" and "open" side. The parameters that have been identified are as follows, naming the "personal" value first and the "shared" value second:

P.1 - Instinctive / New language: Products marked "instinctive" appeal to the immediacy of human instincts and common knowledge, whereas products marked "new language" present a new vocabulary of symbols that the user must learn in order to interact with the device. An example of an instinctive project is a parkour-specific leg band that vibrates in the event of a violent landing, simulating the wave of impact from the ground upwards. A rotating and portable basketball hoop that can be attached to any vertical pole is a project that introduces a new language, revolutionising the traditional game of basketball.

P.2 - Individual / Collective: Products marked "Individual" are defined by a single user, whereas "collective" projects rely on the participation of multiple users who contribute to the device's functioning. The climbing belt is an example of an individual product that, through vibration, "pushes" and accompanies the climber towards the wall, correcting the position without the help of instructors. The floats that confine the water polo field demonstrate the collective aspect. These light up to show the intensity of the fans' cheers for the players in the water.

P.3 - Performance / Entertainment: The projects that present the value of "performance" are those focused on pure sports execution (competitive or training). Instead, "entertainment" indicates the projects that highlight the visual or spectacular aspect for those who are watching. The fencing target that moves to dodge the shots of the fencer is an example of a product for sports performance and training. The kinetic sculpture in the centre of the skateboard arena, which reacts to the noise of the fans, effectively expresses the concept of entertainment.

P.4 - Human-driven/ Device-driven: Products marked "Human-driven" react to user input, detecting human interaction and then providing feedback. On the other hand, the "device-driven" products are the first to provide an indication to the users to guide them through the practice. A bracelet designed for boxing fans is a "human-driven" product that provides vibrant feedback to the wearer based on the power of the boxer's blows. Whereas, a small wheeled robot equipped with a chalk that traces a random path on the floor for the skater to follow is an example of a "device-driven" approach.

P.5 - Wearable/ Tangible: These two values indicate the product's location in relation to the user: "Wearable" projects are products that are actually worn by the user and remain in direct contact with the body; "tangible" products are physical devices that can be either individual objects or applied to sports equipment. An example of a "wearable" device is composed of two leg bands designed for paddle tennis that vibrate alternately to indicate to the player the correct rebound to keep during the game. A "tangible" device applied to the hockey stick warns the player by vibrating when the disc moves too far, allowing them to maintain control.

The visualisation of the data (Figure 2) has made it evident that the majority of the products that resulted from the course tend to place in the "personal" sphere (65%) rather than the "shared" sphere (35%). In fact, the majority of the projects displayed characteristics that were considered personal (instinctive, individual, performative, human-driven, wearable). The third workshop marked a high point for wearable product design, which is one of the main causes of this result. This outcome demonstrates that the interaction between humans and devices is mostly viewed as a private experience, but on the other hand, the tendency to involve the collectivity is relevant. Perhaps as human-machine contact advances, it will become more diverse and inclusive to the point where it serves as a tool for strengthening human unity.

Figure 2. Result of the systematisation of projects through the "personal" and "shared" parameters.

Conclusions

The research conducted to date has made it possible to test the "Smart Design Pills" didactic format with the goal of refining and verifying it in the future also in other fields. The programme includes the formulation of three workshops that focus on the human-device symbiosis, in this specific case in the field of sports, with the aim of transforming quantitative digital signals into sensory and qualitative interactions. Each workshop focuses on a fundamental concept and is approached through introductory activities giving the participants an alternative perspective before tackling the actual project. The products obtained from the workshops confirmed the ability of the participants to start from a basic level of interactive prototyping, but still achieve meaningful results, developing significantly their skill of computational thinking in the meantime. Five versatile parameters with polarised values that lean either to a "personal" sphere or to a "social" sphere have been developed based on the evaluation of the projects that resulted from the course. The outcome of this distinction shows a propensity to view human-machine connection as an individual experience, however the encouraging quantity of collective interactions may provide an opening to a more expansive definition of "human-device" interaction.

From the perspective of the Cumulus community, it would be interesting to see whether and how such principles can be applied by students (and professionals) of different cultural backgrounds (compared to Rome, Italy) and in different fields of activity. Finally, the research confirms the value of Quantified Self as a tool to "reflect, learn, remember and improve" (Wolf, 2010) on the individual's performance, but also confirms a possible "qualified self" approach by treating raw numerical data as a design material, that can lead to engaging experiences and ultimately a more a symbiotic experience between people and data.

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Digital content that offers experience of listening to crystalized music

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Abstract

Presently, many people are listening to music through streaming services. Though listening to music in such a way is convenient, we feel it lacks the anticipation of encountering unknown music like we felt by looking at the album covers. In addition, listening to a vinyl record requires some errands; however, the effort yields a rich and immersive musical experience. In this paper, we design an alternative way to appreciate music that would provide a similar anticipation and immersive experience to encounter music. In the proposed experience, users perceive multiple 3D objects as crystallized music and select a song from them. When an object is submerged in water, bubbles are generated as part of the object dissolves, and music begins to flow. We developed an interactive system that realizes such an experience by creating objects, each with an IC tag inside, and preparing a water tank with a tag reader on the bottom to identify the object. Music objects are created from the sound source and molded by using 3D printer. We tested the interaction and confirmed that the system functions well as expected. We also ran a questionnaire to acquire users' feedback for designing a better experience. Our objective with this research is to design a novel way to appreciate music. The experience consists of listening to music and appreciating it also by sight, by materializing the tune as a 3D object. Digital technology has generally been used to achieve fast and convenient functions. In contrast, this work attempts to design a "slow" experience in which one is confronted with music more carefully.

Author keywords

Digital Content; Interaction with Music; Interaction Design; UX Design

Introduction

We have encountered musical compositions in many different ways. When listening to vinyl records, we have sometimes chosen a song based on a preference for its cover. Presently, people encounter new music through a streaming service by selecting a tune directly or following suggestions and playlists created by someone else. The latter seems to reduce the number of unexpected encounters with unknown music. We think there was the pleasure of collecting music before, by possessing the records and discs. However, such pleasure also seemed lost as people began to listen to music through streaming. Observing such situations, we devised an idea to conceptualize music as a tangible entity when we generally regard them as digital data now. We decided to design music as a crystalized object that produces sound when dipped in water and dissolving. We expect users to feel the music melting out of the object. We aim here to design an alternative experience of appreciating music and develop a system to realize it. We produce an object of music tune by analyzing the sound source and converting the music to a 3D shape as per a specific rule. The crystal's appearance helps in imagining music, as the shape represents the characteristic of music. In addition, we think one could feel like possessing music more directly than owning it as a digital file. We expect this system to offer a novel experience for encountering music, not only providing entertainment. This research can also be regarded as an attempt to design a new experience by giving different attributes from its original perception, allowing the viewer to appreciate the subject from a different perspective.

To realize the idea, we develop a system that identifies music tunes by objects. The system equips a water bowl into which a user throws the object. The object is molded by 3D printer, and an IC tag is installed inside it. The tag is read by a tag reader at the bottom of the bowl, which lets the system match the object with specific music. To make a representation of music melting out, we insert a material like dry ice into the object and let it produce bubbles when submerged in water. We examined the interaction with the developed system and multiple objects, each materializing different music, and confirmed that specific music is played by the corresponding object. To evaluate the experience provided by this study, we conducted a survey and administered a questionnaire to examine whether the system offered an engaging approach to music.

Experience with Crystalized Music

We considered what if we could crystalize a piece of music so one can take it by hand. Since the crystallized object is

music, we should be able to expect to listen to the tune by dissolving it. As it would be natural to expect a different shape from different music (Figure 1), you will have fun imagining the original music from its shape. To make it happen, we designed a mechanism for the interaction. We also prepared a method to transform a music tune into 3D geometry for creating crystalized music objects.

Figure 1. Concept of crystalized music.

We expect a user would have the experience shown in Figure 2. First, the experience begins with viewing multiple music objects. Each object represents a different music. As the shapes represent certain musical features, they are generally different in their looks; some are spiky, whereas others are smooth. Therefore, the user can imagine the tune from the object's shape. A user would choose one to listen, not knowing what music it is. Once chosen, one can throw the object into the water to dissolve it. The user will see the bubbles forming as the object dissolves, and the music starts to play with a lighting effect appearing simultaneously. When it is resolved entirely, the sound will cease.

We aim with this research to propose a different perspective of being involved with music. First, we want to provide a sensation of feeling music crystalized as an object. This expression realizes the transformation of music, a temporary phenomenon, into something static and tangible that one can appreciate before listening to the sound. In addition, users can feel the music by watching and touching the object. That would allow users to select a tune to listen to in a different approach than generally practiced. We expect this interaction would lead to emphasizing the music's transient nature because users will observe the event also by sight.

To establish an immersive experience with our approach, we wish to have the shapes somewhat reflect the music's characteristics. However, we do not want to create an object referring to a personal impression that would differ for each individual. Therefore, we need a method that automatically transforms the music into the sculpture design according to a particular rule or algorithm. We started by employing a simple transformation rule that converts the sound wave pattern to a 3D object. By finding an appropriate transformation rule, people could envisage music by browsing the objects' shapes. One could find similar music by sight but not through recommendations provided by a streaming service. That would be another different experience this approach would provide. Seeking an ideal algorithm is a topic for future work.

Figure 2. Entire process of the experience.

Related Research and Works

Various ways of interacting with music have been proposed. Some make the experience an installation that facilitates a specific space to appreciate listening to and interacting with the music. The Intelligent Street is an installation work that designs a space for interactively listening to music, where people can affect the music by sending text commands via smartphone (Lörstad, 2004). Sound Forest is another installation work, a room with numerous illuminating interactive strings (Frid, 2019). Multiple people can play with a string simultaneously to emit a sound and share the experience. Mayer et al. (2014) have developed a system in which two users collaborate to create music and visual effects by interacting with two-sized semi-sphere domes. While these works and ours share the objective of attempting to design a novel experience of interacting with music, theirs also aim to provide interaction among the individuals entertaining the experience.

From an interaction design perspective, our approach can be considered a variation of designing a tangible user interface (TUI). A first of that kind happens to take a theme related to music (Ishii, 2004). Our work shares the concept of providing an alternative experience relating to music. However, with Ishii's Music Bottle, music is still the same sound phenomenon, though the interaction with music differs from regular listening practices. Our approach is different in making music a tangible entity to interact with. reacTable (Kaltenbrunner, 2006) is a synthesizer system employing a tangible user interface (TUI) to create sound. The user synthesizes a sound by putting circular and cubic objects on a circular table. The visual effects of the objects appear on the table when they are placed on the table. When positioning multiple objects in a neighborhood, their effects link in creating a sound. There is still other research on designing specific tangible interfaces. "The Table is The Score" (Levin, 2006) proposes to use spectrogram shapes formed by a rubber or felt and place them on the table to play sound. In adopting TUI, many approaches seem to treat objects as interfaces. In the case of Ishii's Music Bottle, the interaction is designed by fitting music into the metaphor of a bottle, as a thing to keep something in it. We believe that the interactions with a TUI must be designed so that the object is well integrated with the context of the content, rather than simply being used as an interface. We conducted this study considering this concept.

In realizing this work, we have sculpted the music as a three-dimensional object. Similarly, several attempts have been made to transform music into a visual representation. Narratives 2.0 (Dittrich, 2008) is an example of music visualization. It uses the frequency of a music channel to determine the turns of lines and colors in creating a visual representation. Another visualization work created for a poster (Bremer, 2020) utilizes the music's data and includes information on how the tune has been listened to at a streaming service. In addition, var-

ious methods have been proposed for converting music into visual representation (Lima, 2021, Khulusi, 2020). Macrogroove (Chable, 2019) attempts to interactively convert sound into 3D shapes. A common approach among these studies and ours is that the shapes and colors are automatically generated from the music data according to a specific rule rather than through individual tastes. The resulting expression may not conform to human senses; however, it may lead to discoveries about a tune, providing a different perspective on appreciating music.

Implementation

System for Playing Sound

The system equips a water bowl where users can drop the object. To realize the experience explained in the previous section, we need to implement the following functions for building the system.

1. Identification of objects
2. Detection of an object submerged in water
3. Control of playing sound
4. Illuminating effect (optional)

First, the system should be able to identify the object chosen for playing music. Several approaches can be used to identify the object. In this study, we inserted an IC tag into the objects. We employed this method because the system can simultaneously detect an object's immersion in the water by placing a tag reader at the bottom of the water bowl.

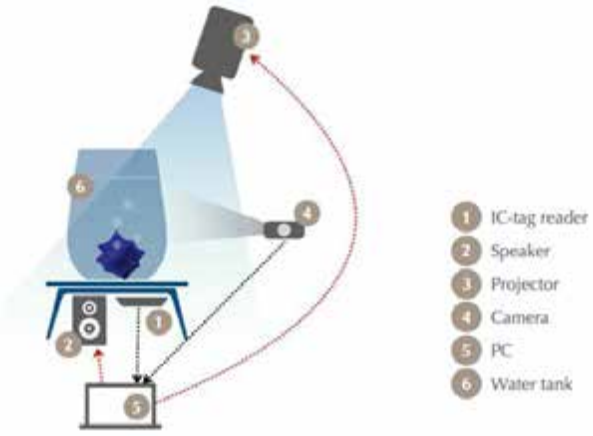

Figure 3. System overview

When the system detects an object submerged in water and identifies the corresponding music tunes, the system starts playing the sound via a speaker at the bottom of the system. Simultaneously, the system projects a visual effect onto the surrounding plane as a supplemental representation of sound. An extra function is required to stop the music by observing the melting progress. However, we have not implemented it yet. It is a topic for future work. Figure 3 illustrates an overview of the system.

Crafting of Music Objects

We need the followings for preparing the music object.

1. Conversion of sound data to a 3D shape
2. A mechanism to identify an object
3. A mechanism to make the object look soluble in water

We do not want to manually design a 3D shape of each music by relying on individual sensitivity and preference. It would be ideal to have an automatic translating rule to create the objects of many different musical tunes. We are currently adopting a method that transforms the sound volume and pitch changes into a 3D object. The objects are then fabricated using a 3D printer (Figure 4). We make a hole in the object for placing an IC tag, as shown in Figure 5. We also place a soluble material in that space. This mechanism generates bubbles, creating the appearance that the object is dissolving in water. The object itself remains unaltered even after the bubbles subside with the current setup, though. We also attempt to prepare molds and create objects out of meltable materials. However, placing an IC tag inside an object created this way is awkward because the tag remains after it melts. Therefore, we need to design another system for object identification, which we have not implemented yet.

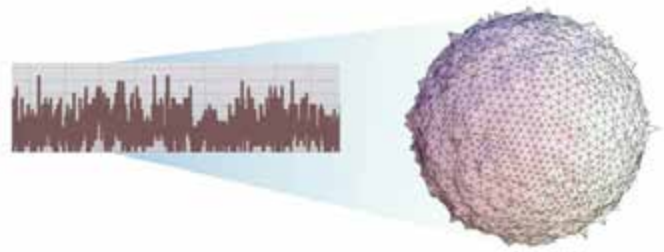

Figure 4. Conversion of music data to a 3D shape.

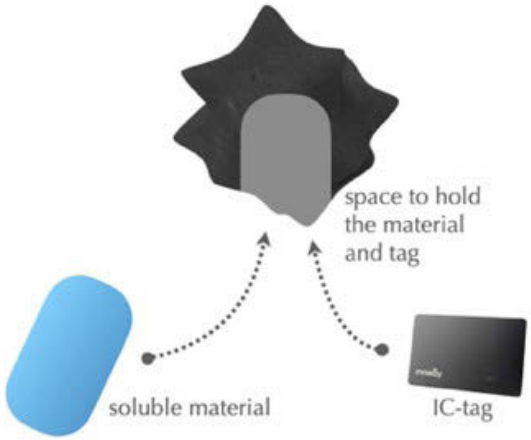

Figure 5. Structure of the music object

Evaluation and Discussion

To verify that the system functions properly, we threw the objects into the water to examine if it correctly identified them. We threw three different objects into the tank in random order 20 times, with 16 times success. The failures were not due to misrecognition but because the function to recognize them was not activated properly. We interviewed 11 persons on their experience with the system. 10 answered that it was an entertaining and impressive experience, and eight answered that they felt music was melted out from the object. The results suggested that the intention of the experience was conveyed to the participants, though we consider further improvements are necessary to provide the experience more realistic.

This work offers the users largely two different experiences. One is choosing an object by imagining the music by its shape, as shown on the left image of Figure 6. The other is to feel the music as if it is melting from a solid object (Figure 6, right, Figure 7). To make the first experience more affluent, we believe the object's shape should reflect the music's characteristics more. It would be possible to extract various other attributes that give the music its characteristics, such as the length of notes and the frequency of specific scale changes on the score. In this study, we only considered shapes to represent a piece of music; however, attributes like color, tactility, and weight could also be regarded as representational elements. Reflecting these in the model is an issue for future research.

We have added some small interaction designs to reinforce the feeling of listening to crystallized music. After the system detects an object is submerged, an interval is inserted before the music begins, making the sound start at a low volume and increase in volume over time to match the amount of bubbles. Another design is applied to the music's sound. If the sound is clearly audible, users cannot feel the music is playing underwater. Therefore, in addition to placing the speaker at the bottom of the water tank, we have digitally converted the music so that it sounds like it is playing underwater. These small designs are not necessary to achieve functionality. However, when creating an experience, we believe it essential to mind these small details. Currently, the object remains after the bubble and music ceased because it is plastic. However, we want the object to disappear to express the one-time nature of crystallized music. We consider this would alter the experience further.

Conclusion

To design a new experience of appreciating music, we devised the concept of listening to music by melting a crystalized object. The innovation of this study is designing music

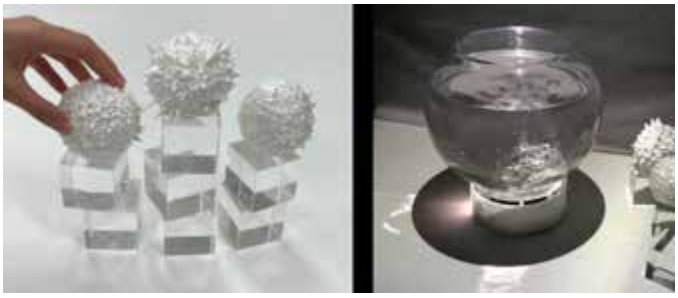

Figure 6. Choosing a music (left), music and light are coming out from object (right)

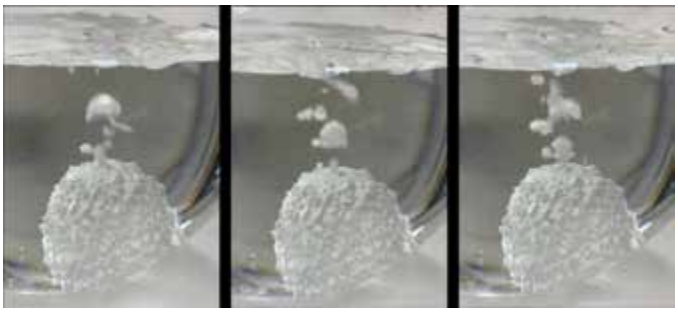

Figure 7. Bubbles coming out of the object

itself as a tangible entity. Further modifications are required to make the user's experience of listening to the crystallized music melted out more natural. Having reviewed the result of the user experiment's feedback, we became aware of the need to reconsider the design method for the object's appearance. However, we believe we succeeded in demonstrating this idea's feasibility. In the future, we would like to revisit the molding of objects and formulate conversion rules that will produce many variations in object design. We did not design this system for listening to music in daily use. The experience would be one that users would encounter in exhibitions. The experience must also be evaluated from such a viewpoint in future work.

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The body can not be thought: design practice at the intersection of human-computer integration and critical disability studies to develop new paradigms for health and well-being

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Abstract

This paper explores the intersection of Human-Computer Integration (HInt) and Critical Disability Studies (CDS) to explore how a posthumanistic epistemology in design can produce knowledge and know-how for the application domains of Health and Well-being. To use disability as a catalyst for innovation, a rethinking in the philosophy of sciences is necessary to establish knowledge production that emerges from new fluid politics that operate in 'composition' instead of 'organization'. By placing an emphasis on nomadic practices that move beyond fixed borders, the encounters between Disability Studies or Human-Computer Integration can produce situated, embodied and contingent design knowledge that study deviant and complex embodiment, and the kinds of alterations of human characteristics and abilities through technology. The first section of this paper explores the rethinking in the philosophy of sciences. The second section argues for a posthumanistic epistemology in design, which can be seen as the perfect way to produce situated, embodied and contingent design knowledge on the intersection of HInt and CDS. The final section of this paper highlights the potential for the disciplines of Somatechnics and Soma Design to engage in each other's body of knowledge to produce transformative knowledge through a shared focus on deviant embodiment and disability. The takeaway message of this paper is that the intersection of HInt and CDS potentially leads to new – otherwise overlooked - insights on the human-technology relationship, and therefore can take part in the historical strive for man-machine symbiosis. The posthumanist epistemology allows for alternative ways of thinking that move beyond the current Humanist perspective, and builds on a plural, relational and expansive foundation for the development of design practices that catalyze innovation in the application domains of Health and Well-being.

Author keywords

human-computer integration; critical disability studies, design epistemology, philosophy of science; disabled body, disability, deviant embodiment, complex embodiment; conflict, connectivity, creativity; design practice, nomadic practice.

Introduction

Current developments in the field of Human-Computer Integration (HInt) (Mueller et al, 2020) shift the focus away from the 'stimulus-response' model of HCI towards integral relationships between humans and computers (Danry et al., 2021), that have the potential to fundamentally alter human characteristics and abilities through computing systems (Andres, 2023). The paradigm shift towards HInt can be seen as a continuum from interaction to integration, which extends but does not replace the HCI field (Farooq & Grudin, 2017). HInt operates from a different worldview than the often traditionally narrated stories on the progression of man, which are rooted in ideas on Enlightenment embodiment (Mitchell et al., 2019). This worldview 'proclaims to the Renaissance parameters of Vitruvian symmetry and aesthetic perfection' (Braidotti, 2013). In Human-Computer Integration, which is part of the historical strive for man-machine symbiosis (Licklider, 1960), provides an opportunity to question, collapse, or even eliminate traditional perspectives on what it means to be 'human'. These relationships between humans and computers revolve around symbiotic partnerships between humans and computers (Semertzidis et al., 2022), which means that the relationships exist upon interdependence, focusing on 'complex relations of trust, respect, dependence and communication' (Wolfe, 2010), rather than putting the emphasis on values of agency, ownership, and autonomy. An example of such a scenario is the bodily integration with 'computing systems that can sense, interpret, and automatically act to body-based and contextual signals' (Andres, 2023). Designing for the 'webs of asymmetrical relationships' (Shildrick, 2022)

in bodily integrated systems (Mueller et al., 2021) requires a deep understanding of micro-biologies, (bio)assemblages, or phenomenology of organ and tissue (Shildrick, 2022). Alternative ways of thinking about embodiment are necessary to move beyond the separate disciplinary structures that exist in scientific organization. Critical Disability Studies (CDS) historically has required alternative ways of thinking as it has always been 'about the kind of complex relationship between the body and the machine' (Braidotti, 2006), and 'has always contravened the traditional, classical Humanist conception of what it means to be a human being' (Goodley, 2017). Therefore, Critical Disability Studies can be seen as a well-established body of knowledge, that starts from traditionally narrated divisive and pathologized bodies to uncover alternative materialities to bring bodies and minds into being (Mitchell et al., 2019). In this paper we highlight a posthumanist epistemology for design at the intersection of Human-Computer Integration and Critical Disability Studies, to allow us to move beyond the current Humanist perspective. A posthumanist epistemology builds on the development of design practice through a plural, relational and expansive foundation, aimed at the potential catalyzation of innovation in the application domains of Health and Well-being. The *first* section of the paper starts with a rethinking of the philosophy of science, moving away from rationality-oriented (humanistic) philosophy towards a relationality-oriented (posthumanistic) philosophy. The *second* section explains our ideas on posthumanist design practice further in depth and emphasizes a compatible connection between HInt and CDS. The final section highlights the potential for the disciplines of Somatechnics and Soma Design to produce transformative knowledge for both Critical Disability Studies and Human-Computer Integration through a shared focus on deviant embodiment. We *conclude* with a short reflection on the intersection of HInt and CDS, and how this potentially leads to new – otherwise overlooked - insights on the human-technology relationship.

CONFLICT – Paradigm shift from rationality to relationality

As this emerging paradigm shift in Human-Computer Integration has more to do with 'becoming-in-the-world' (Shildrick, 2022) than with 'being-in-the-world', the contingency of its existential-ontological evaluation (Keane, 2015) requires a rethinking in the philosophy of sciences to establish alternative modes of knowledge production which are able to integrate the disciplines of Critical Disability Studies with Human-Computer Integration.

Philosophy of Science

The ongoing debate regarding the potential meanings of technology in the application domains of Health and Well-being often draws upon 'models of explanation in medicine, concepts of health and disease, clinical judgment, as well as the meaning of human dignity, the definition of death, or the significance of beneficence, virtue, and consensus' (Meacham, 2015). However, these debates often start reasoning from out of the medical, or the social model of disability, which emphasize the context of 'human enhancement' (medical model) or 'corporeal surroundings' (social model) (Retief & Letšosa, 2018) of the disabled body. These models regard the disabled body as being inferior (medical model) or as something to be ignored (social model; Barnes et al., 2010)). The disabled body has been studied for centuries through a Humanistic perspective, which poses rationality to the forefront of the scientific process. This work, influenced by Anglo-American thinkers, such as Popper (falsifiability), Kuhn (paradigms) and Lakatos (research programs) rely on objectivist viewpoints to produce knowledge and work from a disciplinary perspective (Chimisso, 2006; Darwin, 2010; Walker, 2010). In the Humanist worldview, disciplinary structures are operating separately, and researchers are often driven towards choosing one of these structures to move forward in the scientific process. This could potentially have supported the objectification and further pathology of the disabled body, since the influential medical model emphasized on determining law & principles (Major Science) rather than questioning and investigating the relationship that these disciplines have to themselves (Minor Science). However, knowledge production in the 21st century can no longer be created only through one disciplinary structure. In contrast to the search for objectivity and universality in the scientific process, the deployment of the posthumanistic worldview, as described in French philosophy of science by famous philosophers Deleuze, Guattari, and Foucault, bases its worldview on relationality rather than rationality. This paves the way for a pluralistic, relational, and expansive way of thinking in design and design practices (Marenko & Brassett, 2015). For the intersection of HInt and CDS, this can be translated towards a design epistemology that emphasizes nomadic design practice without fixed borders. Design practices on the intersection of HInt and CDS revolve around 'making hacks into reality' (Von Busch et al., 2022), and make use of a kind of 'designerly realism' (Von Busch & Palmås, 2023) to explore, unveil and excavate power relations shaping the production and dissemination of knowledge, and vice versa, knowledge production in turn shapes and reinforces those power relations as well. These design practices look like a intertwined spectacle of 'competitor, allied, non-allied, collaborative, competitive, contradictory or aligned practices of design' (Wakkary, 2020), that result in new fluid politics which operate 'in composition' rather than 'organization'.

CONNECTIVITY – Posthumanist epistemology in design

The posthumanistic epistemology in design (Wakkary, 2020) emphasizes nomadic practices that move beyond the fixed borders of the disciplines of Disability Studies or Human-Computer Integration, and situate in specific places, dealing with embodied encounters and unexpected contingencies.

Posthumanistic epistemology in design

Bodies matter, in 'the fleshiness of the world which inhabits us and is inhabited by us' (Merleau-Ponty, 2012). The experience of partnership in the fragile, sensitive, and intimate characteristics of deviant embodiment with its technological instrument 'constitutes the self' (Shildrick, 1997, 2009; Shildrick & Söffner, 2017). To comprehend the kinds of qualities that can be found in the paradigm shift from Interaction towards Integration, we need to think about different ways of looking at knowledge, practices, techniques, design tools and methods - the 'dispositifs' (Deleuze, 1992; Marenko & Brassett, 2015) - through which our bodily 'becoming-in-the-world' (Shildrick, 2009) is formed. In short, *how* we come to 'matter'. This 'matter(ing)' - represented in the 'active forms

and repertoire for how it plays' (Mitchell et al., 2019) - can be seen as a body of knowledge - 'learned by doing' - that is already well-developed in Critical Disability Studies. The daily encounters of resistance to power and dependency, as well as the daily grappling with the gritty (painful, (Siebers, 2015)) and messy (pleasurable, (Shildrick, 2009)) materiality of the disabled body can be seen as knowledge about the relation of human *difference* to social organization and human perception (Siebers, 2015; Mitchell et al., 2019). A society that wants the disabled person to 'pass' (through playing roles) or 'masquerade' (through disguising the disability) their difference (Mitchell et al., 2019) potentially does not shy away from the same mechanisms when Human-Computer Integration becomes part of everyday life. The institutional, physical, and administrative mechanisms (Deleuze, 1992) are important because our bodies become part of the systematic assemblages that affect how our bodies and minds develop. Rather than pursuing design to be just about the physical world around us, it also encounters the way we interact with that world through language and ideas. New politics of fluidity could come out of the possible question how deviant embodiment – meaning the alteration of human characteristics and capabilities - is treated in relation to 'complex embodiment' – meaning disability materiality and its 'the fruits of the interaction between body, mind and environment' (Siebers, 2015).

CREATIVITY – Somatechnics and Soma Design

Although Somatechnics is not directly linked to its pragmatic counter half Soma Design in HCI, these disciplines do relate. Therefore, we state that these disciplines should move beyond their own existences and get involved in each other's body of knowledge, assemblage, and reality-making to embrace the high-end potential for knowledge production that can result out this.

Deviant and complex embodiment in Somatechnics and Soma Design

Somatechnics, as explored in Critical Disability Studies, is used to re-imagine the embodiment of technobodies (Verhoeff & Van Der Tuin, 2020) through 'multifarious ways in which embodiment exceeds established boundaries and meshes with non-human entities' (Shildrick, 2022). 'Tekné' refers to ways of seeing, knowing, feeling, moving, being, and acting in situated contexts through the body structures and 'active forms of interplay' (Easterling, 2012) of the embodied subject, including practices such as politeness, elegance, poetry, and language. Somatechnics critically engages with the ethico-political implications of a wide range of practices and techniques (Shildrick, 2022) and emphasizes the importance of understanding the body in relation to the materialities of the world. It calls for 'a recognition of the body in the world as an artifact wrapped up, entangled and produced by the materialities of that world' (Sullivan, 2012). In HCI, the design practices of Soma Design (Höök, 2018), 'soma' can be recognized as the unity of mind and body, intellect and experience, and Soma Design Theory engages in experimental activities that 'will always depend on the affordances of the technologies and materials used to shape the designs (Höök, 2018). Soma Design has interaction design at its base, meaning that 'it is always the study of the socio-digital material: the coming together of people with designed interactive artifacts and the behaviors and experiences generated in the combined material of people, practices, tools and design.' Both Somatechnics and Soma Design emphasize the transformative relationships between the body, environment, and materiality, and exemplifies the unique knowledge that arises from interactions in the 'enmeshment of body-material and environment-material' (Mitchell et al., 2019). A shared focus on the complexities in deviant embodiment, whether represented in Critical Disability Studies or Human-Computer Integration, could potentially teach us how to design for artefacts that bring something new to the world that may otherwise go unrecognized (Mitchell et al., 2019).

Conclusion

In this paper we explored the intersection of Human-Computer Integration (HInt) and Critical Disability Studies (CDS), to learn how this intersection can become a catalyst for innovation in Health and Well-being. Human-Computer Integration (HInt) shifts the focus away from the 'stimulus-response' model of HCI towards integral relationships between humans and computers. As this emerging paradigm shift has more to do with 'becoming-in-the-world' than with 'being-in-the-world', the contingency of its existential-ontological evaluation, requires a rethinking in the philosophy of sciences is necessary to establish alternative ways of knowledge production which move away from the Enlightenment perspective and engage with a posthumanistic epistemology in design, which produces knowledge and know-how through nomadic practice beyond the fixed borders of the disciplines of Disability Studies or Human-Computer Integration. The body of knowledge that emerges from the interconnected disciplines potentially results in new fluid politics operating with situatedness and embodied repertoires and contingency. The symbiotic partnerships of humans and computers, which is embedded in Human-Computer Integration, will be studied in design practices, and be intertwined with the matter and 'mattering' of disability materiality. The compatibility of HInt and Critical Disability Studies is further explored in the disciplines of Somatechnics and Soma Design which can produce transformative knowledge for both Critical Disability Studies and Human-Computer Integration through a shared focus on deviant embodiment.

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Did you know that... the many traumatized and disabled veterans returning from WWI resulted in more acceptance of disabled people participating in the workforce? Also, the famous Bauhaus model (Otto & Rössler, 2019) originated from the idea that this educational model would make it possible for a heterogenous group of artists, designers, craft-makers to learn together, despite their different backgrounds and WWI traumas. Bauhaus' emphasis on 'making' and materiality redefined what design can do for society amidst the leftover anxieties and revolts of the past.

Metaphysical instruments: prototypes for hybrid and live music-making

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Abstract

We present a series of musical instrument prototypes that inquire about how live music can be produced simultaneously in the tangible world and within the metaverse. Our study is centred around a workshop with seven young Interaction Design students and follows a Research-through-Design approach. We invited participants to ask what musical instruments for the metaverse should look like? how they are played? and what affordances do they provide for both tangible and virtual audiences and performers? Participants prototyped working electronic musical instruments that can be played and listened to in both the real world and in virtual space. We took a Critical Design stance and followed a vision-driven design process, foregrounding the non-existent rather than problem-solving or market demands.

The resulting physical prototypes deviate from existing musical instruments and offer novel interactions that affect how music is performed and listened to. Our findings show that hybrid music-making provides possibilities for collaboration, explorations of scale between tangible and virtual worlds, and notions that challenge who is in control of the music-making process. We also analyse how mapping between senses and feedback drive experiences for performers and audiences alike.

Author keywords

Metaverse; virtual reality; internet of things; music-making; live performance; prototypes.

Introduction

The digitisation of sound dramatically transformed music, its production, distribution, and consumption. Since the disappearance of the mix-tape in favour of mp3 players and the usage of samples from online files in live performances, digitality has blurred the roles of musicians, distributors and consumers (De Notaris & Savonardo, 2022). As Internet connections grew faster, mobile and broadly available our lives became mediated by online services and social media platforms. Our tangible world is increasingly interwoven with software and the idea of inhabiting virtual environments -the metaverse- has gained momentum with attempts to turn it into reality (Ball, 2021; van der Merwe, 2021). In this work we explore how music can simultaneously be performed and listened to both in-person and within the metaverse. We focus on musical instruments as tangible and virtual objects that emit sound in both of these environments.

With the metaverse beginning to be recognized as a space for musical opportunity, we ask ourselves how live music can be performed and experienced within it. There has been some research around networked music performance (e.g. (Rottondi et al., 2016)) and some companies (e.g. Sensorium Galaxy, Mizic.io) are starting to offer virtual reality (VR) and hybrid concerts, with some of these happening within video game environments (Groux, 2020). Attention has also been placed on how networked music enables collaboration between musicians and enhances audience participation (Carot et al., 2009; Xambó et al., 2017; Yamchareon & Herkenrath, 2005). These studies focus mostly on the technicalities of synchronization or on the social aspects of collaboration and how they exist online. There is however little work around the design of musical instruments for online and VR performance with Serafin and colleagues (Serafin et al., 2016) and Turchet (Turchet, 2019) presenting some ideas and guidelines. The instruments described for VR and networked performances in these works resemble traditional instruments such as guitars, xylophones and assorted percussion instruments. We therefore centre our research on what novel instruments for hybrid performance look like, how they are played, and how they sound; trying to distance our work from existing instruments.

Focusing on instruments as objects allowed us to follow a Research-Through-Design methodology (RtD). Taking ideas from Frayling (Frayling, 1993), Gaver (Gaver, 2012), Andersen (Andersen, 2014) and, Wensveen and Matthews (Stephan Wensveen & Ben Matthews, 2015) we consider the process of discussing and developing prototypes as a form of inquiry. Since our research questions revolve around objects which do not yet exist we find Critical Design (Dunne & Raby, 2001) to be a useful frame for our design activities as its vision-driven approach allowed us to consider possibilities that are neither problem-solving nor market-driven.

Metaphysical instruments

Using prototypes as objects of inquiry invited us to write a brief guiding the research and development of musical instruments for hybrid performance. We named the brief *Meta-*

physical Instruments, a combination of the words *Metaverse* and *physical* that also references philosophical metaphysics. Metaphysics' ideas of *being* were useful for exploring how reality and experience differ within the Metaverse and outside, however our engagement with metaphysics was superficial as an in-depth analysis was beyond the scope of this work.

Our brief considered the divergent experiences of performing and listening to live music within the metaverse versus tangible space and prompted the following questions: How should instruments for hybrid performance be played? how should they sound? What social opportunities are there for live music in VR? And what novel experiences can VR provide for live music? These questions were broad and ambiguous allowing participants to project and use their own definitions of music, instruments, and live performance.

Workshop

Given the complex skillset involved in making electronics and VR we took inspiration from Bowers and colleagues (Bowers et al., 2016) in organizing an open-ended workshop that leveraged participants' existing knowledge. We invited interaction design students to a 12-week workshop. Seven undergraduate students (authors four to eleven) joined and divided themselves into three groups. Participants were in the second year of the Design for Digital Media and Technology programme at CENTRO University and had knowledge in programming, 3D modelling, animation and digital drawing. The first four weeks of the workshop were spent developing skills in electronics, microcontroller programming (ESP-32 and the Arduino IDE), digital manufacturing (3D printing, CNC mills and lasers) and VR development using the Unity game engine. The final eight weeks were devoted to prototype production.

The workshop started with a launch presentation explaining the brief and an outline of existing experimental musical instruments was provided. We wanted to distance ourselves from stablished categories of instruments such as (Temilola, 2020; Turchet et al., 2022) and encourage participants' definitions of what an instrument is and can be. Following our Critical Design perspective they were also introduced to vision-driven design processes. A short description of each of the resulting prototypes follows.

CQNC: Community in Quest for Noise Connection

Patricio Pous-Pierson, Alejandro Lobo-Barrera, and Jordi Fragoso-Terreros developed CQNC (pronounced sequence). It bridges the metaverse and tangible reality through real-time sound recording. CQNC uses field recordings to produce music and explores how these can work as an instrument. It requires at least two players, one using a VR headset while the other physically carries a device (Fig.1, left) capable of recording sounds and uploading them to a server.

When a recording is made it is downloaded into VR and represented as a ball. Users can then place sounds into a playback area (Fig.1, right). Sounds in this area are looped and mixed into a single output. A sound's volume is modified by moving it up and down in space and its playback speed and pitch are controlled by rotating the sphere. New recordings increase the samples available for mixing. In VR players compose complex soundscapes from samples recorded live in distant environments.

Figure 1. The CQNC sound recording controller (left) and its VR environment (right) showing the playback area and the sounds it contains.
Video documentation can be found at https://en.centro.edu.mx/3JC4yd1

Conditioned Freedom (CF)

In CF Paola Ferrari-García and Ximena Peña-Rios present an interactive sound installation. It provides contrasting experiences for tangible and VR users by placing one of them within a woven structure (Fig 2, left) filled with light beams and annoying sounds. Blocking a light mutes one of the sound channels and makes the space more bearable. Within VR users experience an open landscape (Fig 2, right), an opposite environment to that of the physical installation. Each time a light is covered in the installation a relaxing sound is played in VR accompanied by a visual effect.

Figure 2. The Conditional Freedom installation (left) within which the performer interacts with light to control sounds both in tangible space and within a VR landscape (right)

CF's driving concept was that art is experienced through its end result but we seldom see the struggle of making it. Their title links this struggle with constrains in creative freedom and places the physical user in the role of a creator and the VR audience as spectators of a finished work. In their view the greater the struggles in the tangible world the more beauty is produced in VR.

Llum

The instrument made by Fabiola Toledo-Galindo and Julio Torres-Cazares is played and listened to both from the outside and from within. Llum is a handheld tangible instrument and a large virtual space at the same time. The project explores how the functionality of a tangible object can change when its scale is altered.

The instrument is a 3D-printed cracked sphere that emits light from within (Fig 3, left). Each piece works as a key that synthesizes sound and light in both tangible space and VR. Its virtual counterpart is an enlarged version of the same sphere (Fig 3, right) within which the VR audience exists. The walls of

this space match the object's keys in shape and functionality; That is, if a user touches a wall, it will synthesize the matching sound both physically and virtually. The nature of the instrument blurs the line between audience and performer as they are all capable of contributing to the composition. For this collaboration to work sounds from each key are added together when they are played simultaneously, either physically or virtually. The sounds produced in VR therefore match those emitted by the instrument in tangible space.

Figure 2. Llum, an instrument that is played both physically (left) and virtually (right). VR users experience and play the instrument form the inside while tangible ones hear the sound coming from within the object. Video documentation can be found at https://en.centro.edu.mx/3YSY65z

Findings

The following subsections analyse how the prototypes function as musical instruments, how they approach liveness, and how scale and control were used in driving users' experiences.

Mapping and feedback

Serafin and colleagues (Serafin et al., 2016) highlight the importance of feedback and a clear mapping between senses in VR musical instruments. We base our initial analysis on these features. Both Llum and CF map gestures to sound with visual and auditory feedback. In Llum's case, the single sound output that amalgamates inputs from all participants breaks the auditory feedback, as performers increase in number it becomes difficult to recognize sounds triggered by individual users. This collective feedback makes players respond to one another's actions rather than focusing on individual composition, turning the metaverse and live-music into social spaces. This suggests that communal feedback can favour collaborative and improvisational practices.

The CF installation also has a direct mapping between visible rays of light and sound but contrary to other instruments, gestures remove sound rather than creating it. The sounds produced in VR do not provide feedback to the performer to whom the resulting composition is unknown. The contradictory interactions arising from this multiplicity of experiences resonate with Dunne's view that objects working contrary to established logic can be very engaging (Dunne, 2008). In CF the instrument's feedback also takes a narrative role in a story, the performer's attempts to silence the whole installation are contextualised as a creative struggle.

CQNC challenges views of what an instrument and its music are. There has been research presenting field recordings as music (Shaw & Bowers, 2020). However, CQNC provides a novel perspective as it is difficult to decide what the instrument is: Is it the sound recorder as an object or is it the spheres sounding in virtual reality? This difficulty in assessing where the music-making happens and who the performer is suggests that it is truly collaborative and explores musicality in a way only made possible through networked co-creation. Referring back at Serafin and his team's principles for VR instruments we find that CQNC breaks some of these: it has no direct feedback or mapping, it embraces latency and provides no visualization of a player's body. It is yet engaging and rewarding to use, suggesting that current definitions of instruments for VR and the metaverse should be questioned in the field's early days.

Virtual and Live

Liveness is central to the resulting prototypes. Not only in the technicalities of device-metaverse communication, but also in overcoming the lacking senses of unity and unexpectedness inherent to remote emulations of live-music as described by Tarumi an co-authors (Tarumi et al., 2017).

Llum's collaborative nature demands that tangible performer and VR audience co-exist. This temporality gains depth when seen from a social perspective. As the virtual audience shares the same space, they must also synchronise their actions in order to drive their portion of the composition. We believe that implementing communication between audience members in a future version would further enhance this social coordination.

In CQNC liveness is less straightforward. Tim Shaw describes field recording as "a practical activity that often requires one to spend long periods of time outdoors hunting for sound" (Shaw & Bowers, 2020). This is seemingly contrary to live performance, waiting for sound samples to arrive could frustrate players in VR. However, receiving a new sample provides an exciting element of unexpectedness. Users were found to restart compositions when a good sample appeared. Simulating this with pre-recorded sounds could be done but knowing that they are being recorded live adds a sense of complicity between tangible and virtual players.

Control

The prototypes revealed issues of power and control that were not built-in by design. By control we mean people having power over one another and not interface features. In most performances musicians have complete control over what to play, how to play it and when. Our work suggests that the distribution of control is central to the metaverse but difficult to define.

In CF control is approached from an unusual angle, the person within the installation has complete control over sound production but that control is unpleasant to wield and must be endured for the pleasure of the virtual audience. This creates a dynamic in which the person in the installation controls the content but is emotionally subordinated to those in the metaverse.

CQNC and Llum show a different form of control, one in which users react to sounds provided by others. These instruments

allow adversarial or collaborative interactions between participants, where players will conform to what is being provided or try and subvert it. Llum distributes control amongst participants: If few people are attending in VR control shifts towards the person playing physically. In contrast, with tens of VR participants, the notes from the tangible instrument are quickly outnumbered by collective online behaviours. The distribution of control in CQNC is slightly simpler, every player ultimately controls their own composition but VR players have no agency over the received sound and must work within the constraints created by the person recording. It is also possible that the recorder feels pressure to provide adequate samples, despite not knowing what each player is doing, resulting in a self-constrained curation of sounds.

Scale

All three prototypes incorporate aspects of scale. The digital flexibility of scale has been extensively explored within design; however, we see value in presenting it from a music-making perspective. Llum incorporates shifts in scale by making the tangible instrument inhabitable within VR space. This shows that VR can not only place users in otherwise inaccessible spaces but also alter our reading of tangible objects: The instrument ceases to be to a standalone object and becomes a model of the VR space, therefore containing its audience. This illusion of containment is further reinforced by making the tangible instrument emit sound and light from within while in VR it is spatially emitted from the key that was pressed.

CF uses scale to drive its concepts. The installation as a constrained space is designed to overwhelm the user. Its virtual counterpart is a large, well lit, and calming landscape. The interplay of scales between VR and installation provides an entry-point to the project's ideas, appreciating this difference in scale is sufficient to understand the project.

Both CF and Llum present VR worlds much larger than their physical counterparts. Contrastingly, in CQNC the scale of VR space is fairly small, with minimal movement and interactions restricted to a sphere in the middle. This limited space serves as an interface for an instrument that could be of global scale. Reducing sounds gathered over a large area to such a small space suggests that the metaverse could be not only an alternative world but also a container for parts of our tangible reality.

Conclusion

Designing, developing and using our musical instruments provoked many questions that were not originally foreseen. We set out to make prototypes that questioned the ontology of instruments in the metaverse, outlining what they are and how they exist. This starting point was however greatly expanded through our process.

Our findings around feedback and mapping do contribute to characterising our prototypes as instruments but they also promted questions about collaboration and improvisation that emerge from the instruments' online nature. When discussing liveness, we were surprised to be focusing on feelings of unity and the unexpected rather than the technicalities of internet communication protocols. The themes of scale and control were not initially identified in our research and were prompted by the prototypes, we find them very relevant when discussing the metaverse and see their emergence as an indicator of how open-ended and protype driven processes can elucidate unidentified questions that contribute to research. We would like to expand on this inquiry in future work by further exploring our prototypes through live performances with a breath of different audiences and performers from various musical backgrounds.

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Virtual skin: co-creating 3D materials with synesthetic artificial intelligence

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Abstract

Humans explore the world around us using our able senses. Numerous studies have suggested that the greater the number of sensory modalities stimulated at any one time, the richer our experiences will be, in that the experiences may have a higher level of impact and be more memorable across a variety of our senses. (e.g. Bahrick & Lickliter, 2000; Spence,2002; Stein & Meredith, 1993). This is becoming increasingly important and relevant as we enter the AI-generated virtual worlds where our visual perception should have a certain resemblance to our analog world experiences. If human perception is a cross-experiential phenomenon, how could we enrich artificial intelligence with multisensory creative abilities to support the same processes and outcomes for material interaction?

The ability to perceive correspondences across sensory modalities resembles the phenomenon of synaesthesia (Cytowic, 1989). Synesthesia is the combination of several senses simultaneously. It is an unusual condition which gives rise to a merging of the senses. For example, smells may trigger the experience of shapes, or letters may give rise to the perceptual experience of colour or may cause the experience of any combination of tastes, smells, shapes or sensations (Simner, 2012). These misunderstandings may be why the phenomenon was considered unreliable for over a century after its discovery by Francis Galton (1883; Sachs 1812). In the last decade, we can trace an increased interest in cross-sensory experiences signalling synaesthesia as its correlated phenomena (Dixon, Smilek, Cudahy, & Merikle, 2001; Mattingley, Rich, & Bradshaw, 2005; Ramachandran & Hubbard, 2001a, 2003). While for most, mental imagery may be most vivid in the case of visual images (Kosslyn, 1994), it is of keen interest to note that rich mental images can be generated via the sense of smell, touch, taste, and sound (e.g. Klatzky, Lederman and Matula, 1991; Reisberg, 1992; Stevenson and Case, 2005).

Through the intersection of two disciplines, User Experience Design (UXD) and Color and Materials Design (CMD), we aim to explore the possibilities of employing an intelligent agent to generate 3D materials based on merged multisensory inputs rather than relying on existing algorithms, visual styles, and previously constructed patterns. The exploration will be in the form of an experiment and workshop conducted with a trans-disciplinary group of graduate students from the User Experience Design and Colour and Material Design disciplines. We will use customised text to engage a 3D scene AI generator trained with available sensory data sets enriched with multi-perceptive input from the workshop participants. Our key novelty is the use of artificial intelligence trained with multi-sensory material properties to generate AI-generated 3D materials for virtual and potentially hybrid products and environments.

Author keywords

AI creativity, 3D virtual materials, Human-AI interaction, Synesthesia, Multi-sensory User Experience Design, Transdisciplinary Co-creation

Introduction

In this paper, we aim to investigate opportunities for involving artificial intelligence in the design process of creating 3D virtual worlds. Our focus will be on the AI generation of 3D digital materials and their potential to arouse sufficient sensory and emotional stimuli. Several studies have suggested that the greater the number of sensory modalities stimulated at any one time, the richer our experiences will be, in that the experiences may have a higher level of impact and be more memorable across a variety of our senses. (e.g. Nikolic & Russo, 2019; Bahrick & Lickliter, 2000; Spence,2002; Stein & Meredith, 1993). Accordingly, In the AI-generated virtual worlds, our sensory and cognitive expectations lead us to search for resemblance from our analogue world experiences. Hence, if human perception is a cross-experiential phenomenon, how could we enrich artificial intelligence with multisensory creative abilities to support the same processes and outcomes for material interaction?

Through the intersection of two disciplines, User Experience Design (UXD) and Color and Materials Design (CMD), we aim to explore the possibilities of employing an intelligent agent to generate 3D virtual materials based on merged multisensory inputs rather than relying on existing algorithms, visual styles, and previously constructed patterns.

Our approach is hybrid and includes several methods applied in different research stages. In the first phase, we conducted a single case experiment, which we will describe in detail and present the findings. This led us to the second phase, where we prototyped and experimented with the AI-driven text-to-image platform for generating and rendering virtual materials on 3D objects. The whole process and the framework used are described in this paper's Synesthetic Artificial Intelligence Generation chapter. Lastly, we plan to conduct contextual interviews in a workshop with a mixed group of students selected from the User Experience Design (UXD) and Color and Materials Design (CMD) majors.

Our key innovation is using artificial intelligence trained with multi-sensory material properties to generate AI-generated 3D virtual materials for meta – and potentially hybrid – products and environments.

Background

In our conceptual approach, synesthesia plays an important role in designing multi-sensory meta-perception beyond the physical world. Synesthesia is a psychological phenomenon related to the human brain's capability to combine several senses simultaneously. In particular, stimuli on one particular physical sensory can produce additional sensory experiences for which sensory inputs do not exist (van Leeuwen, Singer & Nikolić, 2015). It is an unusual condition that gives rise to a merging of the senses. For example, smells may trigger the experience of shapes, or letters may give rise to the perceptual experience of colour or may cause the experience of any combination of tastes, smells, shapes, or sensations (Simner, 2021). One of the most reported types of synesthesia is audio-visual (AVS)(Afra, Anderson, Funke et al, 2012), where sound stimuli can evoke the visual experience and vice versa. In particular, sounds such as the middle note 'C' can induce a red colour experience, but the same note three octaves higher can become green (Ginsberg, 1923). Likewise, we can have different varieties of sense responses to sensory stimulation, such as; the taste of a particular food (gustatory) can associate us with the visual appearance of the food (Cytowic, 1989); when we hear a particular sound (auditory) can induce smell of a specific food (olfactory) (Beeli, Esslen & Jäncke, 2006). Therefore, despite early scepticism, contemporary research in the field proves that synesthesia exists.

Furthermore, the interaction with materials in regard to a product, space, or environment is essential for a completely holistic multi-sensory user experience. Hence, from the perspective of colour and material design, "texture is an essential component of materiality that evokes the sense of tactility," often translated through a flat, 2D image that is applied onto the surface of a 3D object to define its colour, gloss, transparency, roughness, and other key physical attributes (Lefteri, 2014). A texture in 3D rendering engines like Photoshop, Substance Painter, Substance Designer, Blender, and Keyshot require inputs whose details must be specified unambiguously. These tools make use of generating textures in a *procedural material workflow*. (Jantunen, 2017). Procedural materials are created using mathematical models instead of pre-stored data, reducing the storage needed for these materials and thus creating texture maps to be applied to models in an actual runtime. Dong et al., 2019).

As an example case study, *Procedural Material Generation* (Jantunen, 2017) delves into the steps to create a procedural material in five steps with a focus on different material properties such as texture, patterns, micro-surfaces, colour, and lastly, defines the *procedural aspect* of the material to identify the properties which can be changed while still retaining the essence of the material. Our *workflow* (Figure 1) combines the aspects of synesthetic modalities with procedural material workflows to generate multi-sensorial materials, unlike a 3D rendering engine, whose inputs must be specified unambiguously and in complete detail, without further sensory extension when it comes to no explicitly stated properties (Ramesh, et al., 2021). The design of products and experiences are typically the result of many fine-meshed and complex processes (Jongerius, 2010); and our proposed workflow uses the sensory nature of synesthetic procedurality when designing multi-sensory meta-perceptions.

This multi-sensory, layered approach is based on an archival collection of information sourced through 1) scent, 2) sound, 3) emotion, 4) taste, and 5) movement. The sensory experiences are categorised as layers that, when combined together, compose a unique material outcome.

Figure 1. Multi-sensory layered approach

During the first phase, digital prototypes of 3D virtual materials were created using Open AI's text-image generation AI system DALL.E. Over 150 unique samples were created through prompts that described various material attributes regarding colour, texture, finish, and form. For the experiment, fifteen samples of visual distinction were short-listed (Figure 2).

Figure 2. Virtual material samples created on DALL.E with prompts (left to right) beige green exploding fuzzy fluidic sphere, black white eternal colliding amorphous sphere, and high gloss stretchy blob slime beige sphere

Experiment

A single-case experiment research was employed to initiate the first phase of the 3D virtual materials generation. We invited six graduate students to participate in the experiment from two graduate design programs, User Experience Design (three participants) and Color and Materials Design (three participants). The participants included three females, two males, and one non-binary, of American, Indian and Mexican origins, and in an age range of 23-27 years old.

The experiment was conducted in a controlled lab environment with a defined layout, ambient temperature, sound,

light, and projected image control (Figure 3). The AI-generated digital material samples were displayed on the screen for a period of three minutes, during which the participants observed the sample and noted their sensorial responses in a provided worksheet. (Table 1). The experiment lasted 45 minutes, followed by 15 minutes of guided discussion.

Figure 3. Single-case experiment set-up

Findings

Upon the completion of the first phase, participants revealed directives toward sensory modalities in regard to a series of AI-generated materials. The results from the experiment revealed the ability of the participants to look beyond the aesthetic attributes of the virtual materials. With this in consideration, it should be noted that half of the participants stated had it not been for the structure of the worksheet, they would not have related the visual with all of the senses. Four out of six participants stated that they found associations to be made quicker with certain senses than others. The sensorial responses experienced by the participants were then used as inputs to generate the synesthetic AI-generated virtual skin.

Table 1. Example of worksheet and responses from the experiment

	Touch	Smell	Taste	Sound	Visual	Emotions
Sample 1 	Tender Soft	Soft scent of a mother	Delicate sweetness	Lullaby	Baby's skin	When pressed will release the flow of milk
Sample 2 	Fuzzy Soft	Wet grass	Fresh taste of blooming spring time	Soft breeze	A planet with unknown biome	A walk through paddy fields in the morning

Synesthetic Artificial Intelligence Generation

Starting from text descriptions, we used DALL-E to generate the image of a sphere texturized according to the initial prompt – as demonstrated in the single-case experiment – and then we extracted the corresponding texture. The procedure to fit the bump map and the texture was then refined using the Stable Diffusion model to progressively refine the starting template mesh, which in our case, is a sphere.

A neural network generates an RGB texture and predicts the magnitude of the movement along the normal direction for each vertex. To compute the displacement, we encode the position of the vertex $x \in R^{Nx3}$ using Multiresolution Hash Encoding (MHE). We parsed the features obtained $h \in R^{NxF}$ to a SirenNet, an MLP (MultiLayer Perceptron) with sinusoidal activation function:

$$\bar{x} = \bar{x} + \bar{n} \cdot d \cdot SirenNet(MHE(\bar{x}))$$

where $\bar{n} \in R^{Nx3}$ are the vertices normal and d the maximum displacement. The texture is computed in a similar way by mapping the positions of the pixels to the range $[-1,+1]$,

$$RGB_{i,j} = SirenNet(\sin\sin((2i/(H-1)-1)\,\pi), \sin\sin((\,2j/(W-1)-1)\pi))$$

where H, W are the texture dimensions. This initial transformation ensures periodical textures. Using a sinusoidal activation function makes the training shorter and more stable for this task. During the generation, we optimise the material gloss level to reduce artefacts, like light reflection included in the texture.

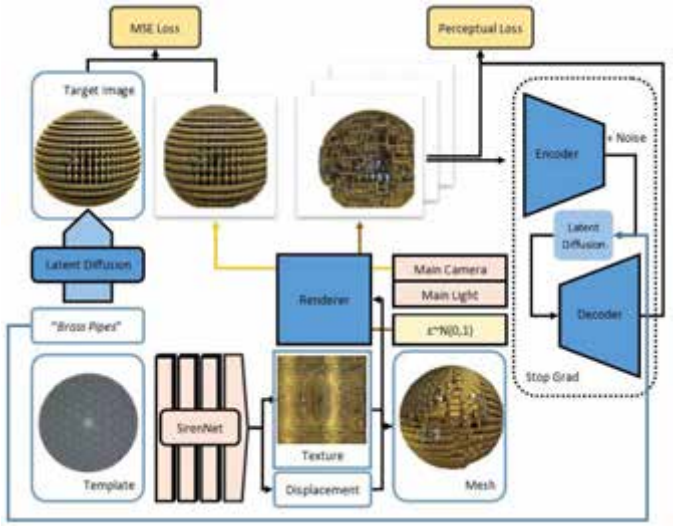

Figure 4. AI Synesthetic Virtual Materials Generation Procedure

For each training step, we start with generating the texture and the displacement along the normal for each vertex, then we produce a refined version of each render using the Stable Diffusion Img2Img pipeline conditioned on the text prompt. Finally, we compute the MSE (Mean Square Error) between the main render and the target image, then compare the renders from the cameras sampled uniformly around the sphere and their refined version using a perceptual loss based on a pre-trained VGG19 net.

This solution led to faster convergence and better quality than using a loss based on CLIP embeddings, moreover the refining procedure must be executed without the gradient computation, allowing to reduce the memory occupancy and increasing the training speed if compared to the SDS (Score Distillation Sampling) used in Magic3D, because it does not require backpropagation through the encoder network at the cost of having to decode the denoised latent vector. In this way, we produce textures with 712 pixels of resolution. To enforce a more coherent bump map, we follow the same procedure with a uniform texture. To guarantee stability during the training, we must ensure semantic consistency between the refined images and the corresponding renderer. For this reason, we set a low strength (around 20%) and a not too high guidance scale (we used 12.5).

Conclusion

We aim to explore the possibilities of using AI for 3D virtual material generation, with the potential to arouse sufficient sensory and emotional stimuli. Hence, we have collected and designed multi-sensory material properties to generate AI-generated 3D materials for virtual – and potentially hybrid – application to products and environments through User Experience Design and Color and Material Design (CMF) workflows.

In the first of several on-going experiments, we have investigated procedural approaches to collect sensory data to train our neural network model toward enabling its synesthetic reasoning and virtual material rendering based on multi-sensory data inputs. By increasing the number of sensory modalities stimulated in the multi-layered, procedural material approach, the sensorial experiences related by the observer have an increased impact in regard to their virtual material experience.

While we seek to find a balance between our real and virtual worlds, in turn, the expectations of our senses have linked our findings to human perception within the collaborative environment where User Experience Design and Color and Material Design enrich the ability to support synesthetic material interaction.

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Cabinets of curiosities for the postcolony II: tokens: collections I-V

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Abstract

This paper offers a discussion and reflection on my work titled "Cabinets of Curiosities for the Postcolony II: Tokens, Collections I-V" (hereafter referred to as "Tokens") which was exhibited in 2022 both physically in a gallery in Johannesburg, South Africa, and virtually on the non-fungible token (NFT) marketplace OpenSea. The physical component of "Tokens" consists of five entomology cases, each displaying a collection of unique, handmade objects, and an artists' book, and the digital component takes the form of 51 NFTs. I describe the origin, development and nature of the project and explain the reasoning behind the creative decisions that I made. Initially the project was driven by my need for tactility and experimenting and crafting with physical materials, but it evolved into an exploration of the question of what is considered "new knowledge" in creative practice. This exploration eventually led me to the world of NFTs and resulted in a final creative project that engages with further questions around uniqueness, the aura of physical and digital art, and value.

I propose that by making and naming new objects, I created new knowledge, which I then attempted to validate by minting the objects as NFTs. However, I realised that by digitally reproducing the physical objects I ran the risk of destroying their "aura" as postulated by Walter Benjamin in his 1935 essay "The Work of Art in the Age of Mechanical Reproduction". I consider Benjamin's concept of "aura" in relation to physical and digital art and highlight more contemporary views that refute his claim. This leads to a brief discussion of the financial value of NFTs and the importance of community in creating value in the NFT world. I conclude by noting that many questions remain on what blockchain technology can do and become for artists and the study contributes one such perspective and experience. Creative practitioners are encouraged to become acquainted with this technology.

Author keywords

Non-fungible token; NFT; digital arts; crypto art, uniqueness; aura; knowledge; value

Introduction

In this paper I discuss and reflect on my work titled "Cabinets of Curiosities for the Postcolony II: Tokens, Collections I-V" (hereafter referred to as "Tokens") which was exhibited from 20 September to 26 October 2022 in real life (IRL) at the Art Gallery of the Faculty of Art, Design and Architecture (FADA) at the University of Johannesburg (UJ) in Johannesburg, South Africa, as well as virtually on OpenSea, the largest marketplace for non-fungible tokens (NFT) (Fries 2021).

The physical component of Tokens consists of five Iroko wood and perspex entomology cases, accompanied by an artists' book digitally printed on ILFORD Fine Art Textured Silk paper and folded into a leporello format (figure 1).

Figure 1. Physical display of "Tokens", FADA Gallery (picture by author)

Each entomology case displays a collection of unique, handmade objects organised according to formal qualities such as colour or material. The objects are small, ranging in size from approximately one to ten centimeters and were created through the combination of existing things, or the manipulation of natural and found materials. Figure 2 shows a close-up of one of the collections of objects, Collection I. The objects in Collection I were made from a variety of materials, including air dry paper clay, acrylic paint, felt, beads, plastic animals and figures, safety pins, a rose thorn and bra components. Their creation was prompted in 2020 by my need for experimentation and crafting with physical materials as I missed the tactility of making following decades of primarily creating art and design with digital media. I was inspired by developments in art jewellery design and interested in applying various traditional and non-traditional jewellery making techniques and materials to craft beautiful and intriguing objects which blurred the boundaries between sculpture and jewellery.

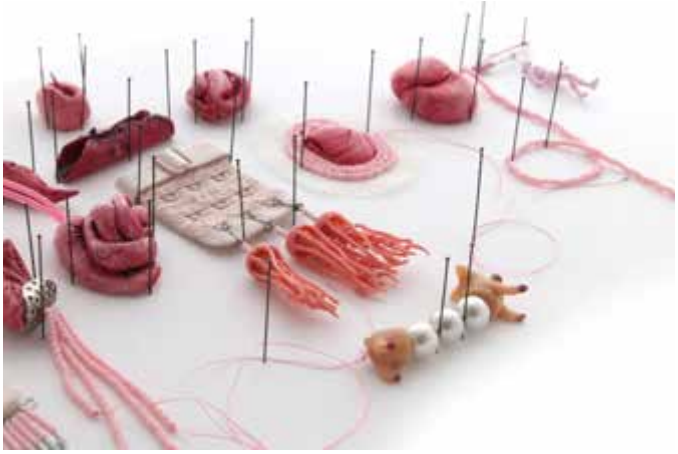

Figure 2. Close-up of Collection I (picture by author)

The objects contained in the collections are documented in the artists' book by way of 51 photographs captioned with the object's name (figure 3). The word tokens in the title refers to both the dictionary definition of token, which is "...a thing that you give someone, that expresses your feelings or intention, although it might have little practical effect" (Cambridge Dictionary) and the NFT component of the work.

Figure 3. Page from artists' book

Figure 4. NFT "card"

Each object was minted as an NFT in the form of a "collectable card" containing, within a frame, a photograph of the object captioned with its name and the title of the artwork at the top (figure 4). The collection of 51 NFTs comprises the virtual component of the exhibition and each token was available for purchase on OpenSea (figure 5) for the duration of the exhibition at https://opensea.io/collection/tokensi-v. The NFTs can be viewed on OpenSea where they have been given, in the words of Friedman and Hawkes (2021) an "afterlife where it is no longer subject to mortal decay" because, as Betancourt (2006) observes "[t]he limit for a digital work is not based on its physical demise, but rather on its availability within contemporary technology." In minting the NFT on OpenSea a unique token ID number was generated providing proof of the uniqueness of the NFT and therefore I exhibited a list of these numbers in the FADA Gallery alongside the physical work.

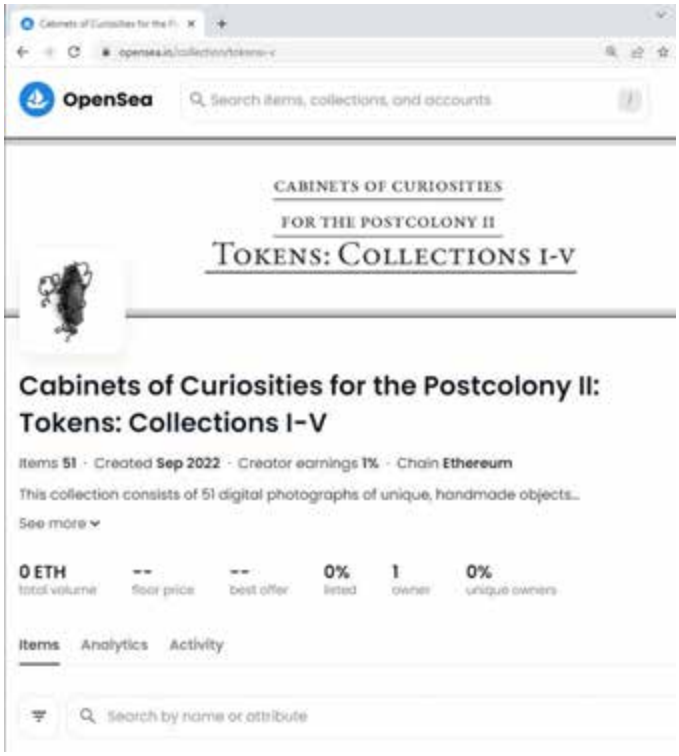

Figure 5. Collection of 51 NFTs on OpenSea

While creating the physical objects during 2020 I considered a variety of display methods, including entomology display cases and creating a cabinet of curiosities. These experiments would eventually lead to a project named "Dead Living Things: A Cabinet of Curiosities in the Postcolony" (hereafter "Dead Living Things") (Pretorius, 2023) which was exhibited at the FADA Gallery as part of the 2021 staff exhibition "Interventions in Practice". While the objects served as a starting point for "Dead Living Things", I did eventually move away from creating new and unique objects, to collecting and displaying existing objects in a cabinet of curiosities (Pretorius 2023). "Dead Living Things" aimed, amongst other things, to understand the role of colonial collection practices in constructing knowledge and to show how our understanding of the world is mediated through existing objects, text and language. "Tokens" builds on this interest, but in addition, explores the question of what is considered "new knowledge" in creative practice and how objects can help us to understand this question. The process of working on this question led me to the world of NFTs and resulted in a final art work that engages with further questions around uniqueness, the aura of physical and digital art and their value.

Creative practice and new knowledge

Exploration of the question "what is new knowledge in creative output" was prompted by the purpose of the 2021 and 2022 FADA staff exhibitions, which aimed at creating opportunities for FADA academics to exhibit creative work with the purpose of applying for creative output as research production. Since 2019 the South African Department of Higher Education and Training (DHET) has acknowledged, through policy implementation, that creative work can be formally recognised as research output through a process of peer review, as is the case with textual research (Pretorius 2023). As part of the required documentation for peer review the crea-

tive practitioner must "demonstrate the contribution to new knowledge" which the creative output makes (DHET 2017:9).

Therefore, in preparation for the 2022 exhibition I revisited the objects I had made in 2020, and then, working from the belief that the existence of things IRL and in our minds are understood and expressed through naming and language, I named each thing with a pseudoscientific name in Latin using the binomial naming system used to name living organisms. I chose the binomial naming system as the process of collecting, naming and classification of living organisms is linked to the scientific project of new knowledge creation, which in the past was linked to the tradition of cabinets of curiosities and colonialist collection practices. Incidentally, entomology, the study of insects, and etymology, the study of a word's history, are words that appear somewhat similar, a pleasing coincidence which I thought appropriate for the project.

In the binomial naming system, living organisms are given a two-part name, where the first part refers to the genus, which the species belongs to, while the species name constitutes the second part (Amateur Entomologists' Society 2023). I assigned each object to a genus based on a similar material or colour as follows: Rubisco (pink) (Collection I), Margarita (pearl) (Collection II), Lignum (wood) (Collection III), Cuprum (copper) (Collection IV) and Tenebris (dark) (Collection V). The species was identified more broadly based on a characteristic of the object, such as medium, symbol, association, shape, or material. In cases where this resulted in two objects having the same name, I added a variety name. I included an x between the names to indicate that the object is a hybrid of materials, objects and techniques. I used Google translate to create the names by way of literal translation, therefore, Rubisco x polypus (figure 5), literally translated means pink octopus. I selected the translation for octopus as Google translate did not provide a Latin translation for jellyfish. My reasoning was that by creating objects and naming them, I had created new knowledge, although of questionable value. To ensure that this knowledge was validated as new and unique, led me to the decision to mint each object as an NFT.

The blockchain and NFTs

An NFT is "a unique digital item stored on a blockchain" and "can represent almost anything", for example art, collectibles, profile pictures, and event tickets for events, and "serve as a digital record of ownership" (OpenSea 2022a). The difference between fungibility and non-fungibility is that fungible items are "interchangeable with another of the same item", such as a $1, whereas non-fungible items "has its own unique value" because the item is "totally unique" (OpenSea 2022a). On OpenSea minting "is the process of writing a digital item to the blockchain" through which "its immutable record of authenticity and ownership" is established (OpenSea 2022b).

The blockchain is a generic technology which, like the web, allows developers to "build almost any kind of workable system on top of it" (Vinay Gupta in Catlow 2017, p. 23). It is a powerful, disruptive technology which some argue has the ability to "change everything forever" (Catlow 2017, p. 31) due to its inherent features that include "decentralization, immutability, anonymity, traceability and transparency" (Del Vacchio and Bifulco 2022 2-3). Jones and Skinner (2017, p. 9) aptly refer to the blockchain as "Janus-faced", with one side holding the promise of "fairness and accountability" due to "its traits of transparency and decentralization", whereas "on the other its monetary roots born as a financial payment system … mean its implementations are often stridently capitalistic." This duality between "art as currency and art as socio-political arena" (Jones and Skinner 2017, p. 13) runs through the literature on art and blockchain.

The literature on the blockchain, including NFTs, is vast and rapidly growing (Casino, Dasaklis and Patsakis, 2019). Del Vacchio and Bifulco (2022) provide insight into the impact of blockchain on art and cultural heritage by identifying three themes through a review of literature. The first is provenance and authenticity (Gipp et al 2017, Anagnostakis 2018, Angelova 2019, Ch'ng 2019, Whitaker et al 2020, Wang et al 2021); the second tokenization and fractional equity (Whitaker 2019, Whitaker et al 2020, Franceschet et al 2020) and the last, rights management and digital protection (Zeilinger 2018, O'Dwyer 2020, Ch'ng 2019, Huang and Dai 2019).

De Vacchio and Bifulco (2022, p. 6) define tokenization as "the process of converting a right on an asset (usually owned) into a token, digital information, which is then issued on a blockchain platform for its exchange between users." Tokens may originate as a physical object IRL or be "digital-born" as is the case with "crypto art". Franceschet et al (2020, p. 402) refers to "crypto art" as "a recent artistic movement in which the artist produces works of art, typically still or animated images, and distributes them via a crypto art gallery or their own digital channel using blockchain technology." The tokenization process as explained by Franceschet et al (2020, p. 402-3), in which an artwork is uploaded to a crypto art marketplace and a transaction created on the Ethereum blockchain resulting in an NFT, is similar to the process I followed to create my NFTs on OpenSea. However, whereas crypto artists tokenize their work to create proof of uniqueness, ownership and authenticity with the aim of encouraging sales (Franceschet et al 2020, p. 402-3), my interest was less in selling work than using the blockchain to record and validate the creation of new knowledge.

To be able to mint my NFTs, the physical objects which I created needed to be digitally reproduced, in this case into jpeg format by way of digital photography. I found it very ironic that in the NFT marketplace the act of placing a digital copy of my original object, and assigning a unique token ID to the copy, renders the copy unique. The infinitely reproducible digital image of the original object, with its accompanying ID, becomes the "original" work of art which accrues value in the digital space, whereas the true original, the physical object IRL is arguably of less value. The implications of the reproduction of a physical work of art in relation to its value was explored by Walter Benjamin in his influential essay "The Work of Art in the Age of Mechanical Reproduction", first published in 1935.

Aura and physical and digital art

Benjamin (1969) argued that the reproduction of an original physical work of art, such as a painting or sculpture, by mechanical means, for example photography, robbed the artwork of its "aura" thereby diminishing the value of the work. According to Benjamin (1969, p. 3) "[e]ven the most perfect

reproduction of a work of art is lacking in one element: its presence in time and space, its unique existence at the place where it happens to be." It is this existence that determines the artwork's history, including changes over time in its physical condition and ownership. For Benjamin (1969, p. 3) authenticity is dependent on the "presence of the original" and authenticity cannot be reproduced through technical means. Benjamin (1969, p. 4) describes authenticity as an art work's "most sensitive nucleus... the essence of all that is transmissible from its beginning, ranging from its substantive duration to its testimony to the history which it has experienced". The element which is lost in reproducing a work of art is termed "aura" by Benjamin, and, as Betancourt (2006) observes, it is logical to assume that aura is lost not only with mechanical reproduction, but also digital reproduction.

Friedman and Hawkes (2021) state that aura is linked to the "viewer's visceral reaction to the physical traits of the work" such as the "variable pressure of the crayon on paper, the thickness of impasto brushstrokes or their glossy translucency, the weave of the canvas showing through the loosely applied imprimatura, the mutable effects of light playing on the surface at different times of day." Such tactile qualities resulting from physical making was what I particularly craved when I initially started creating the objects, and it was these qualities that was remarked on and appreciated by visitors to the FADA Gallery exhibition in their comments to me.

A review of the literature examining digital art in relation to Benjamin's concept of aura shows that several researchers have concluded that digital art does not lose aura through mechanical reproduction, but instead, a new type of aura emerges which some ascribe to the difference between digital and physical objects (Bozkanat 2022:3, Emison 2021:13, Friedman & Hawkes 2021, Trice 2020:5, Bakker 2018, Betancourt 2006). Betancourt (2006) argues that digital and non-digital art objects are fundamentally different due to all digital objects consisting only of binary code, while physical objects take on many different and unique forms. Therefore, Betancourt (2006) argues, digital objects "constitute a new class of object" that contains the "aura of information", which refers to "the separation of the meaning present in a work from the physical representation of that work". Betancourt (2006) explains that "[b]ecause the material aspects of digital works are ephemeral, lasting no longer than the phenomenological encounter with the presentation of the digital object, (typically on a screen of some type), the 'aura of information' suggests that the digital itself transcends physical form. This illusion defines the 'aura of information'".

Similarly, Friedman and Hawkes (2021) argue that "NFTs simultaneously embody two kinds of abstraction: financial value and the aesthetic aura". They formulate this argument by referring to the controversy surrounding the burning of a Banksy print by its owner in 2021. The print was purchased for $95,000 and after a reproduction in the form of an NFT was sold for $380,000 the original was incinerated. Friedman and Hawkes (2021) maintain that when the original is destroyed "it becomes possible to package, market and sell the aura in the absence of the original. The destruction of the original allows the NFT to monetize the aura, imposing on it the form of financial value". The financial value of NFTs has been a prominent preoccupation since the emergence of blockchain technology and cryptocurrencies and as Friedman and Hawkes (2021) observe, because financial value and the aesthetic aura are collapsed into "the same symbol at the same time ... they have become functionally identical. And if identical, then interchangeable."

The entanglement of these two types of abstractions have led to NFTs being considered both a "craze" and "the future of digital art" with sales skyrocketing from an estimated $12 million in December 2020 to $340 million in February 2021, with collectors being prepared to pay millions of American dollars for a single NFT (Chohan 2021, p. 1). Chohan (2021, p. 1) rightly observes that "despite in essence representing little more than code" NFTs sell for millions because "a buyer has ascribed 'value' to the code". Chohan (2021:6) notes that this leads to the ultimate question raised by NFTs: "how valuable is an NFT in reality?" The answer, according to Chohan (2021, p. 6), is that "[i]t is as valuable as people express a willingness to pay for it".

NFTs and value

I put my NFTs up for sale on 22 September 2022 for the duration of the Interventions in Practice exhibition priced at 0.510 "wrapped ether" (WETH), a decision based on a cursory analysis of the pricing of NFTs on OpenSea, and symbolically on the fact that I was minting 51 tokens. WETH is a cryptocurrency and at the time of minting my NFTs 1 WETH, at closing, equated to $1,267.87. Therefore, at that point in time, the price of one of my NFTs was $647 US dollars, which I thought was quite a substantial amount.

However, this price was nothing compared to the oft cited example of $69 million paid for the work "Everydays: The First 5000 Days" created by Mike Winkelmann (Kastrenakes 2021). Winkelmann, an American graphic designer working under the name Beeple, started creating an image every day from May 2007—a practice which he continues at the time of writing this paper—and posting the image to his Instagram account "beeple_crap". "Everydays" is a composite of the images which he created over the course of thirteen years and was auctioned off by Christie's (Gompertz 2021). Kastrenakes (2021) notes a development in Winkelmann's work from "somewhat crude sketches" to "evolving digital shapes and sceneries" while Gompertz (2021), in his review of "Everydays," grudgingly concedes "I won't pretend to have viewed each and every image, but I have seen enough to know it is of artistic and documentary merit".

Kastrenakes (2021) ascribes the value of Winkelmann's work to his "large fan base, with around 2.5 million followers across social channels", his productiveness, the staggering growth of the NFT market, and collectors and investors belief that digital art will continue to be traded in this way into the future thereby promising large returns for early investors. In addition, Christie's involvement in the sale legitimized "both Winkelmann's art and NFTs as a technology".

Winckelmann's enormous following—2.4 million on Instagram alone—indicates the importance of what Franceschet et al. (2021, p. 404) identify as engagement and community in the "Crypto-Artistic Movement". Participating in and building NFT

communities are considered essential for NFT artists (Lisa 2022) indicating the importance of connectivity between artists, collectors and other role players in the NFT world.

It is therefore not surprising that with my mere 482 Instagram followers and 301 posts—compared to Beeple's 3181 posts—and no presence on Telegram, Twitter, Reddit or Discord, I did not sell a single NFT. But then, selling art was not my intention when venturing into the world of NFTs and neither is it for many other artists who are exploring the possibilities offered by Blockchain in interesting ways. The publication Artists Re:Thinking the Blockchain presents a diverse range of such projects from the speculative to the playful exploring the "meanings, possibilities and implementations" offered by the blockchain" (Jones and Skinner 2017, p. 12).

Chohan (2021, p. 9) laments the fact that the focus on making "a quick buck" through NFTs has "detract[ed] from the genuinely interesting idea that a decentralized mechanism can offer a public recognition of the specialty of an encoded object." Chohan (2021, p. 9) observes the presence of "an exploratory, counter-hegemonic element to virtual participants engaging with NFTs" and it is this space which I believe is the more interesting area for exploration and creative work involving NFTs and the blockchain.

Conclusion

I set out in this paper to reflect on my work Tokens and how in engaging with the question of what is considered "new knowledge" in creative practice I entered the world of NFTs, which resulted in further questions around uniqueness, the aura of physical and digital art, and value. In addressing Benjamin's view on the "aura" in relation to digital reproduction, current arguments refuting his claim were raised and I touched on the financial value of NFTs and the importance of community in creating value in the NFT world. As my reflection progressed, the questions proliferated, and these could, unfortunately, only be addressed in a limited way by providing my perspective and experience of venturing into the NFT arena. What did become clear to me is that blockchain technology cannot be ignored by creative practitioners. As Catlow (2017, p. 21-22) notes, "blockchain technologies are here to stay. They are overtaking the WWW as the next big network technology for speculation and disruption ...artist have a crucial part to play here".

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Speculating futures in an age of nostalgia

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Abstract

This paper will present an exploration of the relationship between the past and the present and how that interaction influences design thinking when speculating about possible futures. It will argue that the growing influence of nostalgia, supported by the exponential growth of data creation and consumption, together with the democratisation of sophisticated tools, has the potential to introduce the unintended effect of flattening the very creativity that is central to design. The key argument is that design is influenced by visions of futures from the past, either intentionally or unintentionally.

The concept of Hauntology will be introduced as a way of framing how visions of possible futures are continually bound up with the concerns of the present which are, in turn, connected to the past through the "spectres of lost futures". More recently, critics have discussed Hauntology in the context of describing contemporary culture's persistent re-cycling of retro aesthetics and the subsequent inability to escape old social forms.

In the time that it takes to attempt to recall the name of a TV programme from our past, it is now possible to view original footage on a myriad of different platforms and services. These tools have the effect of making time plastic and stretchable, where the past has never been more accessible. The paper will argue that slowly and imperceptibly we have become beguiled by the increasing capacity to store, organise, access, and share vast amounts of cultural data and that this could lead to a dampening of creativity.

Author keywords

Speculation; Future; Hauntology; Nostalgia; Data.

Introduction

In the city of Bristol UK, during the summer of 2020 a bronze statue was toppled by protesters, dragged through the streets to the harbour and thrown into the sea. In the grand scheme of things, this might seem like a small local disturbance, but what it raised were much more fundamental questions about our relationships with the past and how these are affected by the present and possible futures. The statue was of Edward Colston, a 17th century merchant and slave trader who was born in Bristol. Colston's memory had been divisive for years, with some thinking history can't be changed and others campaigning successfully for his name to be erased from streets, schools, and venues. The toppling of the statue served as a powerful reminder that the past is intimately bound up with futures and critically that the past is also a contested space (Stead & Coulton, 2022). It is subject to many different interpretations when viewed through the lens of the present.

Like so many people, I have been working from home for most of 2020 and 2021 but now I move between home and the office as I engage in what has become known as hybrid working. On a daily basis, I navigate the technology landscape moving between Webex, Teams and Zoom to communicate with colleagues. I am living the 1990s dream of Computer Supported Co-operative Working (CSCW) (Grudin, 1988). Moving seamlessly between meetings comprised of people who are having similar experiences, while all the time I remain physically in the same location. Paradoxically I seem to have caught up with a technological view from the past. From this perspective, the idea of what a future or indeed futures, might hold has become increasingly difficult to imagine. In response to this dilemma, I found myself looking more to the past. Imperceptibly my social media feeds became populated with terms such as retro, vintage, and redux and these curated images from the past provided a sense of nostalgia in uncertain times.

What is the appeal of nostalgia and why does something that is impossible to achieve continue to have such a hold on us? As our lives push forward, seemingly ever faster doesn't it feel natural that we should sometimes stop and wish that we could have some part of it back. Nostalgia keeps happening, even though it is impossible, and it is in that duality that part of the appeal resides (Berry, 2020).

In season 1 of the TV series Madmen in an episode entitled The Wheel (2007), directed by Matthew Weiner. The anti-hero Don Draper during a pitch to Kodak, describes nostalgia as delicate but potent. He continues that it literally means the pain from an old wound, it's a twinge in your heart far more powerful than memory alone. Just like Don, we are constantly looking forward and as designers we are always wondering how to improve our futures when we don't always realise that true power comes from the past. The past can offer nostalgia, and, like Don, it is only when we accept the past that we can properly move forward. Speculative design (Dunne & Raby, 2013), in many ways is as much about understanding the past as it is about imagining futures.

Hauntology — How futures are connected to the past

As with the case of the statue of Edward Colston, what these stories illustrate is that our visions of futures continue to be intimately connected to our past. Raising the question of whether that relationship is intentionally acknowledged or is the past an ever-present but perhaps unseen backdrop as we consider our futures? The nature of this relationship between the past and the future was articulated by the French philosopher Jacques Derrida who coined the phrase Hauntol-

ogy (Derrida, 1994). What he meant by this term is that the present is haunted by the metaphorical "ghosts" of lost futures. The concept raises the question of how "spectres" of alternative futures influence current and historical discourse and if "haunting" has real effects on how we conceive possible futures. In short, our visions of possible futures are always bound up with our concerns of the present which are, in turn connected to the past through these "spectres".

More recently, critics such as Mark Fisher have discussed Hauntology in the context of describing contemporary culture's persistent re-cycling of retro aesthetics and what he considered to be an inability to escape old social forms (Fisher, 2012). His position is captured in his characterisation of 21st century culture as being "20th century culture distributed over high-speed networks" (Fisher, 2014). For Fisher, creative and cultural production needs to either explicitly reference the techniques of the past in the means of production or risk being implicitly tethered to the past. In his 2012 paper entitled What is Hauntology?, Fisher frames an argument that there is no leading edge of innovation anymore and that we are living in what Franco 'Biffo' Berardi referred to as "after the future" (Berardi 2011). Fisher states that "what haunts the digital cul-de-sacs of the 21st century is not so much the past as all the lost futures that the 20th century taught us to anticipate" (Fisher 2012). From the perspective of Speculative Design, Anthony Dunne has discussed the idea of "broken futures" which I suspect refers to the promises of past futures and how these have failed to be delivered or, what was in fact delivered was a pale shadow of the original concept. In a similar way James Auger (Auger, 2013) refers to Alternate Presents or Lost Futures when considering different development paths, so rather that asking the question "what if?" it is reframed into asking "why are things the way they are?".

These ideas echo the position of Berardi who, when discussing the influences of the 1960s on the speculation of futures described this effect as "the slow cancelation of the future" in the context of being unable to break free from the shackles of these decades (2011). The horizons of the future seem tethered to ideas that emanate from this period of "peak future" (Smyth, 2021). We are seemingly bound to these spectre's of the past, for example the utopian ideals born in the 1960s and forged in the "white heat" of science. An imagined world of flying cars and jet packs for all, each somehow encapsulating the promise of a future so far removed from the everyday reality and so beloved of fictional secret agents of the time.

Influential Spectres in Uncertain Times

But fast forward to today, as we come to terms with the experiences of various lockdowns, what has become increasingly apparent is that the spectres of lost futures are ever more present as the uncertainties of the present begin to reshape our desires and dreams for the future. These are perhaps not best represented by the canonical visions of futures mentioned earlier, but rather by a gradual shift to a more holistic view of where humans fit in the wider ecology. The impact of climate change is being felt across the globe, sustainability and the circular economy have become a central part of any discussion about production and consumption. The Royal Society for arts, manufactures and commerce (RSA) in the UK refines this conversation when it talks about re-generation, with the twin focus of repair and improve. Meanwhile, the emergence of vintage, up cycling and re-use reflects one of the few growth areas of the high street. This is typified by Waste! a relatively new addition to the growing number of vintage shops in London. What makes Waste! stand out is its deliberate reaction to the modernist aesthetic of many shops. In the shop the owners have created the experience of a teenage bedroom from the past as it foregrounds the work of local designers to a wider public. Our relationship with the past is bound up in the pre-loved world of vintage and recycling both creating sustainability and a direct link to the past. Magnified by the uncertainties in society, economics and the environment, nostalgia provides the balm for this triple bottom line itch. From the perspective of technology, specifically Human Computer Interaction (HCI) and Interaction Design (IxD), the increased interest in Artificial Intelligence (AI) and More than Human Design (Giaccardi & Redström 2020) considers our place as humans in these eco-systems. These nascent entanglements of human and non-human agency pose significant challenges for human centred design processes. Just as we get used to Human Centred Design, the ground shifts again, which could indicate a desire to return to a more symbiotic relationship with nature and the environment. Hauntology extends the concept of action taking place over multiple sites and actors to consider how participation happens across multiple temporalities, to not only consider the present but also what was the past and what might be possible futures (Gatehouse, 2020).

The pressure is coming from technological change or perhaps more accurately the application of existing techniques but manifest in new forms. AI is a verdant ground for the ghosts of lost technological futures and much of the rhetoric associated with the Expert Systems of the 1980s and 90s is echoed in the current discourse around AI that pervades the discourse concerning interaction and its wider impact on society. These mysterious algorithms make selections and predictions that effect our lives. From the relatively trivial, such as choosing where we are placed in the phone queues based on our location and previous behaviours, to the selection of job applicants and the prediction of academic grades. The unconscious bias somehow one step removed as it permeates the code, distancing responsibility from the human actors. Does the promise of AI somehow speak to our lost futures, its vagueness adding to the allure and promise as this particular ghost in the machine quietly monitors in the background, making unseen decisions? This is set against a backdrop of an increased deployment of AI into industry (Industry 4.0) and the environment (Internet of Things) that has re-cast the role of technological artefacts and their relationships with humans.

We are living in times of seemingly constant change, but the direction of travel is uncertain. Technology fuels this illusion of progress, where change seems to equate to ever faster iterations off the same products, services and experiences. The spectre of Berardi looms large. But this is not the whole story, behind the technological tools lies the resource of data. Year on year the amount stored data grows exponentially, as we create and consume ever more amounts. The devices we use to traverse the datascape require more memory capacity to cope with the scale of data. This, coupled with the next generation of data hungry apps that harvest our data on an industrial scale, is a vicious circle that far from trying to avoid, we seem intent to run headlong towards as we upload, comment and retweet, creating vast data sets for third party vendors.

Nostalgia and Technology

The role of data, particularly from the perspective of innovation and skills has been a topic of interest for some years now. Technology lies at the heart of such innovation, but the situation has been further complicated by the growth of media data sets and the diversity of tools available to search such repositories.

In the time that it takes to attempt to recall the name of a TV programme from our past, it is now possible to view original footage on a myriad of different platforms and services. These tools have the effect of making time plastic and stretchable, where the past has never been more accessible. Fisher (2013) refers to this as "technologised" time, where the past and the future are subject to ceaseless de and re-composition. Time becomes compressed and, in effect begins to disappear much in the same way as Marc Augé (2009) talks about "non-place" when referring to airports, retail parks and chain stores as places that have become generic and have lost their meaning and connection to us. Now we can add "non-time" into that discourse.

In a recent article by Lauren Cochrane she describes a similar situation in terms of how we are experiencing an acceleration of nostalgia, which she characterises as being "trapped in what we might call a Revival Spiral" (Cochrane, 2022). She describes the current retro culture as "anemoia", a nostalgia for an era that a person has not actually lived through, whereas the Revival Spiral is perhaps better characterised by a seemingly increased longing for the recent past. This could be because of the rate of change in digital culture, resulting in a nostalgia for eras that we have just left and accelerated by the plentiful data that documents that last ten years. The situation has been compounded, Cochrane argues, by the turbulent times that we are living through. Pre 2016 might only be eight years ago, but it feels like a lifetime: Trump; Brexit and a global pandemic. The effect has been the tendency to romanticise the cultural signifiers from 2019 or earlier.

The article describes how Sarah Lloyd from University of the Arts (UoA) London, considers the revival culture as a way of gaining a sense of control over the ever-shifting cultural landscape and relocating oneself in the past to better understand the present. The accompanying technological tools are crucial to this relationship. With so many data resources available to us, we can create experiences of the past without the need for newness. A situation that mirrors the concerns of both Berardi and Fisher. With the same search engines and algorithms available to everyone, the effect has been to "flatten the zeitgeist" (Cochrane, 2022) leading to a monoculture across the generations. This view was similar to that explored by Superstudio who were one of the key exponents of the Radical Design Movement that emerged from Florence, Italy in the 1960s. By adopting a speculative approach Superstudio sought to give voice to a new generation of architects who wanted to critique the traditional methods of planning and question the very nature of what cities might become in the future. The Continuous Monument (Figure 1) imagined cities as anonymous megastructures where the last vestiges of local cultures would be removed. Though never intended to be built, their aim was to act as a catalyst for discussion and reflection on the lived experience associated with such a future. There can be little doubt that the spectres of Superstudio haunt the glossy renders of many visions of future cities but perhaps most strikingly in the case of The Line the Saudi governments plan for a 170

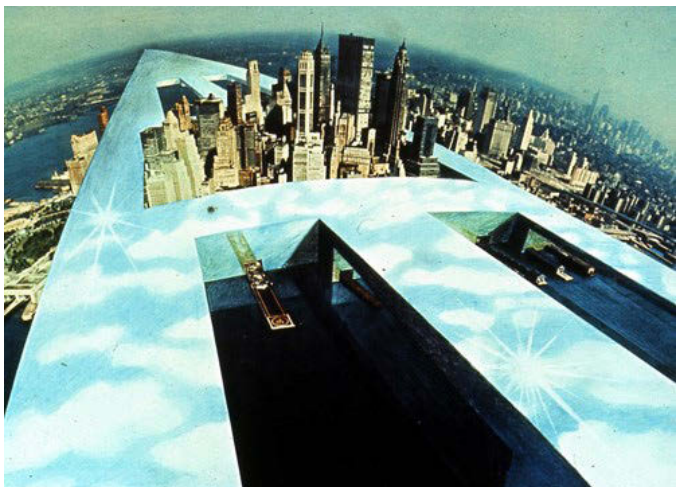

Figure 1. The Continuous Monument, Superstudio (1969-70) image courtesy of C.Toraldo di Francia Archive

kilometre long structure to be built near the Red Sea, complete with 500 metre tall mirrored facades.

But let's return to the idea of nostalgia and how the past continues to exert influence and beguile our imagination of futures. Simon Reynolds coined the phrase "retromania" to describe what he saw as the growing influence of nostalgia on popular culture and the commodification of the past (Reynolds, 2011). Coverley (2020) cites the impact of digital technology on cultural memory, in particular the internet and its power to democratise and make accessible vast resources of data that were once in limited supply and are now available for manipulation and nostalgia. He summarises the 21st centuries' obsessive curating of the past as a "symptomatic yet futile attempt to control time which has only intensified as new technologies become a facilitator for nostalgia, providing instantaneous access to endless new swathes of the past" (Coverley, 2020).

The remix culture continues to pervade many aspects of creative and cultural production, from the "cut-up" techniques favoured by authors and musicians, from Burroughs to Bowie. The technique of "cut-up" refers to the process of literally cutting up existing texts to generate new meanings with the rearranged pieces. There is now a new generation of artificial Generative Adversarial Networks (GANs). These employ neural network architectures to generate new data based on learned patterns. As well as generating images of human

Figure 2. The Zizi Project: 7-channel installation at Inspace City Screen, Edinburgh Fringe Festival 2019, image courtesy of Jake Elwes

faces and creating images from text, GANs can generate entirely new data making them core too many leading-edge AI systems. An example of this approach is the work of Jake Elwes, who in the Zizi Project (2019) used films of drag artists to train a neural network to enable audiences to create a synthetic facsimile that could dance to particular songs. The work was exhibited as part of the Edinburgh International Festival in 2019 (Figure 2). Part of the appeal is the capability of seemingly endless recombination of images of the past based on the promise of insight through serendipity. In short, an automated cut up for a new generation.

So, what is the effect of the exponential growth of searchable and retrievable data; the growth of publicly available AI based tools that can manipulate and endlessly re-purpose such data into new forms and the allure of nostalgia? This paper has argued that slowly and imperceptibly we have become beguiled by the increasing capacity to store, organise, access, and share vast amounts of cultural data. The laudable aim of data driven innovation needs to explicitly take on board the prophetic words of Berardi and Fisher and, what these mean for the design and development of technological tools for the creative industries, as these tools might have the unintended effect of dampening the very creativity that is central to the endeavour.

Acknowledgments

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Computational thinking in design and fabrication for augmented and accessible museums

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Abstract

The attention to the universal accessibility of spaces and culture is rapidly growing, and both computational thinking and emerging technologies are fostering the proliferation of innovative strategies and processes, from design to management, to facilitate the inclusiveness of museum spaces and the dissemination of cultural heritage.

In this context, starting from the small scale of museum devices and installations, computational design strategies, new digital fabrication technologies and advanced multimedia narratives are gaining ground in the design-research and original development of immersive and rewarding inclusive experiences.

Our research work on this subject started in 2019, tackling the design and prototyping of an accessible device for the multimedia and tactile exploration of pictorial works for people with visual impairments. The brief had the potential to tackle the historic debate on the concept of the frame, a debate based on a visual fruition of the artworks that totally loses its value from the perspective of a visually impaired person. A new question emerged: Can we reformulate the role of the frame and envision a new model that encourages alternative cognitive processes and facilitates the tactile exploration of pictorial artworks?

Lately, in 2021, ALO was commissioned the design and prototyping of a larger multisensory and accessible installation for the Lazzaretto Cultural Art Centre in Cagliari, the Digital Story Explorer. The DSE was originally conceived as an adaptable system to tell the story of historic buildings, cities and territories through a hybrid multisensory narrative strategy, physical, digital and tactile at the same time.

The search for a strategic combination of advanced design, digital fabrication techniques and uncommon building materials (such as composite materials) carried out so far has led to identifying both current critical issues and potential directions for rethinking the role of museum exhibition devices as nodal to the creation of accessible cultural spaces of immersion for active involvement of visitors. Through a sample of projects realised within ALO's current architectural practice, the paper will illustrate this ongoing design research on contemporary strategies, processes and new materiality aimed at an accessible and experiential museality.

Author keywords

Accessible museums, Digital fabrication, Craftmanship, Smart cities, Digital

Introduction

In the field of design research on accessible spaces and culture, starting from the small scale of museum devices and exhibition systems to the full scale of museum buildings, computational design and digital fabrication technologies together with advanced multimedia strategies have a special potential to engage visitors in inclusive, immersive and rewarding experiences. From the designers' point of view, one of the most significant aspects of a direct access to digital fabrication technologies is the ease and speed of in-house prototyping and self-production of final designs. A significant added value is given by the ability to produce complex solutions not feasible with traditional manufacturing techniques. This allow to deliver fully customized projects that are strictly adhered to the specific content, design scenarios and physical spaces which are all ever different case by case, as well as to implement specific strategies to address accessibility requirements and target visitors for a social but more individual experience.

In this sense, conventional products and exhibition systems and space design can no longer provide a fully contemporary experience, so that the visitor is not a passive spectator, but an active agent of the narrative(Hall, 1987). Hereby emerges the need for new strategies based on the integration of multisensory storytelling to intercept the expectations of visitors who are becoming, most of them unconsciously, increasingly demanding due to the ubiquitous exposure to multimedia, sensing, interactions, interconnections and automations that are pervading all spheres of human life(Bekele et al., 2018). In this sense, advanced design techniques and digital fabrication, understood as inextricably intertwined constituents of a holistic thinking, take on a new value. Design innovation and non-serial production become critical towards creating inclusive and experiential landscapes for visitors' engagement.

Then, furniture, podiums and content display elements might acquire a new role and design dignity as means of communication and involvement of the public in a physical and architectural experience. If we no longer simply observe, but we are forced to move by the experience(Manning, 2012), museum spaces can become landscapes for active immersion. Hence, from a utilitarian approach, which started leading the design of museum spaces and displays starting in the XX century (Desvallées & Mairesse, 2010), we might shift to the design of immersive museum installations to encourage a complete multisensory experience of contents.

This article will showcase two projects (Aptica and DSE) framing our R&D agenda and take on the subject from a design studio practice point of view.

Our research agenda on this subject started in 2019, thanks to the collaboration with CRS4, Sardinia's Centre for Research, Development and Advanced Studies, which commissioned ALO the design and prototyping of a functional device for the multimedia and tactile exploration of pictorial works. Lately, in 2022, we completed the development of the DSE, an accessible storytelling system to tell the histories of historical buildings, cities, and territories that has been commissioned by the Lazzaretto Art Cultural Centre in Cagliari.

The DSE represents a new milestone as it provided the opportunity to deepen our research with respect to the conception of exhibition systems as agents to trigger a physical and multisensory experience of cultural content.

Aptica. A multisensory interface for museum accessibility

Our work stems from the initial studies developed by CRS4 researchers as part of the 'Over the View' research project. CRS4 initiated the development of software and hardware infrastructure to transform pictorial works of art into scaled 3D representations suitable for tactile exploration. The simplified miniatures were to be equipped with sensors to enable the playback of multimedia content describing the area being touched. Hence, ALO prototyped a new complete and functional physical interface called APTICA (fig.1), which gave he systems the integrity of a complete and finished product.

Figure 1. The APTICA interface with 3D miniature of the artwork. The touch feelers sensing surfaces enable the multimedia tactile navigation of contents.

Accessibility by design

Museum experiences and art exhibitions are undergoing a transformation(Allen & MInnion, 2020): from passive viewing of exhibitions and exhibits, there is a shift to entirely new ways of offering imaginative tours that stimulate viewers and offer accessible, rewarding and memorable experiences. As summarised by A. Marras (Mameli et al., 2021), museum accessibility emerges at the intersection of physical aspects of museum spaces and displays with cognitive, sensory, cultural, economic and digital aspects.

Zooming on the process of tactile experiences from a practical point of view, it requires training and preparation(Galati, 1996); this was a critical observation that emerged also during the meetings with the CRS4 research team including Andrea Ferrero, a visually impaired researcher and artist; as Ferrero pointed out, a strategy is needed to see objects with the hand. From the perspective of a designer, there are certain drive criteria that should be taken into consideration in order to facilitate the process of tactile recognition and achieve the most effective results (Levi & Rolli, 1994).

In this regard, in addition to the relevant utilitarian aspects, the brief from CRS4 showed the possibility of opening a new chapter within philosophical, historical and semiological discussions about the frame, an object that has so far assumed the status of a theoretical object as observed by Pinotti (2018) (Daniela Ferrari & Pinotti, 2018). Pinotti illustrates the story of the frame, which appeared in a context that intended art as a reality detached from the one we live in. The frame was a boundary between the representation and real space which purpose ranged from intensifying the perception of the depth of the field or projecting the movement outwards.

The historical evolution of the role of the frame went through various phases until its denial. However, the whole debate starts from the assumption of a visual fruition of the artworks; therefore for people with severe visual impairment, the frame in its traditional conception loses its value. This raised a new question: Can we reformulate the role of the frame and imagine a new model that perhaps supports alternative cognitive processes and facilitates a tactile exploration of pictorial artworks?

Moving from the concept of the frame as a boundary for the eye to that of an intensifier of the senses was a critical challenge of the project. For this purpose, the research agenda explored the design of an interface that would serve to prepare the hands for the tactile experience.

Preparing for the tactile exploration

Figure 2. Global view of Aptica interfcace.

Aptica was designed as a tabletop object which body seems floating over the supporting surface. The aim was to isolate it from the surrounding physical world and stimulate the perception of a suspended, autonomous object on which to focus one's senses.

Following the instructions of a tour guide, the first part a visitor should come into contact with is the perimeter of Aptica: a fragmented edge consisting of a sequence of thin ribs that point towards the centre of the 3D touch tablet. The fragmentation aims to provide an initial intense tactile transition from the surrounding solid objects to the sensory space. (fig.2)

Then the hands meet the skin: a continuous and smooth surface that finishes the top of Aptica body and surrounds the tactile tablets. It is a neutral transition zone intended to evoke new feelings in contrast to the previous one to familiarise the touch with a smooth and continuous surface. The goal is to prepare the touch for the perception of three-dimensional figures which edges are necessarily more complex. The concave shape of the skin guides the hands towards its deepest part, suggesting an immersion into the sensory space of the 3D miniature. To achieve a smooth and sturdy surface, the skin was made of composite material and cast in a mould fabricated at ALO's workshop by CNC robot milling.

Finally, at the centre of the skin there is a platform featuring a set of spring-loaded electrical connectors ready to plug the interchangeable tactile tablets (fig.3). These are automatically recognised by the system via an embedded RFID card that recalls the respective audio and video descriptions. All software and system data are stored on a PC in a technical compartment integrated into the body of the Aptica. (fig.3a)

The tactile tablets are produced according to the subjects to be represented. On the top of each figure there is the touch feeler, a sensing inductive surface consisting of a sophisticated design that is generated through a computational process to meet project brief requirements.

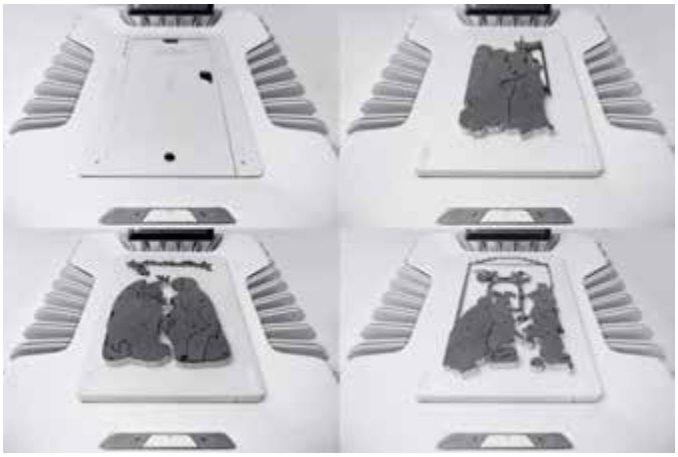

Figure 3. The APTICA interface features a technical compartment (3a) and it is designed to host interchangeable 3D tactile boards that can be swapped without the need for any technical intervention.

The computational design of single line touch feelers

As illustrated by L. Lanzi (Mameli et al., 2021), the realisation of the prototype involved a preliminary careful study of the artworks selected for the project from an iconographic point of view, with the consequent choice of the main elements to be reproduced and arranged as 3D figures of different height, so as to make them easier to read through touch. This initial work was carried out by CRS4 research team and experts involved in the Over the view project.

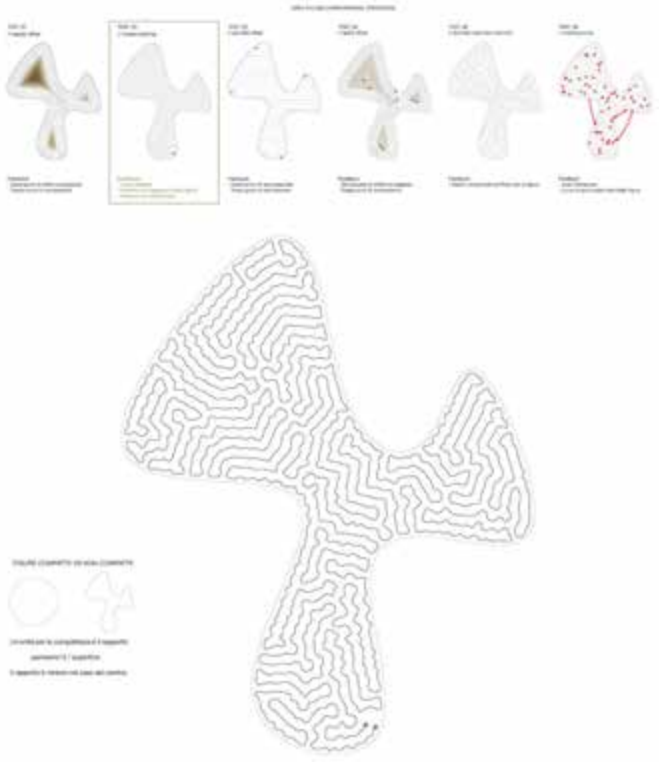

Figure 4. On the top a catalogue of attempts for a single-line filled surface with the points for electrical connection. The diagram on the bottom shows a final sample generated by the computational process.

The top-layer of each figure has been developed as a sensing surface, the touch feeler, which perceives visitor's touch and activate an audio narrative dedicated to the user, also with the possibility of asking specific questions. The development of the touch feelers was the second major design-research topic indeed.

ALO was asked to develop a sensing system based on two electrical connections (positive and ground) that would work without bracelets or additional connections involving the user. The main goal was to finds a system that could adapt to every kind of figure with minimum amount of electrical connections. Various geometric approaches were explored (fig. 4) to design conductive traces that could even detect the touch of a single finger anywhere on the surface of the figure.

However, in the case of non-compact figures, most of them failed to produce single-curve occupancy, which was very important in order to avoid over-complicated wiring and ensure system stability and scalability. Moreover a non-directional pattern appeared to be beneficial to avoid confusing the tactile exploration. Hence, we decided to investigate a computational method to generate an occupation pattern consisting of a single curve filling any kind geometric figure, compact or non-compact.

The studies of D. Hilbert or W. Sierpinski on space-filling curves(Sagan, 2013) showed a possible way forward, so we researched a computational protocol that, starting from a given boundary condition (the edge of the figure) and a set of genotypic parameters and constraints, modulates and folds

back the edge on itself up to fully occupy the figure with a single complex curve.

Figure 5. Detail of the conductive graphite pattern of the touch feelers prototype.

Through this procedure, which combines physical-computing methodologies and parametric-associative design strategies, we obtained a generative system that fills the space of the figure, while still matching production and functional constraints. The graphite based touch feelers were then prototyped in our laboratory by fine-tuning a fabrication protocol combining painting, cutting and laser engraving as to achieve repeatable and stable results.

Aptica prototype has proven the viability of the solutions researched and developed. Moreover, as the entire object and all its part has been designed as a parametric system, it is adaptable to every artwork, independently of shape and size and it is ready for immediate digital fabrication with basic CNC machinery.

Digital Story Explorer (DSE). Digital technologies for museum accessibility

The Digital Story Explorer (DSE) is the prototype of a multisensory museum accessibility system designed to tell the story of historic architecture, cities and territories in a contemporary, immersive and accessible way. In its first implementation (DSE 1.0), the system was customised for the permanent exhibition "Lazzaretto ieri e oggi" (open at the Lazzaretto in Cagliari since 13/2022) curated by the Cooperativa Sant'Elia 2003, to tell to tell the story of the Lazzaretto in Cagliari (Italy) and the life of doctors, quarantined, and people hosted and working in the building at the time of the plague (1830).

The DSE project continues the design-research undertaken during the Aptica project and the design of the tactile and interactive models of the Genna Maria and Serri Nuragic archaeological sites (also developed as part of CRS4's Over the View project in 2020) toward the larger scale of the exhibition space and its constituent elements.

Thanks to a renewed design and production approach, the agenda aims to establish a deeper relationship with the specificity of the exhibition spaces and content, and even the display podiums and structures acquire a pivotal role in the experience. Design research thus expands from the field of museum devices to that of immersive spaces, intending to amplify and awaken the sensory engagement of visitors by combining the very architecture of installations with more exploratory and trans-modal storytelling.

Hereby, digital design and fabrication techniques, including 3D printing and robotic fabrication processes, become strategic to personalize museum experiences by perfectly adapting them to the content and exhibition spaces and offering rewarding one-off experiences.

Design for all. A matter of form at the intersection of space and media.

The agenda is to blur the boundaries between the visitor's senses through the very materiality of exhibition elements and multimedia. The very design of the exhibition architecture and its constituent elements, such as display podiums, can play a central role in creating an inclusive and immersive atmosphere, in establishing immediate engagement with visitors, evoking feelings of curiosity and encouraging them to imagine themselves in other times and places, guiding them in a subtle manner through an active experience of the contents. (Waern & Løvlie, 2022)

The DSE 1.0 provides that the narrative about the Lazzaretto is unfolded through the support of a scale model. The structure of the building was reproduced following the plans of the 1830 from Alberti stored at the State Archive of Cagliari. However, telling non-experts the story of a building as a whole, its internal organization and life, with a static model is particularly limiting. Therefore, the challenge was to build a fine dynamic model with a hidden mechanical system. Finally, the ground floor opens up by sliding under the first floor according to the visitor's actions on the graphic navigation interface.

The entire 3D model was optimized for 3D printing with photo polymeric resin combining transparent resins for the facades and roofs and opaque ones for the structures and interior partitions to maximize the final efficacy. In addition, a dynamic lighting system accompanies the exploration by following visitor's actions down to the interior of the individual rooms which story is told. The rooms themselves come to life through the reproduction of animations from the graphic novel "Bartolomeo Salazar, the Last Plague Doctor," created by artist Stefano Obino, which are played back on the display of the navigation station and the wall in front of the DSE accompanied by a narrator's voice telling the story of those spaces among historical facts and memories passed down from generation to generation.

An advanced design of exhibition devices can provide new opportunities for a more immersive and pleasant cultural dissemination. With this goal, the podium displaying the dynamic model and the trans-modal navigation station (fig.6) were designed as a single entity. Even though they are two separate objects, their spatial relationship and shape are inextricably entwined (fig.7).

The design of the two elements pays special attention to younger visitors and those with visual and physical impairments. The intersection of their needs was made possible by an integrated parametric design approach that relays on a non-serial production approach to digital fabrication. This synthesis, guided by a humanistic approach to technology, helps to fulfil multiple requirements through formal articulation.

The wooden structure of the podium prevents the youngest and most exuberant visitors from touching the moving 3D-printed parts, while it also favours total enjoyment from above and below. It was also a deliberate decision to eliminate

Figure 6. Close-up view of the transmodal navigation interface with touch displays and touches tablets representing the two floors of the Lazaretto building with built-in touch sensors.

any protective cover to avoid barriers between visitors and the main subject of the narrative. As an alternative, an integrated sensor system activates an acoustic alarm signal to warn visitors in case of need.

The navigation station features a touch screen and an integrated tactile interface, consisting of two 3D-printed tablets representing the plans of the two-storey building and incorporating sensors for navigation. Finally, both the screen and the sensors, in a complementary manner, activate both the navigation through a 3D digital simulation of the building, the dynamics of the physical scale model and the multimedia content related to each room explored by the visitor.

The supporting structure of the navigation station is especially dedicated to wheelchair users, who can use the monitor or touch tablets (fig.6) while maintaining almost total visibility of the model and the rooms in which the narrative takes place without having to move.

The DSE features an embedded custom-made brain taking care of its behaviour. DSE mechatronics, both software and hardware, was custom-made by ALO team to allow communication between the digital graphic navigation system, touch screen, sensors and the physical model, controlling at the same time the synchronized payback of all multimedia contents, the dynamic lighting and the actuation system the makes the ground floor of the model opening to show the interior structure. All graphic effects, animations and lighting behaviours are generated through code and executed by an integrated mini-pc; the control engineering relays on the open-source Arduino platform to allow maximum flexibility and adaptability of the system to future, unexpected developments.

3D printing and digital fabrication for museum accessibility

Providing a contemporary and rewarding experience is perhaps one of the challenges with the most significant impact on the material and construction aspects of an exhibition, its structures and devices and, at a larger scale, on the museum space itself. In this regard, Digital fabrication fosters the realisation of effective interventions that require, by their very nature, unconventional and deeply customized solutions(Scopigno et al., 2015).

Only a few years ago, neither Aptica nor DSE would have been feasible with the same final quality as well as in a reasonable time and cost-effective manner.

Today, thanks to the democratisation of digital fabrication processes, coupled with the research-oriented approach that characterises ALO's transdisciplinary agenda on non-serial production, the basic research, design and prototyping phases come together to address accessibility with innovative solutions quickly and with reliable results, starting with clean and functional details such as those of touch tablets (fig.6) with embedded sensors.(Dellantonio, 1993).

For the DSE, in particular, all the technologies directly accessible at the ALO laboratory were strategically combined: the wooden display structures were manufactured using six-axis robotic milling, as was the complex 3D mould for the fibreglass finishes of the upper part of the podium. All the parts of Lazaretto's dynamic model, on the other hand, were produced by large-scale stereolithographic 3D printing allowing high quality and fine details. Finally, DSE 1.0 is a prototype but has all the characteristics of a finished product.

Conclusion

Digital technologies for design, production and interaction are proving to be excellent instruments for high-impact storytelling and dissemination of cultural heritage. Perhaps, for an inclusive and emotional engagement, technology alone is not enough.

Figure 7. The podium with the 3D printed dynamic model and the navigation station

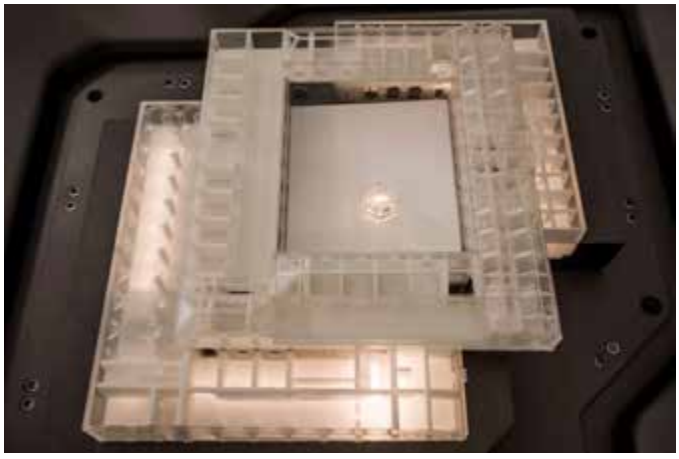

Figure 8. View of the ground and first floor of the 3D printed dynamic model. Ground floor lighting is on as this is the floor currently selected for the exploration.

Rather, it seems that it is particularly necessary to adopt technology from a humanistic and creative perspective as much as to engage with a holistic, interdisciplinary practice to rethink museums' space and equipment design.
The search for novel strategies and modalities to establish more dynamic and evoking connections between visitors and contents might pass by the materiality itself of the display elements and spaces and the embedded digital technologies as a whole.

Both Aptica and DSE are an applied and functioning expression of an original take on the subject by addressing design and production as inextricably interwoven aspects. The two projects proceed from an interdisciplinary approach whereby computation, matter and fabrication actively merge in the pursuit of a physical and emotional involvement of visitors, as to prompt them to move and explore contents and museum space as a whole, with curiosity and in a more personal and intimate way.

Hence, devices and exhibition infrastructure are no longer solely intended to be functional furniture to display content, but they are conceived as agents themselves for a complete, accessible and satisfying experience. These take on a new role with a significant dignity that requires renewed design intensity. Hereby, they become suggestive subjects of research and expression for practitioners to address universal accessibility and the design of rewarding experiences beyond already acquainted models.

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Usability and UX evaluation of an online interactive virtual learning environment: a case study of Wales' Virtual Hospital

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Abstract

Clinical placements are an essential component of the education provision for students of medicine and other health professions. However, opportunities to achieve learning outcomes cannot be consistent across students due to the very nature of their exposure to different patients in different timeframes and settings. In addition, the unpredictability of attendance of patients and the impact of the COVID-19 pandemic has resulted in few opportunities to experience more than one point in a patient journey. An innovative online virtual environment named Wales' Virtual Hospital (WVH) was developed using agile software development and User-Centred Design approach. This research paper presents the comprehensive usability and user experience (UX) studies that were conducted to evaluate all aspects of WVH by end-users and experts. The main contribution of this research is in the case study of evaluating a newly developed innovative online virtual environment, where behavioural and subjective feedback were collected to test the usability and the effectiveness of the learning experience. For this paper not all the outcomes of the evaluation process are reported, instead a key outcome of each iterative cycle is given as an example. The evaluation approach developed and used in this research could be adopted by other researchers to evaluate similar systems.

Keywords

VR, Educational Challenges, Usability, User Evaluation, Expert Evaluation.

Introduction

Medical learning requires a multimodal approach, with the need to offer students up-to-date evidence-based knowledge and the explanation of processes and key procedures (Philippe et al., 2020). Alongside scientific theory and the use of multimedia or online-resources, a core part of supporting medical students involves practical elements, such as placements in clinical settings. Clinical placements are considered an essential component of the education provision for students of medicine and other health professions. It enables the vital and unique experience of applying textbook knowledge to 'real' patients and the demands of an often-evolving clinical situation.

However, in clinical placements opportunities to achieve learning outcomes cannot be consistent across students due to the very nature of their exposure to different patients in different timeframes and settings. Hence, not all students will have the chance to experience a variety of specialisms, departments, and see the vast number of presenting complaints and patients (Life Sciences Hub Wales, 2022). As a result, students often see only one point of the patient's journey. Furthermore, the COVID-19 pandemic has brought a more critical challenge to experiential learning with face-to-face interaction becoming limited (Pears et al., 2020; Chan et al., 2021). Simulation can be used to augment clinical placements (Schiza et al., 2020, Macnamara et al., 2021). This learning technique provides strong engagement and offers students many technical skills. It offers the chance to learn from situational awareness, making judgements, and implementing practical processes (e.g., fitting a catheter) without affecting the safety of a real patient, and the opportunity to receive feedback and a debrief on their performance (Chao et al., 2022).

Immersive technologies such as Virtual Reality (VR) have received a lot of positive attention in the fields of medical education, with evidence to show that it creates realistic and interactive simulations; supporting the transmission of knowledge; instilling emotional engagement; role expectation and learning by doing (Dubovi, 2022). This should complement other forms of teaching and training and not be used as a substitution (Bruno, et al., 2020).

However, creating medical scenarios, such as 3D-modelled wards featuring virtual patients and colleagues using computer-generated environments, can be quite expensive to produce, especially when creating multiple scenarios for different types of clinical situations. Using 360° video, which is sometimes referred to as VR because it can be viewed in a VR Headset, gives the students an omnidirectional field of view simply by moving their head to look around, providing a passive sense of immersion (Snelson & Hsu, 2020). The limitation is that they cannot interact in the same way as the computer-generated environments where they can walk around,

interact with objects, and feel more present in the experience (Huang, et al., 2020; Witmer & Singer, 1998).

To address some of the limitations of clinical placements and to develop an inexpensive VR content creation platform that would allow clinicians to generate bespoke content, an innovative online virtual environment named Wales' Virtual Hospital (WVH) was developed. The design of the virtual environment allows clinicians or academics to create three types of interactive learning experience framed around a patient presentation in three formats: 360° still environment, 360° video environment, and fully immersive 360° VR environment. The goal is to build a library of medical case studies from a range of specialisms and to deliver more experiential learning of healthcare, with opportunities for interactivity in the form of answering questions as the content progresses. Clinicians or academics can use an online toolkit named the "Creator Mode" (CM) to create the different types of interactive learning experiences. This can be done by recording 360° video content which is currently very inexpensive, available to a consumer market, and easy to set-up and capture (Harrington et al., 2018). Students would be able to access the "Viewer Mode" (VM) portal to view the content and interact with it on their mobile, computer, or VR Head Mounted Display (HMD). As part of the WVH system, students would also be able to answer key questions as the scenario progressed, allowing them to make judgement calls at different stages through a graphical interface, which would appear within the 360° environment. Clinicians or academics can view students' engagement data using "Data Mode" (DM) toolkit (e.g., number of correct or wrong answers).

The development of WVH was carried out by integrating Agile software development approach and User-Centred Design approach (UCD). This resulted in more frequent usability evaluation iterations and a systematic way to examine and confirm end-user needs (Jurca, et al., 2014). Research shows that iterative evaluation and refinement cycles are essential to develop an educational intervention (Sandars & Lafferty, 2010). As the WVH system relies on collaboration between the academics, recording and uploading 360° videos and creating the interactive content and then the students engaging with it, it is important to make the system user-friendly, with intuitive functionality, for both types of users (Fisher and Wright, 2010). This would encourage its adoption into the course pedagogy and ensure learning opportunities are effective and optimised. In this paper, we present the comprehensive usability and UX studies that were conducted to evaluate all aspects of WVH system by end-users and experts. The aim was to ensure that the system design adhere to design principles and meet users' needs, across the WVH system modes, and making the delivery of the interactive virtual learning content more streamlined and engaging for the users.

Evaluation Method

Figure 1 illustrates the experimental approach that was adopted to critically evaluate the usability of the different types of modes and interactive learning experiences created using the WVH system, and to measure the effectiveness of these learning experiences. An iterative development cycle and testing with both experts and end-users were conducted while working closely with the WVH development team. The expert evaluation technique is typically conducted by professionals who have a high level of expertise in a particular field or subject matter (Ghaoui, 2005), in the case of this project Human-Computer Interaction and Design specialists. Experts used their knowledge and skills to assess the usability of the system and user learning experience. Whereas end-user evaluation technique involves collecting feedback from actual users of a product or service (Ghaoui, 2005). This approach allowed for a more practical and realistic assessment of WVH system, as it is based on the experiences and needs of the users (i.e., students, lecturers, and clinicians).

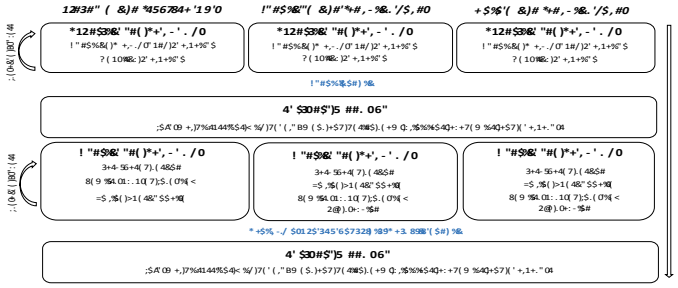

Figure 1. Evaluation Approach

Expert-based Evaluation:

Three expert evaluators evaluated the system's three different modes with the different level of interactions. This evaluation process was iterative starting with early conceptual prototypes and finishing with a high-fidelity prototype. Two expert evaluation techniques were followed, this included:

- Cognitive walkthrough (CW): This rigorous expert analysis technique was used to check through the system design and logic of steps in user interaction (Lewis & Wharton, 1997). The focus of this technique was on evaluating the learnability of the system from the perspective of new or infrequent users. The evaluation was structured around three design principles: visibility, affordance, and feedback (Donald, 2013). During the evaluation process the expert evaluators went through the user tasks provided by the development team and discussed the four key questions cited by Wharton and his colleagues (1994).
- Heuristic Evaluation (HE): This usability engineering technique allowed the expert evaluators to go through the system design looking for usability problems, guided by Jakob Nielsen's standard usability heuristics (Nielsen and Molich, 1990; Nielsen 1994) and visual-design principles (Gordon, 2020). At the end of the session evaluators rated the identified usability problems using the severity rating scales for impact by Nielsen (1994). The severity ratings created a priority list for the development team to work on to improve the system. Nielsen's standard usability heuristics were chosen as they are relevant when evaluating the different modes of interaction (Joyce, 2021) and for educational systems (Mohamed & Jaafar, 2010).

The expert-based evaluation techniques were regarded as a first pass of evaluation to identify as many usability problems as possible. This was followed by user-based evaluation to focus the evaluation further.

User-based Evaluation:

A total of 12 medical students evaluated the VM using the different levels of interactions. Individual testing sessions were conducted at ATiC's laboratory on the high-fidelity prototype of the system with five students (VR mode) and remotely with seven students (other modes). The CM and DM of the system were evaluated by five professionals (clinicians and academics). Research shows that 85% of usability problems can be identified with five participants (Asarbakhsh & Sandras, 2013).

Task scenario-based sessions using thinking aloud protocol: Participants were invited to complete a series of tasks related to the key activities they need to complete to use the system. Participants were provided with scenarios to give them an explanation and context (Dumas & Redish, 1999). As participants move through the system to complete the tasks, they were asked to verbalise their thoughts, feelings, and *opinions.*

Behavioural observation: To avoid the observer effect (Blalock & Blalock, 1982; Bloombaum 1983), the user-based evaluation sessions were video recorded using Noldus Viso system and screen capturing software for tracing and recording participants' actions and navigation. Allowing the researchers to analyse the participants' system interaction retrospectively. Observations were made on the key metrics of *Effectiveness* (were participants able to complete the tasks with a high degree of accuracy), *Efficiency* (how fast can participants complete a task) and *Errors* (how many errors do participants make and how easy it is to recover from those errors). To allow for a more visual presentation of the user interaction (Andrade, 2018), Tobii eye tracking was used to capture users' unconscious behavior, preference, and to understand their decision-making.

Post-session interviews: Semi-structured interview sessions aimed to collect more detailed feedback from participants on the following aspects:

- Likelihood of use: thoughts on the likelihood of themselves and other students using the system.
- Content and learning experience: the quality of the educational content available and what could be added; how effective and efficient this type of experience on learning; thoughts on the feedback they get from interacting with the system; and finally explore if the multiple-choice question is the best way to test students' knowledge and learning.
- Utility: does the system offer the functions that end-users need.
- Overall experience and usability: aesthetics; typography; learnability (ease of learning); ease of use; memorability (ease of remembering), and overall satisfaction.

Post- session online questionnaire: The online questionnaire consisted of three sections:

- System Usability Scale (SUS): a simple and reliable standard 10 item questionnaire with 5-point Likert scale used to collect participants' subjective feedback. The SUS was chosen as it is a well-researched and widely used to evaluate similar systems (Brooke, 2013; Orfanou, Tselios, & Katsanos, 2015; Renaut, et al., 2006).
- Look and feel of the design, consisted of four statements with 5-point Likert scale, which investigated participants' thoughts on different aspects of the design.
- Satisfaction: a statement with 5-point Likert scale about how satisfied participants are with the overall experience using the system.

Implementation & Results:

For this paper, an example of each iterative evaluation study will be discussed to highlight a key finding of that evaluation study and to illustrate how the evaluation method presented in this paper was implemented. Hence, not all the detailed feedback from the expert and user evaluation which has been shared with the development team is discussed here.

The first round of the iterative process was carried out with early WVH prototype of the VM using CW technique, the objective of this study was to evaluate two scenarios using the different level of interaction. The evaluators walked through the system thoroughly inspecting the two scenarios several times and completing a series of tasks. The outcome of each task was presented in the format illustrated in Table 1. A representative task of this study was to locate and enter the bay number 06. Once the participant was in the bay, they were required to check some important information about the patient (e.g., patient history, ECG; Figure 2).

Table 1. The outcome of a cognitive walkthrough

CW questions	CW Answers
Will users try to achieve the right effect?	**Yes.** Users will be able to attempt to enter the bay and find the key patient information.
Will users notice that the correct action is available?	**No**. Not everyone will look around naturally. Users should be provided with information on how to navigate the 360 environment and what actions will take place all around them or what interactive elements will appear.
Will users associate the correct action with the result they're trying to achieve?	**No.** Important interface components, or actionable items should not be placed too far from each other.
After the action is performed, will users see that progress is made toward the goal?	**Yes.** When the users click on the white dot to enter the bay the user is taken to inside the bay. Every time the user click on the actionable items inside the bay the user is presented with the related information.

Figure 2. Screen shots of the WVH viewer mode in a Shift Scenario

All the problems encountered in this study were categorised under four themes: (1) navigation; (2) interactivity; (3) feedback given to users; (4) visual communication. The problems were shared with the development team with a list of recommendations to improve on the design. The improved prototype was then tested with medical students using the user-based evaluation method discussed previously.

In this study participants evaluated a scenario using Oculus Quest VR headset. All participants said they could see themselves and other students using the system. Overall, participants found the experience engaging and fun. The immersive environment as participants noted gave them the experience of 'being there', which supports memory and practice-based learning. All participants commented on how it may benefit the way they learn best – by being in the role and in the hospital (such as on a clinical work-placement). They could see potential as to how this platform could support practice-based learning – or used as a library for extending their knowledge. They also said it may better develop their experiences for areas where they may not have had the opportunity first-hand. Two participants thought the video quality was not 'crisp', and that they felt they were 'floating' within the VR environment. However, this did not present a large problem towards overall UX. Unfortunately, none of the participants were able to complete all the tasks as the system kept crashing before reaching the end of the scenario. However, if we considered the number of tasks they completed before the system crashes, then all participants were able to complete all the tasks with a high degree of accuracy. On average efficiency level was 14 minutes (SD=0.7), and no errors were made (getting a question wrong was not counted as an error).

In the follow-up interviews, three participants said that they did not realise that answers were behind them, with one participant wondering whether they could be brought forward, but then became undecided because they recognised that having to search the environment for answers suits the immersive format. Participants suggested that having a fixed number of answer options would encourage them to look around for them. Participants commented on the quality of the production of the scenarios (e.g., quality of acting skills) which could be improved based on the content created by clinicians. Generally, participants found the structure of the scenarios very useful to test their knowledge and learn from any mistakes. Participants found the multiple-choice format useful for both learning and testing.

In this version of the prototype, SUS mean score was 78 (Grade B, Good) with a standard deviation (SD) of 6.2. Participants thought the system offered the functions that they need, and they were happy with its look and feel. Overall, all participants were very satisfied with the system.

Table 2. The outcome of heuristic evaluation

Heuristic	Ratings	Problems encountered
Visibility of system status	2	It is not clear which of the text fields are optional and which are compulsory. The appropriate feedback is presented, however, the display time of the error message is too short to read.
Match between system and the real world	1	'Preview Image' does not indicate upload image. Consider clearer labelling.
User control and freedom	4	Unable to upload a video making it hard to complete the task of creating a marked scenario.
Consistency and standards	1	Inconsistency in labelling, when selecting an image from the "Images Library" the dialog box labelled 'Select Media' and then you are presented with 'Select Images'.
Error prevention	1	You are allowed to select two images as scenario cover even though you only need one. Users should be constrained from selecting more than one image.

The iterative process of evaluating each design cycle continued with another round of expert evaluation of the re-designed VM, and the newly developed CM and DM. For each mode a series of tasks were tested. For the purpose of this paper, one example of a representative task from evaluating the CM will be used to illustrate the process (See Table 2). The task was to create a marked scenario, adding a stopping point at 30 seconds with one correct and two wrong answers. The evaluator should then move and place these answers in a location in the 360° environment. The outcome of the CM evaluation uncovered some violation of the design principles. As shown in Table 2, one of the encountered problems prevented the evaluators from completing the task. In contrast, both the VM and DM insights were mostly positive, where most of Nielsen's Heuristics were adhered to. After fixing the problems identified by the experts another round of user-based evaluation was conducted. Where medical students evaluated the VM, and professionals evaluated the CM and DM.

The updated version of the VM scored 84 (SD=13) (Grade A, Excellent) on SUS an improvement from the last round of evaluation. The system, as participants noted, was user-friendly, easy to access with clear graphic design, navigation, and interactivity. However, the audio quality during part of the scenario was reported as "poor" by some participants. Answers placed spatially around the scene were still causing some confusion to several participants. Participants were generally satisfied with the learning experience.

CM and DM were evaluated by clinicians and academics. In the CM, participants were tasked to create new learning content using the platform. The task involved building a 360° virtual scenario: inputting information, uploading videos and images, and then creating questions and answers and placing them within the 360° virtual space. All users had no prior experience and were still able to complete the task effectively, with some commenting that they would have no problems reprising the task now they had completed it once, adding that an initial demonstration video would have better prepared them. Two key challenges users encountered were (1) understanding how to move (or look) around the 360° content within the preview windows; (2) the choice of symbols and their placement in the interface.

Users began by setting up their scenario content by inputting basic information and uploading media. Following typing a title and description, many users were hesitant regarding two buttons, "Show to Users" and "3D Video", before progressing. This can be seen in the eye tracking data in Figure 3, where they fixated on these elements overall. It was not clear to us-

Figure 3. A heat-map of scenario information page

ers that these buttons were in fact switches, and by clicking them it would toggle on/off different options for the scenario.

Following uploading 360° video content, users were presented with a window titled "Camera Centre" displaying a preview image of the video with a symbol of a target in the centre. Upon hovering, the cursor would change from an arrow to a hand icon, which indicated to users they could interact or move this element. All users tried to click and drag the target symbol first to move the 360° video, which had no effect, rather than clicking the background or the image to move the perspective. This can be seen in eye tracking data in Figure 4.

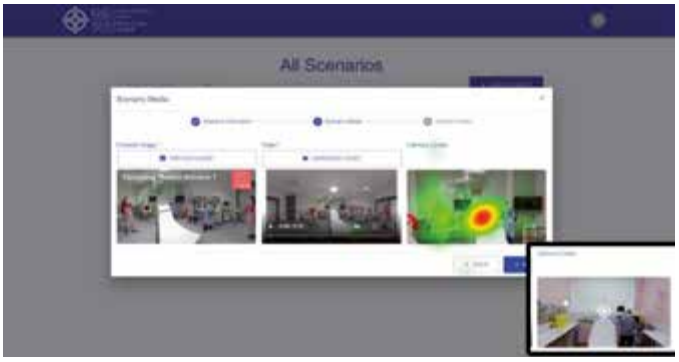

Figure 4. A heat-map of scenario media page

In the final screen, users can input questions and answers into their 360° scenario at any moment during the playback of video. There were specific challenges when placing answer boxes within the 360° environment. Each answer box had three symbols, a target, a pencil, and a tick or cross to denote if it was created as a right or wrong answer. Users assumed the pencil would allow them to 'edit' and move the answer box, instead this sent their cursor to the text entry box on the right. Upon clicking the target, it changed to a green computer disk icon, this would save the location of the answer in the 360° environment. However, it wasn't clear that users had to now move the background video by clicking and dragging, and instead users tried to drag the answer box. Once this process was finally worked out, users tried to click the green tick (representing 'correct answer') instead of the disk symbol. The eye-tracking heat-map reveals a definite focus on the green tick symbol (Figure 5).

CM and DM scored 69 (SD=10) and 71 (SD=13) on SUS respectively (Grade B, Good). Overall participants were somewhat satisfied with both modes, with all participants suggesting that having a demo instruction video for first time users would have increased their satisfaction rate.

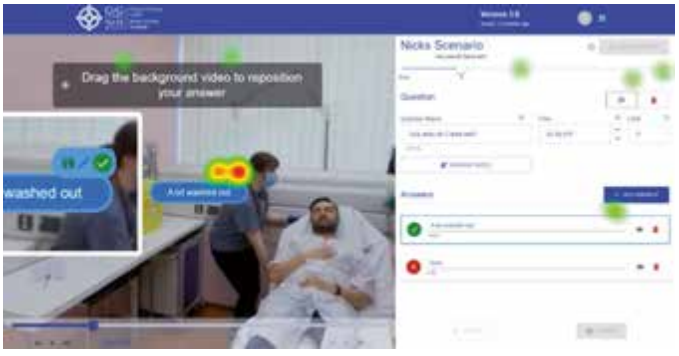

Figure 5. A heat-map of the final page where users can add questions and answers

At the end of each design and evaluation cycle, all project partners and stakeholders were invited for an informal evaluation testing session. The outcome of these sessions feedback to the next design cycle with all the data collected via expert and user evaluation.

Discussion and Recommendations

Conducting the evaluation in this thorough and rigorous manner allowed for a more comprehensive and well-rounded understanding of the designed system and led to better decision-making and improvements to the system.

The paper offers insights on how to evaluate an interactive educational system using the different interactions levels. Designers and project teams should take in consideration the following:

- It is crucial to start validating design ideas at the early design stage and continue evaluating the system throughout the whole development process.
- The findings from the expert-based and user-based evaluation complemented each other as they provided different perspectives. The expert-based evaluation can be regarded as a first pass of evaluation to identify as many usability, design, and technical problems as possible. While the user-based evaluation highlighted user-experience issues and areas where the system did not meet the needs of the users.
- By combining the two approaches and collecting both subjective and behavioral data, it is possible to validate and confirm findings from both approaches. This helps ensure that the findings of the evaluation process are accurate and reliable.

The case study of evaluating the newly developed innovative online virtual environment contributes to research in this field by demonstrating how this evaluation methodology, where iterative collection of behavioural and subjective feedback is undertaken, can be used to test the usability and effectiveness of similar systems. However, there are some limitations of this research that need to be addressed, especially regarding evaluating the effectiveness of the learning experience. This research has only collected subjective feedback from students. Further research is planned to investigate the effect of VR simulation teaching prior to in-person simulation training. The research will involve 300 medical students using the Randomised Control Trial (RCT) method. In addition, there was no comparison between different levels of interaction to understand which students preferred or found more engaging. Lastly, future evaluations could be further strengthened by increasing the sample size.

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Design perspectives for the future of work in industry 5.0 environment: the digital and physical space in augmented reality uses

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Abstract

The advent of Industry 4.0 has introduced into the manufacturing environment a new level of interconnection between machines, operations and sensors that have been able to automate entire processes. Along with this decentralization of the workforce, the new concept of Industry 5.0 aspires to elevate humans to the focal point of cognitive, physical and digital activities, by bringing advanced technologies that autonomously work beside humans in a human-centered perspective.

This is proposed to go beyond the productive purpose by enhancing the experience and quality of work itself, generating questions about how design could intervene to foster effective communication (by limiting misunderstanding and conflict between the technology and the operator) especially in situations where digital and physical are blended.

The object of study is the manipulation of the operator's work environment through the use of Augmented Reality (AR), investigating how it can be integrated into the work experience in terms of performance and psychological response, with particular attention to the type of interface placed in the worker's own spatial reality.

After an overview of the use of eXtended Reality (XR) modes and how such technology can support human work, the focus will be placed on the category of Spatial Augmented Reality (SAR) aimed at operator training and assistance during production routine, which will then be analyzed from a design perspective involving reflections on how the discipline could intervene to enhance learning and use. These definitions point to raising the human factor above the task of assembly and the related operations, therefore the experience over the process, supporting the concept of human-centered manufacturing.

From a design point of view, this becomes subject of exploration not only regarding the configuration of the interface itself, but how its functionality can be manipulated to make the experience engaging in terms of tasks to be performed and human cognitive response, to arrive at considerations derived from a literature review with observations about possible ways in which the figure of the designer could act in such a typically engineering context.

Author keywords

human-centered manufacturing; spatial augmented reality; industry 5.0; interaction design; user experience design.

Introduction

The industrial sector is the protagonist of a current technological evolution characterized by an increasingly close interconnection between digital and physical systems, resulting in a loss of the human component in relation to ever more autonomous and sophisticated technologies. Hence the advent of a new stage of Industry, the 5.0: a vision that intends to implement a human-centric evolution that places operators and their well-being at the center of the production process (European Commission, 2021a).

The ways to achieve this goal will define the "work of the future" which, as cited in the thematic area of Cluster 4 that constitutes Horizon Europe's interventions, is intended to increase understanding of the human-machine relationship (European Commission, 2021b).

This concerns in particular the coexistence of the intangible digital and tangible physical reality that ever more often meet in working scenarios, opening new views of experimentation connecting those two worlds by using eXtended Reality (XR) as a tool: an evidence is the programme 2021-2022 of the Digital, Industry and Space cluster of Horizon Europe, which comprehends "eXtended Reality Modelling (RIA)" (CORDIS, European Commission, 2022a) and "eXtended Reality Learning - Engage and Interact (IA)" (CORDIS, European Commission, 2022b).

In this scenario, design is interpellated as a tool capable of elaborating new ways of relating humans and technologies around their workspace, so that two different but collaborative worlds can be merged. Indeed, if that of humans is unpredictable and subject to emotions, that of machines is predictable and automatic, but lacking human judgment, adaptability, and logic (Haight and Kecojevic, 2005). The goal of this intervention is to establish fluid communication that fosters and accommodates progress in favor of optimized processes for production and those who work in it, combining the skills of both.

The article takes eXtended Reality technology as its object of study, observing how its use is able to meet the goals

of the new industry of the future and how it promotes inclusiveness and involvement of the human component.

The exploration is articulated in a literature review focusing on the uses and limitations for which design needs to be involved, so that new development hypotheses can emerge in which the discipline is integrated into the design process of such technologies.

The aim is to be able to define a vision in which future industry grows naturally around humans, so that they can evolve spontaneously in circumstances in which they are now alienated: in front of machines and processes whose operations do not take into account human comprehensibility and presence. This with particular focus then not only on production, but on those circumstances in which cognitive capabilities (such as during learning and assistance) take center stage for the optimal performance of operations.

In the next chapters, the dimensions touched by XR in the factory will be investigated, starting with new work scenarios in the industrial 5.0 context and its current use, and then arriving at Spatial Augmented Reality (SAR) and how it can be designed to optimize the course of work without devices acting as intermediaries between humans and processes.

The evolution of industrial work and the XR

Industry 4.0 has introduced a new level of interconnection between machines, operations and sensors, ensuring that operators have technological support at their side, designed however to be primarily performance-centric, opening opportunities for possible human replacement in favor of automation (Coronado et al., 2022). The 5.0 view, on the other hand, opposes this probability by considering the machine only as a tool to complement/enhance human work (without replacing it) while also improving its quality.

We thus move away from the sole purpose of production and closer to a more experiential conception of work itself, which is currently instead focused on a dehumanization that worries not only operators but also society and governments (Grabowska et al., 2022). Indeed, the same authors state how the term "human-centric" classifies a still narrow segment of research that needs to become a key area of it.

The human factor is therefore a fundamental requirement in the design of Industry 5.0, which places it no longer as an element to be discarded but rather in a position of understanding the technological complexity through a clear dialogue with it, suitable preparation, and a directional openness to development (İşcan, 2021).

It is evident how as technologies and operations within the factory progress, work is destined to evolve, opening new possibilities for work performance and well-being, and defining new figures and duties: the use of cognitive skills in tasks, is capable to increase engagement and interest while working, making individuals more flexible. This evolution toward more cognitive rather than mechanical contributions is the result of adaptation to an increasingly digital environment, that makes the operator of the future able to dialogue with and be assisted by machines.

The recent production methodologies open up new possibilities for increasing human capabilities: Romero et. al (2016) classifies various typologies in which humans are combined with specific technologies, describing their figure in relation to how they are assisted by them. Specific examples may be the "Augmented Operator," the result of the combination of the operator and Augmented Reality, or the "Virtual Operator," derived from the combination of the operator and Virtual Reality. Both types describe an operator whose skills are enhanced, whether in mobility, vision, or processing, and refer to a type of cognitive interaction between humans and the mechanisms of the workspace. The latter is included in an industrial context characterized by Cyber-Physical Systems (CPS), in which information is transmitted by physical and virtual elements, that through feedback and data acquisition generate automated operational decisions. A new dimension of human-machine interface is able to place humans between cyber systems and the physical world, through an enhancement of the human: it is the concept of Human Cyber-Physical Systems (H-CPS) elaborated by Romero et. al (2016) that aims precisely at a dynamic interaction with machines in the cyber and physical worlds, enhancing human skills and senses through the technologies themselves.

Indeed, industry is following the current technological trend toward immaterial universes, as evidenced by the report of Accenture Technology Vision 2022, which states that "the most ambitious companies will bring to life new physical and digital worlds, populated by both people and artificial intelligences [...] gathering not only advantages over automation, but experimenting with new forms of collaboration between humans and machines" (Daugherty et al., 2022). This evidence is closely related to the use and development of eXtended Reality technologies, whose work is to reduce the distance between humans and the virtual through different manipulations and representations of reality, in this case intended as the work environment.

As described by Rauschnabel et al. (2022), the main definitions of XR, namely Augmented Reality (AR) and Virtual Reality (VR) can be easily distinguished based on the presence of the physical environment as part of the experience: if there is a local presence, it is referred to as AR. The latter can be declined into types such as Mixed Reality (MR), Tangible Augmented Reality (TAR), and Spatial Augmented Reality (SAR) that will be discussed later.

In industrial settings, the most widely used XRs are MR and AR. They, once integrated, are capable of improving several aspects of the industrial system, in particular:

- Time management: AR is leveraged for long and advanced tasks in manufacturing, such as "complex setups, operations with many tasks/long cycle time and advanced maintenance" (Fast-Berglund et al., 2018), and the same authors state how connecting digital/cyber/virtual and physical worlds can lead to significant time savings in that application area. Doolani et al. (2020) also call XR technologies into question, introducing new features such as increasing time-room flexibility.
- Personnel training: one of the major applications of augmented reality concerns the training of operators, who today need to be prepared and resilient precisely as a response to increasingly advanced technologies. Doolani et al. (2020) define how AR can be used in this regard, especially for tasks that include "monitoring assembly line, sorting, picking, keeping, assembling, installation, inspection, packing, cleaning routines (process, shovel, sweep, clean work areas) and using hand tools, power tools and machinery". Werrlich et al. (2018) testify how a virtual assembly phase, tested before going physical, can improve the training transfer.

- Communication with machines: scope of use can include the communication between workers and technologies in the industrial environment, as mentioned by Materna et al. (2018) regarding the programming of collaborative robots, in which workers were able to program, collaborate and readjust the cobot to new uses with a reasonable time.
- Cognitive load on workers: the experiment by Hou et al. (2013) demonstrates how animated AR systems cause a positive effect of cognitive facilitation on workers in training, no longer having to rely solely on their memory to complete an assembly, and therefore reducing errors.

SAR design for the workplace

Augmented reality applications help increase human presence in a clear dialogue with the surrounding digital and intangible environment, especially when it comes to Spatial Augmented Reality (SAR). In fact, Doyle Kent and Kopacek (2021) among the categories of intervention to foster efficient collaboration between operators and machines, include confidence in the use of surrounding technologies and an exploitation of them that, however, do not make the human figure redundant.

This type of Augmented Reality under consideration is capable of enhancing the user's visible scenario and influencing the operator's involvement by offering the real and virtual worlds in the same view, and promoting autonomous workflow by impacting on usability and cognitive workload (Rupprecht et al., 2021).

Such technology moves beyond traditional eye-worn or hand-held displays (Figure 1), exploiting "large spatially-aligned optical elements, such as mirror beam combiners, transparent screens, or holograms, as well as video projectors" (Bimber and Raskar, 2005).

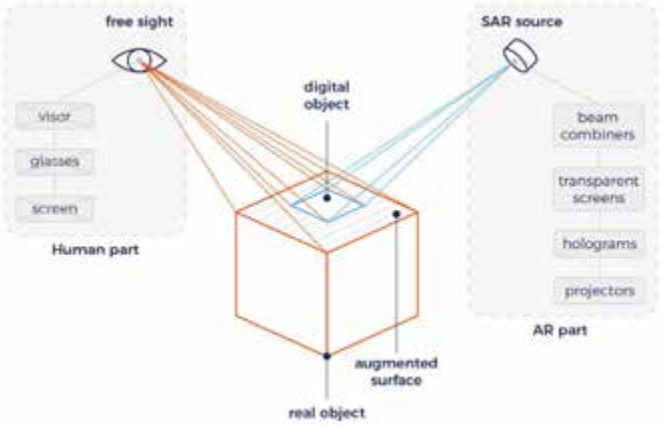

Figure 1. Principal elements for a SAR configuration.

This typology is the most ubiquitous form of AR currently in use (Giunta et al., 2018), in fact it increases the actual visible environment, influencing, in the case of the workstation, the involvement of the operator, who is present between the real and virtual worlds, improving the performance and experience (Uva et al., 2018).

In fact, wearable tools for augmented reality have limitations like those listed by Siltanen and Heinonen (2020), such as the difficulty in seeing the real environment through glasses or visors, or their battery life leading to complicating their use when connected to external power sources. In addition, weight and comfort are also relevant factors for dynamic use such as at work. SAR on one hand offers a solution to such limitations, but it also has disadvantages related to the environment on which it operates such as visibility, surface-based distortions, object relationships, brightness, contrast (Kruijff et al., 2010).

In the work environment it is supportive already from the design phase, Porter et al. (2010) in fact employ it as a means of iterative design, in which the design is projected onto the surface of the physical object and modified in real time, making the idea of the physical prototype and product much clearer and more direct than from the 3D model on a computer screen.

Regarding its purely industrial use, the benefits are evident particularly in assembly and production work tasks. In particular, Bosch et al. (2020) state how less experienced operators are able to operate without or with little supervision, with increased flexibility, employment and reduced training time, leading to an acceptance of the technology by most workers.

In the case of assembly, Uva et al. (2018) compared the instructions viewable by Head-Mounted Display (HMD), tablet, paper, and projections on the work surface. The result was that the latter method proved to be the fastest of the assembly times, with greater reduction of errors and lower cognitive load, collecting positive testimonies especially about having hands free during practice. Such use has proven successful particularly in those situations where even experienced operators are faced with assembling products that are different from each other or modified (e.g., resulting from mass customization), being able to follow the operations without relying only on their memory.

Funk et al. (2016) conducted a similar experiment, comparing the same types of instructions and demonstrating how direct projection to the work location leads to faster assemblies, fewer errors and cognitive load, while also appreciating the freedom in not wearing devices and having free hands.
The increase in productivity and quality given by projected instructions improves not only performance levels, but also the workload itself on the operator (Bosch et al., 2017).

Applications, limitations and opportunities

Analogous experiences related to SAR can be gathered in work domains different from industry, such as in medicine (Bin et al., 2020) or collaborative design (Ben Rajeb and Leclercq, 2013) with related activities such as prototyping (Morosi et al., 2018). Scenarios then extend by investing in wellness (Mousavi Hondori et al., 2013) and culture (Ridel et al., 2014) such as the exhibition and museum domain, where the authors' past experiences show how SAR can give not only contextual information, but also an immersive three-dimensional view, providing an immediate and shared experience, as the visitor's gaze remain free while interacting.

Despite the wide variety of uses and purposes, however, as of today there is no consolidated UI language that could help both designing and understanding the possible interactions, even though there are promising experiments, e.g. Schmidt et al. (2018) have performed studies on User Interface (UI) and user response to interaction. Although the SAR paradigm allows for immediate interaction and does not require learning a new device, it still remains necessary to learn a new way of interacting with projected digital content, which

in 2023 does not yet have a widely shared gestural and cognitive identification.
This is a relative disadvantage compared to HMDs that, promoted by powerful industry players, have vocabularies, toolkits and guidelines at their disposal, such as Microsoft's Design Checkpoints (Microsoft Learn, 2022) in which interaction models, gestures and physical inputs, along with UX Elements and visual rules are well defined and distinguished.

However, there is no common line or framework among the SAR case studies , making the design process of SAR experiences rather challenging.

In the particular field of industrial SAR, effective experience design means not only gains of productivity, but also a facilitated state of mind for operators.

This can be achieved not only by optimizing the hardware part for greater adaptability and adoptability, but by exploiting the role of software often integrated into the systems, configured by the workers themselves on the factory floor.

Such intervention should be performed and studied following User Experience Design concepts (Figure 2) such as those classified by Hillmann (2021) for XR Design: comfort and safety, interaction (affordance, signifiers, feedback), environment and spatial components, sensory input (visual, audio, haptics), engagement (storytelling, gamification), constraints and inclusion, diversity, accessibility.

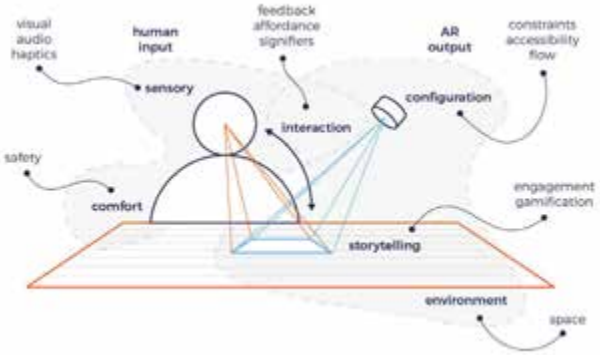

Figure 2. User Experience Design concepts for SAP configuration.

Indeed, authoring tools can be useful in configuring the activities to be followed by the operator, aiming for optimal use derived from a routine that is engaging, simple and not monotonous. The same ease must be present for those who program or modify the experience itself, whether they are the designer, engineer, or line manager. A practical example is the Arkite [1] system that provides both the hardware workstation and the software setup for operators' manual assembly guidance and training.

While there are multiple generic purpose AR authoring tools (e.g. Adobe Aero, Audodesk Forge, Vuforia Studio, Areeka Studio), for the purposes of industrial SAR these services will need to evolve by integrating domain-specific UX Design concepts in order to build an optimal process that takes into account not only the functioning of the various stages, but also the experience in its use, introducing more direct feedback concepts, rewarding systems and gamification.

Conclusion

As we have seen, SAR is capable of enhancing the user's visible scenario and influencing the operator's experience, despite being affected by the number and type of interactions within the augmented space and its positioning.

In order to ensure the optimal use of (S)AR in the industrial context, the presented desk research highlights the need of future research regarding (1) a design methodology that can be applied taking into account who will have to use or configure this technology, since "to advance the use of XR technologies in industrial maintenance and other similar hands-busy type of professional use, there is a need to develop an explicit list of UI and usability heuristics for XR context" (Siltanen and Heinonen, 2020), (2) the human engagement in monotonous workflows such as on assembly line, through the concept of gamification by investigating the design of motivational elements (also employed in the training beneficially influencing the learning process, as stated by Schuldt and Friedemann, 2017), (3) the elements of interaction from human/digital inputs and outputs, specifically investing graphical interfaces, physical interfaces, supporting devices, tasks to be performed, human response and feedbacks received by operators while performing tasks.

In particular, an upcoming experimental research of the authors will focus on how to reach a direct and natural gesture communication with projected and digital objects in order to develop a clearer interaction with the augmented interface, investing visual navigation and kinesthetics studies.

In the increasingly complex factory of the future, design research is fundamental for exploring and enhancing the operator's own senses, making them meaningful and augmented through technologies such as SAR: these could have the power to increase the level of human integration in the factory, especially in such an automated environment.

From the perspective of the Cumulus community of worldwide design schools, it would be particularly interesting to explore the differences between geographical regions and hence different cultures of factory work, which would influence the transversal applicability of new SAR solutions. On the other hand, design education might be influenced as well, preparing future designers to possible new branches of specialization, either by focusing on the technological medium, such as Design for XR experiences, or Design for the intelligent factory, focusing on the industrial domain as an area for systemic design interventions.

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1 The ultimate operator guidance platform. Arkite. From https://arkite.com/

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Assessing the impact of immersive versus desktop virtual reality shopping experiences in the fashion industry metaverse

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Abstract

The digital transition towards the Metaverse deeply permeated by digital technologies is the core of current debates. In this shift, fashion emerges as a relevant context for analyzing the implications of the Metaverse, with fashion companies being among the first industries to implement projects in this persistent virtual space. Today, with fashion being such a relevant global business, but one of the most polluting industries, its transition towards "hybrid" experience modes can produce significant impacts in terms of more efficient and sustainable modes of production.

Also, in the existing spectrum of digital technologies, Virtual Reality (VR) represents an opportunity and a tool from which the fashion industry can benefit. However, although VR has proven its effectiveness in fashion retail, the scientific literature still presents limited studies; yet there is plenty of scope for its potential use in the fashion industry. Also, there is a lack of studies comparing Immersive VR (IVR) to non-immersive shopping experiences, such as Desktop Virtual Reality (DVR). Therefore, researchers must identify the differences between IVR and DVR systems since they may affect users during their evaluation. For this reason, further research is needed to assess how VR technology can improve the shopping experience towards the Metaverse.

The aim of the research is to compare the experience of buying an accessory (i.e., a luxury handbag) on a desktop computer, DVR, with that in IVR, assessing the impact in terms of system usability. To test the differences in terms of usability, we developed two versions of the application. The first is developed as a traditional desktop application and the second is developed for the IVR Head-Mounted Display (Oculus Quest 2).

We hypothesized that IVR modes can be more easily used and accessed by the user. To this aim, we conducted a within-subject experiment with 60 participants by administering the System Usability Scale (SUS) questionnaire to compare the DVR and IVR applications.

Thus, the paper shows that display, interaction, and locomotion in the design of shopping experiences can generate different feedback on the system usability, and therefore IVR could be a more suitable tool for novel shopping modes in the fashion industry towards the Metaverse.

Author keywords

Virtual Reality; Fashion Industry; Shopping Experience; Metaverse; Sustainability

Introduction

In recent years, the retail industry has witnessed an unprecedented acceleration of digitization, where Covid-19 has been the main driver (McKinsey, 2020; Shankar et al., 2021). In this transition scenario, companies have been looking for fast and alternative ways to innovate while adapting to government-issued restrictions (i.e., the isolation and closure of physical shops).

Therefore, companies have started to make exponential use of the new technologies available to make production systems more responsive, flexible, sustainable, and efficient, and to improve sales processes (Bisson et al., 2021; Fiorentino et al., 2022).

Due to this digital transition, the physical reality made of "things" has gradually started to evolve towards a less tangible dimension, characterized by relations between people and immaterial, digital, and "metaphysical" objects.

Among the rising technologies, we focus on Mixed Reality (MR) as the continuum of Virtual and Augmented Reality (VR, AR), (Milgram & Kishino, 1994), which contributes to the development and diffusion of the Metaverse, a persistent virtual space that users can use for work, entertainment and for other activities, such as shopping experiences. Within this emerging space, a new form of 'immersive' interaction between users and services is shaping (M. Park et al., 2018; S. M. Park & Kim, 2022), especially using VR and Head-Mounted Displays (HMDs).

Although the Metaverse does not necessarily require the use of VR technology, recent studies state that it will be an open challenge from a future-oriented perspective (Babu & Mohan, 2022; S. M. Park & Kim, 2022)

But while the general frameworks describing the Metaverse are becoming increasingly accessible, the implementation strategies and their implications on specific industrial systems are largely unexplored.

In this regard, our paper focuses on the fashion industry, one of the industries that can certainly benefit from this ongoing transition towards the Metaverse (Bertola & Teunissen,

2018; Cappellieri et al., 2021; McKinsey, 2023), for several reasons.

First, the fashion industry, traditionally based on physical and material interactions, had to face the consequences of the Covid-19 pandemic, one of the major challenges so far. Since 2020, many companies - both luxury and fast fashion - have closed their manufacturing factories and physical shops, laid off employees, and canceled fashion shows and events due to the severe restrictions in place. The natural consequence of this was a sudden decrease in sales.

Moreover, after the first lockdown, companies had to adapt to the rapid change in consumer behavior caused by social distancing and isolation. Therefore, consumers - especially Generation Z - developed a new approach to fashion shopping experiences. This is because the lockdown has shown how it is possible to replicate our daily lives in the digital world. In fact, almost all the activities we do daily, from study to work, from sports to socialization, can now be accomplished digitally. This is very relevant because it has given digital spaces a whole new meaning for consumers, changing their purchasing behavior and expectations.

Meanwhile, Covid-19 raised a new level of awareness with respect to the planet. Sustainability became a priority in the minds of consumers, who demand different production processes, especially avoiding waste that is difficult to dispose of in the environment.

The fashion industry is widely recognized as one of the most polluting, with a long history of established wasteful practices that increased with the rise of fast fashion. The need to speed up time-to-market and reduce market costs resulted in the use of toxic textile dyes that made fashion second only to the oil industry in terms of global pollution damage (Dhir, 2021).

As a result, the fashion industry is surprisingly one of the keenest to adopt digitization strategies using digital technologies such as VR to transform its business model, motivated by the apparent plethora of options and benefits it offers (Bertola & Teunissen, 2018; Boardman et al., 2020; Ricci, 2022). Indeed, considering the importance of fashion as a global business today, the transition to 'hybrid' modes of experience can have a huge impact also in terms of more efficient and sustainable modes of production (Bulovic & Covic, 2020).

One of the biggest benefits that digital fashion is bound to bring is the promotion of sustainability, helping brands target environmentally conscious consumers. Virtual fashion prototyping allows a company to have a series of products visualized and configured in real-time before the physical product is made. Digital and virtual clothing can save 3,300 liters of water per garment and emit 97% fewer carbon emissions (DressX, 2021).

However, the literature concerning the fashion industry and the use of VR is scarce (Xi & Hamari, 2021) and, therefore, also about its implications in the emerging Metaverse. Thus, although VR has proven its effectiveness in the field of fashion retail, there are only limited experimental studies (Xi & Hamari, 2021). On this basis, this paper aims to provide insights into the use of digital VR technology to improve the shopping experience in the fashion industry towards the Metaverse, by expanding the previous study of Ricci (2022), and by presenting the results of an experimental design.

The objective of the research is to compare the shopping experience of an accessory (i.e., a luxury handbag) on a desktop computer - Desktop Virtual Reality (DVR) - with that in Immersive VR (IVR), evaluating the impact from the point of view of system usability. To test the differences in terms of usability, we developed two versions of the application. The first was developed as a traditional desktop application, while the second was developed for Oculus Quest 2.

To this end, we conducted an in-subject experiment with 60 participants, administering the System Usability Scale (SUS) questionnaire to compare DVR and IVR applications.

The research question is: "Can an IVR shopping application be more usable than a DVR application?"

Background

When investigating the use of VR in the fashion industry, two rather different approaches can be identified (Morotti et al., 2020). The first originates in the fashion industry and the second in the academic field. We will focus on the contributions from academia, as they present the results of experimental studies.

Namely, the Metaverse can be enjoyed with both non-immersive and immersive virtual technologies (Dwivedi et al., 2022). Yet, there are no studies in the field of fashion that clarify the differences between immersive and non-immersive VR experiences. In fact, such comparative studies only exist in one other product area (i.e., groceries) (Lombart et al., 2020; Peukert et al., 2019; Schnack et al., 2019).

In the area of fashion, the present studies are rather concerned with analyzing the implications of VR for enhancing the shopping experience through specific metrics.

For example, Lau et al. (2014) researched how interactivity can enhance consumers' shopping experiences. To do this, they designed an IVR shop in which participants were instructed to look around and explore fashion products within the virtual environment. Subsequent interviews revealed that participants engaged with and enjoyed the experience, demonstrating how interactive design can enhance consumers' shopping experiences (Lau et al., 2014).

Similarly, Jang et al. (2019) studied the role of interactivity along with vividness in consumers' intentions to approach an IVR shop. The results showed that participants who perceived greater interactivity and vividness also tended to show stronger purchase intentions. Furthermore, these positive influences were mediated by perceived telepresence and the value of experiential shopping (Jang et al., 2019). In contrast, Lau and Lee (2019) validated that VR could improve interactive shopping, consumer purchase intention, and hedonic user experience within consumer shopping experiences (Lau et al., 2019).

However, designing an IVR shop may also be useful to measure the dimensions of the user experience within virtual shops and how it affects the shopping results. In this regard, Park et al. (2018) designed an IVR shop, addressing a female target group. During a one-hour individual session, all participants were asked to enter the shop and freely explore it as much as they wanted. Preliminary results showed that the immersive VR experience is positively correlated with pleasure, attitude towards virtual shops, and purchase intention. Therefore, the researchers concluded that IVR could be used as a new shopping tool to improve consumer experience and engagement (M. Park et al., 2018).

Moes and Van Vliet (2017) analyzed to what extent a shopping experience can take place using online material (e.g., a normal shop photo, a 360-degree photo, or a VR photo) and to

what extent these different materials create different effects in an online or physical shop. The main result is that presenting the experience of a physical shop on an online platform is more effective with the help of VR than with a normal or 360-degree photo. In addition, the use of VR seemed very suitable to achieve other positive effects, such as increasing the consumer's intention to visit the physical shop. Therefore, in a society where online shopping is on the rise and physical shops are under pressure, "the use of VR seems a logical step"(Moes & Vliet, 2017).

In terms of interactivity in relation to the hearing sense within the virtual shopping experience, Morotti et al. (2020) discussed the potential of using voice commands in an IVR fashion shop, exploring the benefits of speaking and interacting verbally with a VR assistant embodying a salesperson. Preliminary results suggested that VR could provide effective experiences, and the integration of the voice assistant could help make the virtual experience more natural and easier (Morotti et al., 2020).

In summary, the results of this research provide a strong initial statement on the positive effects of VR for retailers, with respect to the metrics investigated (Moes & Vliet, 2017). However, further research in the fashion industry is still needed to establish the effects of different experience modes. Furthermore, although all contributions address the improvement of the shopping experience in the fashion context, there are no studies comparing IVR and non-immersive VR experiences.

Only Ricci (2022) presented a future agenda about the design and development of VR and haptic applications with the aim of improving the fashion shopping experience.

Therefore, we aim to extend this work by presenting an experimental design, conducting a comparative study, and formulating the following hypothesis:

H1: Users perceive the IVR shopping application as more usable and accessible than the DVR.

Methods

We conducted a within-subjects experiment with two conditions: IVR mode and DVR mode. Both conditions provided the same shopping experience but differ in terms of display and interaction systems within the applications. To balance the treatment orders, a Latin square was used.

Participants

At the Polytechnic University of Bari, sixty volunteers (35 male and 24 female) aged 22 to 58 (M=30,5, SD=10.23) were recruited for this study. Nobody had ever used VR for a shopping experience, although most of them (n=41) had previous experience with VR before the experiment, with a level of familiarity with this technology equal to 4 on a 7-Points Likert scale.

Task

We designed a virtual fashion showroom using the Unity 3D engine. The case study is a luxury handbag, as accessories compared to clothes (such as t-shirts, shirts, etc.) have simpler physics and are much easier to render in the 3D engine.
Subsequently, the task of the experiment assigned to the users was to find a luxury handbag in the virtual shop and explore its features freely until they were ready to buy it.
The features of the handbag user interface included:

- Zoom in or out of the product.
- Display detailed information about the handbag (e.g., brand, history, production process, size guide, washing method, and reviews).
- Call up an attributes window to change the color and finishings.
- When finished, click on the handbag to add it to the shopping cart.

Setup

This experiment was carried out in a university laboratory that included a workstation with a seat, a Zotac ZBOX MAGNUS ONE i7-10400, an Oculus Quest 2 HMD, and two wireless controllers. We designed two versions of the applications: DVR and IVR. The first was a traditional desktop application, while the second was designed for Oculus Quest 2 (See Figure 1).

Figure 1. User testing the IVR shopping application.

Both versions presented the same functionalities but differed in terms of interaction and display devices. The keyboard and mouse were used to interact within the DVR application, and the display was on the computer monitor. However, interaction occurred with the controllers in the IVR application, and the scene was seen through the HMD. In this case, we implemented the standard metaphor of raycasting (Lee et al., 2003), a group of interactive techniques used in IVR for selecting distant targets. We implemented a raycasting-based virtual pointer as a laser pointer that, when intersecting a target object, selects it (See Figure 2).

Furthermore, the locomotion technique also differed between the two versions. Whereas in DVR, locomotion took place using arrows on the keyboard, in IVR we implemented a natural navigation metaphor, i.e., teleportation (Bozgeyikli et al., 2016). Specifically, point & teleport is a locomotion technique that overcomes the problem of limited tracking areas by allowing users to teleport to selected target positions using either controller. Furthermore, teleportation was the most suitable

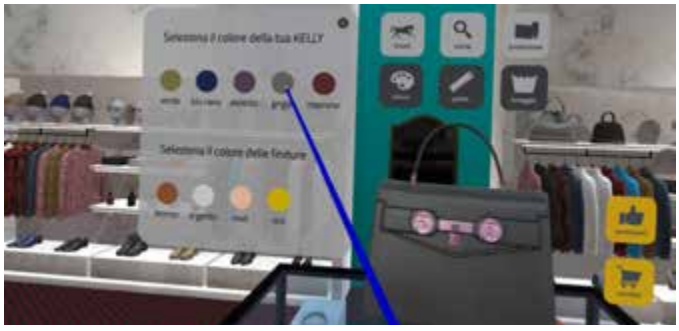

Figure 2. Raycasting technique for the interaction mode in the IVR application.

technique for our application, as the designed virtual shop was very large in terms of spatial extension.

Procedure

We welcomed the participants when they arrived and asked them to sit in a designated position and to provide informed consent. First, we described the purpose and tasks of the experiment to all 60 participants through a PowerPoint presentation. Afterward, we showed the participants how to interact and move in both DVR and IVR modes. We administered the pre-experience questionnaire to the subjects when they were ready to start. Next, participants had to go through the DVR and IVR training sequences, performing tasks like the real experiment, in a cube training environment. Then, once they were ready, they tested the experimental scenario to complete the task.

Measures

Finally, we invited participants to complete a questionnaire at the end of the experiment, both for DVR and immersive VR modes. To test our hypothesis, we assessed the subjective measurement of system usability. As a result, we requested that participants fill out the System Usability Scale questionnaire (SUS). The SUS is a ten-item standardized questionnaire used to assess perceived usability (Lewis, 2018) (See Table 1). To interpret the SUS results, we used the curved rating scale (Lewis & Sauro, 2016) ranging from rating A (Best Imaginable) to rating F (Worst Imaginable).

Table 1. SUS assessment method

Questionnaire	Number of items	Type of rating scale	Time of the administration	Application(s)
System Usability Scale (SUS)	10	5-point Likert Scale	Assessment of the perceived usability at the end of a study	Subjective assessments of perceived usability of products

Results and Discussion

All participants completed the task and answered the questionnaire, returning valid results without outliers. The score returned by the SUS questionnaire for the IVR mode is 81 (Excellent, See Figure 3), corresponding to an A rating, on Lewis and Sauro curved rating scale, while the score returned for the DVR mode is 54.50 (Poor, See Figure 3), corresponding to a D rating. Confirming our hypothesis, the IVR application results in being easier to use than the DVR.

The perceived usability may depend on how the IVR system is implemented compared to the DVR system. Thus, we can suppose that the explanation for this is in the display, interaction, and locomotion systems. The effects of IVR versus DVR display modalities on usability have been investigated by numerous studies but not for retail and, particularly, for the fashion industry.

For instance, in the case of the DVR application, the display system was on a 2D screen and returned flat images with a low degree of immersiveness. In the case of the IVR, instead, users could be fully immersed in a virtual environment that surrounds them at 360°.

Recent literature reports that IVR displays have been shown to positively affect performance in a visual search task (Pallavicini & Pepe, 2019), such as finding the handbag in our experiment. Also, users feel more naturally immersed in the IVR scenario, showing a more intense emotional response in IVR versus after DVR (Othman et al., 2022). Additionally, users commented to feel a greater sense of presence in IVR as opposed to DVR condition, probably due to the higher degree of immersiveness. Interaction could also be a contributing factor. Indeed, interaction in the DVR took place with the mouse, which, regardless of how familiar users were with this tool, was probably not suited to the visual search task compared to the raycasting technique (Pallavicini & Pepe, 2019). The same is true for locomotion, which in the DVR was accomplished using the arrow keys on the keyboard and was limited in comparison to the ability for users to project themselves anywhere via teleportation in IVR. These results regarding the usability of the IVR compared to the DVR are encouraging for further applications in the fashion industry.

Figure 3. On the left: Box-and-Whisker plot of the scores of the ten SUS statements for the DVR mode; On the right: Box-and-Whisker plot of the scores of the ten SUS statements for the IVR mode.

Conclusion

We are currently living in an ever-expanding digital reality, which has affected every part of our lives, including the way we experience shopping. Indeed, the Covid-19 pandemic has accelerated digitization through the spread of technologies such as VR, assumed as one of the elected tools for experiencing the Metaverse. In this transition, the fashion industry can take advantage of this technology to become more sustainable, by reducing its pollution impact.

Nonetheless, the literature concerning VR adoption within the fashion industry is very limited. And, clearly, there is a lack of studies comparing IVR versus non-immersive shopping experiences, i.e., DVR. Indeed, researchers should acknowledge the differences between IVR and DVR applications because this could affect the users during the evaluation. As a result, more experimental research is needed to determine how VR technology may improve the fashion shopping experience in the Metaverse.

We, therefore, extended the work of Ricci (2022) by performing a comparative study between an IVR and a DVR shopping experience and assuming a luxury handbag as a case study. The aim was to test the usability of the applications to assess which of the two was the more usable.

To this aim, we conducted a within-subject experiment with 60 participants, administering the SUS questionnaire to compare the DVR and IVR applications. As a result, the study demonstrated that higher immersion in the design of shopping experiences can provide different feedback on system usability, showing that the IVR application (A rating) is more usable than the DVR (D rating). The explanations for this may be found in the implementation of IVR and DVR systems and their differences in display, interaction, and locomotion systems.

One of the main outcomes of this study is that IVR has the potential to create new shopping modalities for the fashion industry. Indeed, as users find IVR applications more usable than DVR, it is possible to think that in the emerging Metaverse applications, IVR could play a fundamental role among all the technologies involved, being potentially accepted among users.

Also, further research is needed in order to assess other measures such as user experience, customer engagement, and purchase intention, and analyze their implications in the Metaverse.

To conclude, this research may also have potential implications regarding sustainability. In fact, it would also be interesting to analyze in depth what benefits it could bring from a sustainable perspective, quantifying the reduction of waste and product returns.

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A pilot study with the Shaper Origin to determine the learning curve of augmented fabrication

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Abstract

Augmented fabrication is an upcoming technology which combines digital design with physical manufacturing. Since there is a lack of experimental data on the benefits and experiences of augmented fabrication, a pilot study was done with the Shape Origin, a spatially aware manual CNC cutter. The experiment consisted of engraving a set of boards with circular 2mm groove. As a pilot test, the co-authors participated in the experiment and engraved five boards each.

We concluded that the quality and elapsed time improved significantly after repetition. As participants, we ended up with more confidence in operating the machine and growing more knowledgeable about the wood as a material during the engraving, resulting in cleaner cutting results with a flat learning curve.

Author keywords

Augmented fabrication; craftmanship; Human-computer interaction; carpentry

Introduction

Today, evolving technology allows us to design and manufacture automatically (Weigert et al., 2019). Yet because of this, the creative input of the designer and the experience gained during the process vanishes more and more (Zoran & Paradiso, 2013). The experience a designer feels during the process of making the product, will provide insights about the material and applicable fabrication methods. Once it is completely digitally done by machines, the designer is not able to adjust during the process (Loh, Burry, & Wagenfeld, 2016).

With the use of augmented fabrication tools and digital manufacturing, it is possible for people to do the fabrication process themselves, assisted through digital fabrication means (Verlinden & Bekker, 2017;Mahapatra, Jensen, McQuaid, & Ashbrook, 2019; Yung, Li, & Ashbrook, 2018). In this way, the designer of the product can make small adjustments during this process. Also, most augmented fabrication-tools are very mobile (Yung et al., 2018). Due to this high level of mobility, the person can easily transport the fabrication tool from one location to another. This makes switching between workplaces or different contexts possible. A couple examples of such mobile augmented tools are the FreeD, a handheld digital milling device that is monitored by a computer but still preserves the makers gestural freedom (Zoran & Paradiso, 2013), the augmented airbrush an airbrush that allows novices to experience the art of spray painting (Shilkrot, Maes, Paradiso, & Zoran, 2015), and the D-Coil: a 3D modelling approach that uses wax coiling to bring tangibility to the design of digital models (Peng, Zoran, & Guimbretiere, 2015). Each of these devices assist the user in developing a skill that would otherwise be very difficult and would take a long time to learn.

The concept of augmented fabrication is still new in product development and manufacturing, a structured approach to investigate its benefits requires design inclusive research (Verlinden & Horvath, 2009). Most of such systems are still in development while no experimental data is found on its influence on design. This study represents a pilot study of using the Shaper Origin, a commercially available augmented milling machine (Shaper Tools Inc, 2023). The focus is on the learning curve and quality of the resulting workpieces.

Method

In this pilot study, the Shaper Origin will be our practical testing tool (Shaper tools inc., 2023). The research question was formulated as *to what extend (time) does working with the Origin Shaper tool as an augmented fabrication machine improve custom board cutting?* Furthermore, by fabricating a design several times we want to see if the fabrication process is getting faster and easier (i.e., learning effect).

To verify if a learning curve can be flattened by using augmented fabrication tools, practical research is the best option. As Nielsen stated, an estimation of usability requires only 5 participants (Nielsen, 2000), while a subjective verification of the use of such tools is still lacking.

Workpiece design

In this experiment a set of wooden plates were engraved with a circle contour (figure 1).

Since this was a simple design, the engraving design was made on the machine - it comes with a basic toolset in which we could model the contour. This made the start of the process quicker and easier. Figure 2 left shows how the milling path is being mapped in the centre (concentric).

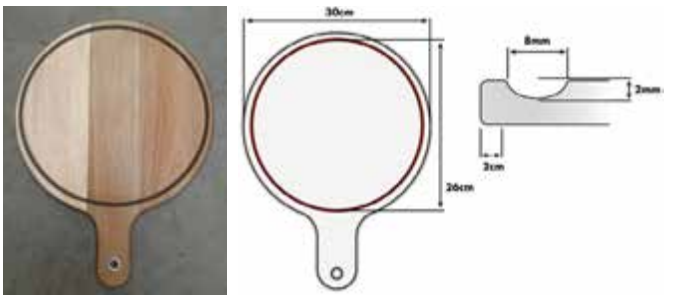

Figure 1. Workpiece and its dimensions.

Figure 2. Left: Shaper Origin display with engraving design, right: finished workpieces.

Each of the participants was tasked to engrave five wooden plates. From a functional perspective, a circular groove/split with a diameter of 26 cm was determined to prevent juices from draining of the plate when dinner is served onto it, as indicated in red in figure 1. Apart from measuring the time to complete the workpieces, the quality of each contour was rated.

Pre-test with Shaper Origin

The shaper origin is a commercially available handheld milling machine that is spatially aware using a specific tracker tape on the work surface, which is observed through a camera by the internal computing unit. The interface guides you by showing a path you need to follow. When you deviate from the milling path, the tool adjusts itself in time to prevent any minor mistakes.

To check if our experiment setup was appropriate, we did a pre-test with a test plate. This way we could make sure the machine was set up correctly, specifically the engraving pattern and depth.

The engraving was designed to be 2 mm deep, this required two milling phases: the first time one millimetre and the second time two millimetres with a ball-end mill (Ø8 millimetre). Thus, the full milling path is 163 cm.

We immediately noticed that the elevated surroundings were not wide and high enough to support the Shaper. We needed to add more of support surface to prevent the Shaper from getting out of balance when moving around the wooden plate.

Furthermore, the tracking stickers required careful planning. Since the elevated surface(s) of the jig had a small surface, these were not usable for placing the stickers. As seen Figure 2 on the right, we ended up using a lower surface as no inaccuracies were noticed by this hight difference.

During our setup and pre-test, we experienced several unexpected challenges, for example the need for more tracking stickers on the board. This caused the Shaper to lose track of its position. Secondly, due to a height difference between the working surface and the support blocks, The Shaper often lost balance. The pre-test findings can be found in the Appendix.

Figure 3. Placement of tracking tape - left: initial, right: final.

Determining engraving quality and flaws

In Table 1, a visual categorisation of flaws is provided. When moving the miller too slow, black spots/burn marks appeared on the edges. This was due to the heat caused by the rpm or because the mill was due for replacement (flaw 1). Another flaw that appeared when going too fast, was these frayed edges (tear-out). These were very visible, so we did our best to avoid them (flaw 2). Not deep enough only shows white marking (flaw 3). Some of the boards had an uneven surface, causing uneven groove depths (flaw 4). This was a flaw we did initially not take into consideration when calculating the quality scores, yet it influenced the overall look of the engraving. Where the starting point and the endpoint met, the lines not always connect perfectly. This was due to starting and ending the milling process abruptly.

The occurrence of flaws determined the quality score for each workpiece. No flaws are represented as a 10 out of 10. Each flaw is subtracted, ranging between -3 (very visible) and -1 (minimal).

Table 1. Categorisation of milling flaws.

Flaw 1 – burns

Flaw 2 - frayed edges

Flaw 3 - insufficient depth

Flaw 4 - uneven surfaces

Results

The participants all are 4th year product development students at the University of Antwerp, ranging between 21-24 years old with no formal training on manual milling/wood-

working. Before the experiment, the participants gave a confidence value they felt about working with the Shaper tool. Afterwards they were asked to rate their confidence working with the Shaper tool again.

For each participant, the time to finish one workpiece was captured. The five measurements were be put on a timeline, shown in Figure 4.

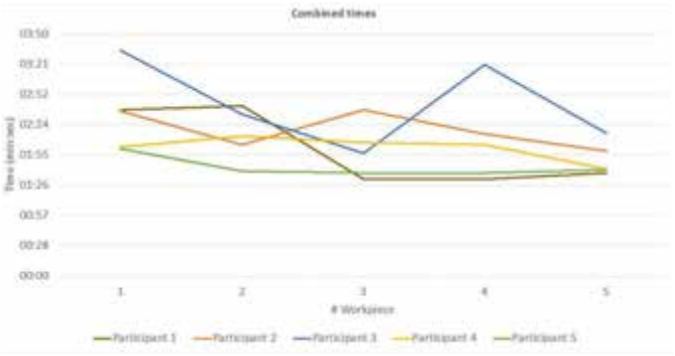

Figure 4. Times per participant.

In most cases, the initial workpiece took most time and there is a gradual decrease of approx. 30-45 seconds to complete each workpiece between first and last plate per participant. Time drops over time occurred for multiple participants, suggesting an increase in efficiency. Secondly, several mentioned the feeling that handling the machine. However, in some cases exceptions happened (like participant 3 in workpiece #4 where tracking was lost) while overall times stayed below 3 minutes – which translates to a minimum speed of 0,9 cm/s and a typical speed of 1,4 cm/s.

Figure 5, the quality plot, reveals increasing scores of each consecutive workpiece in comparison to the initial board. This is due to the fact that the participants found a comfortable tempo of following the contour and operating the machine. The roughness differences between some of the plates were negligible.

In subjective feedback, the nature of guidance and correction felt natural to the participants. Lastly, with more practice, not only the time, but also the quality of the engraving was improving. This became noticeable through the understanding of which groove shape was desired, but also getting used to the manner of operation with the Shaper Origin had an influence across the participants, which resulted in overall better results. There were deviations in the workpiece thickness

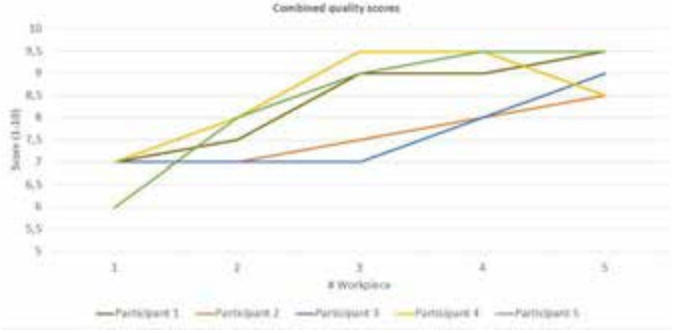

Figure 5. Quality scores per participant.

which on close inspection influenced the performance (flaw #4). The tracking tape should be put on the same level as the milling surface.

Figure 6 shows that the more plates an individual participant cuts, the higher their overall efficiency scored. Even with the difficulties through the middle ground of the plates (2nd plate 2 to 4th plate), the comparison from the 1st plate to the 5th plate all participants scored higher.

Figure 6. Efficiency per participant.

Conclusion

Augmented fabrication tools can potentially greatly reduce the amount of skill that is needed to operate certain machines, this way the steep learning curve might suddenly become much flatter.

This study involved engraving a set of plates, performed by participants that had little experience with carpentry. As the collection of 25 workpieces could be manufactured and objectively tested on quality, this pilot study is a first of a series on the performance of digital craftmanship.

Both by time measurements and subjective evaluation, we can conclude that the augmented fabrication with the Shaper Origin does add sufficient guidance to engrave a continuous curved contour in relatively little time (less than 3 minutes per workpiece). Repeated operation decreases the manufacturing time, while the quality of the engraving was the same during the experiments, while some improvements were certainly visible. Furthermore, the subjective feedback and the confidence score of the participants grew along the executing of the experiment. This all establishes to a small learning curve to operate and design engraving with augmented fabrication – both in performance (time and quality) as well as confidence.

Of course, improvements in small series manufacturing do not necessarily influence the ideation/prototyping process, and specifically with carpentry, more consideration of the material (macro structure, grain, warping) is required to improve quality and creative expression.

Acknowledgement

The authors would like to thank Danny Stoop for the technical support and expertise on carpentry.

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Appendix Pre-test timings and challenges

1st setup	7:17	scanning
Preperation	1:47	Programming circle and dept
Milling 2mm	3:26	Milled to deep, not complete, Too few stickers
2st setup	4:43	Extra stickers, new scan
Preperaton	2:48	Programming circle and dept
Milling depth 1mm	8:26	Lost orientation, no clean groove
Milling depth 2mm	4:02	Lost orientation again, new scan
Milling new supportive blocks, adding extra sticker		
setup 3	2:58	Adding extra stickers and adding support for the shaper
Preparation	1:00	Programming circle and dept
Milling depth 1mm	1:39	No problems, everyhting went good
Milling depth 2mm	1:27	
final test		
Milling depth 1mm	1:23	
Milling depth 2mm	1:15	

Introducing the material experience concept in the metaverse and in virtual environments

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Abstract

Metaverse consists of a set of virtual spaces populated by avatars and allows humans to move from the commonly known detached browsing interaction to inhabiting what is now called the immersive internet or spatial web. Here another dimension is added to interactivity by merging the virtual and real worlds. MetaverseIt is creating new interaction possibilities in content consumption for various fields: health, mobility, architecture, fashion, art, social, retail, etc., improving user engagement.

Material experience plays a key role in how human beings perceive and interact with the world through their senses. While in physical artefacts, material perception is intrinsic to what they are made of, in the case of virtual objects can simulate materials with existing behaviours or even have the potential to create modes of material interaction without precedents.

The Metaverse's technological ecosystem can directly affect how we interact with objects in real, virtual, and mixed environments. However, it still requires intensive research and development to reach its full potential.

This article aims to investigate how material experience is approached in Metaverse ecosystems and in virtual environments in general from two main perspectives: by the users who populate these virtual dimensions interacting with virtual materials and by the designers who take part in their creation and development.

To do so, a framework has been created to classify all the possible characteristics that virtual materials can have in the virtual environments, hence in the Metaverse, following the five senses and in the meantime, a correlation has been traced with the related virtual output defined by the designer who develops material experiences for virtual environments.

This analysis highlighted that it becomes vital for the designer developing material experiences for virtual environments to be aware of the possible hardware devices available stimulating the virtual material experience in the user; that a balance needs to be created between the richness of details and the performance to ensure fluid experiences in relation to energy consumption and the speed of the connection; that, especially nowadays, living in times of conflict, designers should develop more inclusive virtual material experiences opting for a multi-modals experience stimulating multiple sensorial channels fostering connectivity and creativity.

Author keywords

Metaverse, material experience, design, material, virtual environment, virtual materials, augmented reality, virtual reality, mixed reality, user experience, user interaction

Introduction

Mixed reality (MR) is the merging of physical and virtual worlds, where virtual stimuli are overlaid with a real scene in real-time. It allows us to create a fluid and interactive interconnection between the virtual and the real world and potentially become the next big change in the media world (Mott et al. 2019).

The enhancement of MR creates new possibilities of interaction in content consumption in various fields: health, mobility, architecture, fashion, art, social and retail. It creates unprecedented ways to interact with products, from improving customer involvement in the purchasing phase (Grewal et al., 2017) to enriching the product usage experience. The current content is mainly based on visual cues complemented by some audio integration. In this virtual and mixed environment, material experience (MX) plays a key role in how people perceive and interact with physical and virtual objects (Bardt, 2019). While in physical artefacts, the material perception is intrinsic to what it is made of, the processes used in the manufacturing and with respect to the laws of physics, virtual objects have the potential to explore new laws to create unprecedented ways of interaction (Milgram and Kishino, 1995). However, interaction with virtual materials can only be related to the means, tools and devices available to enhance that. MR technologies have been explored for decades and are already available through different devices. It will be possible to consider MR as a continuous between physical and virtual in the very near future (Peddie, 2017). However, it still requires intensive research and development to reach its full potential as the next breakthrough media.

In this paper, the concept of MX is not related only to the physical dimensions but also to the digital ones. Furthermore, the digital dimension is not referring to the actual materiality of the medium (e.g. computer, smartphone, VR glasses), but also to the digital representation of materials in virtual spaces, such as their aesthetics and interactive qualities. Considering the metaverse as a space web (Accenture, 2022), all representations of its elements, objects and environments

displayed need to be manifested somehow to the user called to occupy a virtual space and to interact with their contents. Objects and environments need to be addressed with a visual appearance (e.g. colour, glossiness, texture, etc.) and/or designed to give responses and feedback when the user interacts with them. Therefore, looking at the Metaverse and virtual spaces in general from this perspective makes emerges how MX plays a central role in how users experience them and what the designers need to take into account to create a meaningful experience.

The Metaverse and its challenges

Metaverse is an evolution of the current internet that allows people to move from browsing interaction to inhabiting (Accenture, 2022). It is also defined as the immersive Internet or space web, the spectrum between merging the virtual and real world where the 3D dimension is added to the interactivity. We can see the *"Metaverse not as virtual space but as the junction or nexus of our physical and virtual worlds"* (Smart et al., 2007). In this sense, the metaverse is not necessarily something detached from our reality, a virtual place to escape, but rather it can be integrated into our reality, an evolution in content consumption in a more immersive, natural and interactive way (Giang Barrera & Shah, 2023).

One of the clearest limits of the Metaverse's user experience is that, for the majority of cases, it happens only through two sensorial modalities: vision and sound. Users are still using their old devices (e.g. computers, mobiles, etc.) to navigate in it, so the Metaverse is being designed e developed to respond only to those types of interfaces. This contributes unequivocally to creating poor experiences, even causing some users exclusion in case they have some disabilities (Zhao et al. 2018). The near future of MR technologies is to explore multi-sensorial experiences enabling the construction of a 3D Web (Heller et al., 2019), having the potential to reduce the gap between disabled or regular users by improving mental imagery and the *sense of presence* (Sun et al., 2022). The term *presence* is used because it offers a broad perspective of phenomena and doesn't limit the interaction to certain technologies enabling the users to both *be there* (immersion in a virtual environment) and *be here* (the virtual contents are displayed in your current physical environment). In the context of the Metaverse, the *sense of presence* can be defined as "a psychological state in which virtual (para-authentic or artificial) physical objects are experienced as actual physical objects in either sensory or nonsensory ways." (Lee, 2004).

Material experience in virtual environments

Through the latest decades of technological advancements, people rely heavily on screens to conduct digital interaction. TVs, computers, smartphones and tablets are the dominant technologies to access data, communicate or produce content. However, while on one side, there is a great development in image processing, creation and representation, the other typologies of stimuli have been slowly developed. For this reason, digital interaction has become less and less tangible (Jung & Stolterman, 2010). It was partially caused by the slow technological developments in this area but mainly because the content characteristics developed for web 1 and 2 are characterized by interactions happening in 2D displays (Heller et al., 2019). With the advances done and the expectation of Web 3 spreading, the Metaverse opens wide new possibilities of interactions in three-dimensional environments and richer multi-sensorial experiences. The new generation's powerful processors allow the renderisation of better images, sounds and haptic feedback with more quality and richness at high rates. Faster connections allow exchanging data faster than ever. Hardware sensors are able to make experiences more aware of our surroundings and adapt the content to make us experience the *sense of presence* in digital environments. AI not only assist in performing faster and smarter tasks but also curate meaningful content and create experiences more personal to each user (Huynh-The et al., 2022). All this converges to new levels of interactions and contents. In this way, inhabiting a virtual environment means adopting new rules *augmenting* physical objects and environments or even creating representations of new ones. To this end, the digital materials experience (MX) comes on stage, which means, for designers, designing the MX of new virtual artefacts and environments.

Virtual materials and the Metaverse: cases from the contemporary phenomenology

The number of users spending more time in virtual environments is rising, a trend that has evolved since the beginning of the internet but that intensively increased in the last 3 years of the pandemic with the wide migration of activities and interactions performed in the physical world to a virtual environment (Mott et al. 2019). This creates the need for virtual environments to allow people to express themselves through virtual features such as avatars' appearance, avatars' clothes and accessories, private virtual spaces, virtual artefacts and art (Giang Barrera & Shah, 2023). These push design practitioners to go beyond the laws of the physical world, allowing themselves to design speculative new aesthetics, interactive modalities, narratives, experiences and even identities. The merging of physical and virtual dimensions has been one of the sparkles to the rise of some of the most significant speculative design case studies in the last decades, touching materials as part of their themes. Among them, we can mention the work done by Antony Dunne in the Hertzian *Tales: Electronic Products, Aesthetic Experience and Critical Design*, where the author questions the relevance of materials perception in the perspective of progressive virtualization of electronic products (Dunne, 2008). Still, Dunne, together with Fiona Raby in *Speculative Everything: Design, Fiction, and Social Dreaming*, imagines solutions were treating alternatives to the current dynamic (imagining how things might be) and operating outside reality, proposing radical solutions that affect current society, politics, and economy, thus challenging the building system. Thus, virtual worlds create critical, alternative realities that challenge the real world by contrast (Dunne & Raby, 2013). In this context, Virtual designs emerge from the real and shape the unreal; they are re-individualized spaces where the boundaries of identity are constantly reshaped, as are meeting places hosting new communities and generating new networks (Koozarch, 2022).

As we become more reliant on technology, the speculative design will most likely become more focused on how we interact with devices and virtuality (Chakrabarty, 2023). A contemporary speculative design case study is the work developed by the designer and creative technologist Billy Kwok called *Metaverse Design Manifesto, Undystopianizing the Metaverse*.

The designer developed an artwork including an interactive augmented reality experience that serves as a cautionary tale for the Metaverse and a design manifesto that lays out ten principles to make the Metaverse a positive evolution rather than a potential dystopia. Among his *Metaverse Design Manifesto*'s 10 principles, we can find pr point n°9 *Embrace digital materialism*. Billy suggests to designers to add a bit of physicality and substance to virtual objects to avoid pure photorealism or minimalism, embracing a balanced mediation between digital augmentation and digital augmentation (Billy Kwok, 2023).

Figure 1. Metaverse Design Manifesto, Undystopianizing the Metaverse

The Metaverse is creating endless possibilities to make speculative design cases virtually or hybridly experienceable by users worldwide; on the other hand, it is possible to see that, as a reflection of our physical reality dominated by capitalistic logic, it is possible to provocatively say that the kind of speculation widely spread in it is also the economical one (Giang Barrera & Shah, 2023). In this regard, some designers have been able to lean on the MX to create new virtual artefacts and environments, generating revenues and interesting case studies.

Andrés Reisinger explored the new possibilities of virtual materials in his furniture pieces. He raised US$450.000 on auction with his furniture collection "impossibles" in 2021 (Dezeen, 2021). As the name suggests, the pieces are surreal, looking and behaving in unconventional ways if compared to physical laws. On the Tangled chair (Figure 2), he played with the perception of structured softness by breaking users' expectations when they saw the armchair collapsing, revealing the empty core. Similarly, the Deep Space sofa (Figure 2) presents similar initial characteristics of softness built by exterior fabric texturing and emptying over time, however, there are incongruences between the initial volume movement, the emptying speed, and the final volume. At first glance, it is possible to imply the sofa back is filled with some liquid inside due to the swinging weaving. However, as it starts emptying, the speed is faster than an actual liquid would flow out the volume, remitting to air behave as the final volume also indicates. In both cases, it's primordial the time dimension of the experience. The material and object performed to bring the surprise effect increase the distinction and value attributed to the virtual product.

Figure 2. Impossible sofa collection by Andrés Reisinger

The opportunity to play with materials and interactions has not only been applied to artefacts but also to proper environments designed to generate experience in the user through their virtual materials. The designer/artist Krista Kim designed Mars House, an NFT 3D house. It reached the price of 288 Ether (equivalent to $512,000). It was described by SuperRare (2021) as "the first NFT digital house in the world". The owner Has access to this digital space through VR technology. The aim was to create a zen environment, an escape place to relax. To this, it applied colour gradients on the floor and ceiling similar to sunset pallets, Kwon, to promote relaxation in users. The dichroic effect on the furniture surfaces also creates the gradient to reach the same effect. The use of translucent material emphasizes the environment's lightness avoiding creating solid visual barriers. On the upholstered furniture objects such as sofas and armchairs, it was applied a texture mimicking velvet. It improves the perception of softness, smoothness and worminess strangely related to the idea of comfort and comfortable seating. Even if the cues are strictly visual, we link the visual information to our previous knowledge and past experiences and attribute the idea of comfort and relaxation to the Mars House (Figure 3).

Figure 2. Mars House by Krista Kim

Material experience introduction

Material experience (MX) is usually inherent to the design process of physical goods, and since the early design schools materials have been involved in the creative process. Bauhaus design schools introduced MX by studying materials, advocating that thinking, knowing and exploring materials were fundamental for good design practice.

The designed physical artefact exists in volume, represented by an outer surface and an inner core. An object only exists if it's made of something (Ashby & Johnson, 2013). With the digital revolution, the conception of existence evolved from physical products with physical features to a blurred border between physical and digital until encountering virtual objects built by bits. However, even purely virtual artefacts are still manifested by the representation of substances. Before jumping into how MX occur in virtual experiences is vital to understand its nature briefly. The designed physical artefact made by its essence (matter) is a medium to arise an experience, and MX are those experiences generated with and through the product's materials (Karana et al. 2008). MX consists of four main experiences that users can encounter interacting with materials:

1. *sensorial experience*, those coming from appraisals inspired by material sources, such as smoothness/hardness, warmness/coldness, glossy/matt, deep/shallow sound, etc.;
2. *meaning experiences*, thank the contact with the material, the user can project ad introject a series of meaningful connections with his/her own experience;
3. *emotional experiences* generated on users that are able to create make the MX recall some emotional content inspired by the material;
4. *performative*, how people would interact and how materials can guide them to certain actions.

Designing physical objects means transforming materials into desired artefacts. The materials' proprieties and characteristics directly affect the creative process and final result. It determines possible shapes, functions, interactions, durability, value and sensorial stimulus. Aesthetic shapes, which stimulations we receive according to the *human five senses*. The received inputs will be processed by the person and judged into meanings according to personal standards, raising the question of what the material means to us. It's a cognitive process based on association, situation, memories, past experiences and symbolic significances to objects. It's highly influenced by personal characteristics, cultural differences and actual psychological state (Rognoli, 2010).

Translating physical to digital

This section intends to present an analysis of how the designers are often called to understand the correlation between the envisioned MX, the qualities of the material they want to design and their virtual representations. Consequently, it will be presented as an in dept exploration of the tools, aspects and commands at the disposal of designers working for digital environments. To do so, a framework (Figure 1) has been created to classify the possible interactions (passive and active) doable by the users with the materials present in virtual environments (also the Metaverse) following the five senses. Meanwhile, a correlation has been drawn with the related virtual cues defined by the designers developing material experiences for the virtual environments.

In Figure 1, the lines are divided according to the five human senses, while the columns represent the different subjects divided into:

- *material qualities:* are the characteristics that materials in the physical world can have, e.g. surface, volume, rigidity/elasticity, weight, etc. These are the starting point for giving and designing the qualities of virtual materials.
- *material proprieties:* are those to be designed by the designers for the virtual environments; they can be passive or active.
- *virtual correspondence cues:* are properties and characteristics that the designers use to obtain the desired MX. They can be commands present in software or parameters controlled by the designers to obtain a certain effect.

The *material proprieties* column is divided into *passive* and *active*. *Passive proprieties* are those that do not require an active response, effect or animation. On the other hand, *active proprieties* require something to be performed by the object or the environment made of the designed material. This can be a variation of the original shape, appearance change, displacement, sound, etc. It was chosen to make this clear distinction because it influences how the designer will develop and envision those virtual materials. During the process of designing the MX, it is required to define the materials' qualities to improve the material performance and so the user experience in interacting with them. These aspects are particularly important when we deal with *active material proprieties* that have an important role in the virtual MX. This is because they are designing materials in an environment where they can decide their own reality, with new laws of physics and impossible phenomena. To do so, designers should first understand how the user will actively interact with the object and which device will mediate the experience (screen, mouse,

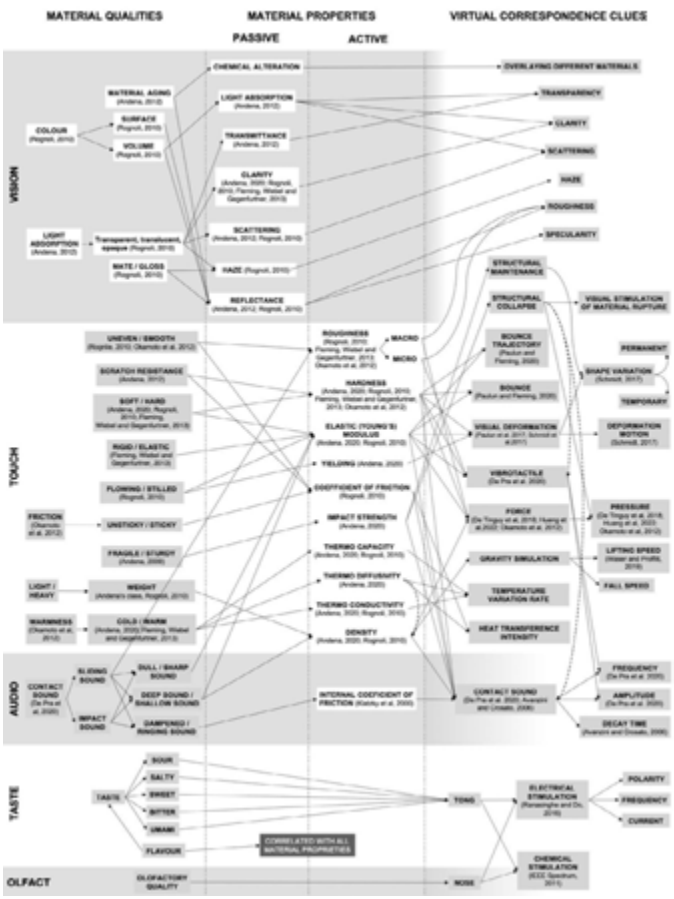

Figure 3. Virtual material experience framework

mobile, VR set, etc.). This is vital to understand which stimuli can be generated and which types of input users will give during the interaction generating virtual correspondences cues as consequent outputs feedback. In the case of *passive material proprieties*, the object would not require any active performance; the object would exist on the scene and react to the environment proprieties (such as global illumination and light interferences from other objects).

Here following, we raised some considerations and mentioned some case studies that have been analysed following our framework (Figure 1). This one has been put together through a rich literature review on MX, materials-related design methodologies, physical materials properties and design for virtual, augmented and mixed reality.

A first consideration observing Figure 1, is that, in general, visual material qualities have a more linear and direct correlation to the virtual correspondence cues. The main explanation for this link is that most of the graphic rendering software uses the PBR technique to render. The PBR means Physically Based Rendering; it is based on real-life surface properties to generate a visual representation being represented by pixels screes. This approach creates a more intuitive and accurate workflow by making analogies with our physical world materials (Souza & Mota, 2021). It calculates the rays of light received in one specific point (referred to as cameras on rendering software) from the light scene. Since the physics phenomena are consolidated, well studied and defined, rendering software programs represent virtually those characteristics.

Physical-virtual perception

Applying a force to an object's body shape influences how people perceive its mechanical properties. Hardness and elasticity are basic mechanical proprieties and are perceived mainly through physical interaction by the users, therefore, they also can be inferred by visual cues. When objects are shown deforming by the action of an external force in dynamic images, people can imply a level of stiffness by comparing the initial shape with the final one when the force is applied to it. Effects such as light, self shadows and surface texture displacement can indicate the deformation of a surface, creating the illusion of deformation and softness during the interaction. As much the texture deforms, and the differences between highlight and darker the self-shadow areas are, the softer the material is perceived. The visual motion of the process of deformation is a key stimulus to perceive the softness/hardness otherwise observer could lose this correlation when presented just with a static image mode of the initial and final shape. Another factor that collaborates with people correctly perceiving hardness and stiffness is knowing the applied force. For example, users who are extremely familiar with this kind of force can easily perceive an object suffering gravity's action effect. Another example related to the perception of stiffness can be given when an object is in free fall and hits the ground, users are able to judge the bouncing and bouncing motion trajectory to estimate hardness and elasticity (Paulman and Falming, 2020). Material density also can be communicated through visual correspondence cues by, for example, controlling the object's lifting speed. In this case, users associate their notion/perception of weight with the fact that the slower the object moves up, the heavier the object is perceived. Moreover, by presenting objects with the same lifting speed but different volumes, the object with the smaller dimension could be perceived as heavier and denser. It indicates that users bring their notion of real-world behaviour to virtual environments (Lv et al., 2022).

Haptic interactions

Haptics cues also can contribute to stiffness perception. De Tinguy et al. (2018) developed a wearable haptic device that simulates the pressure on the finger. They tested the haptic device in combination with VR and AR, simulating interactive objects, such as buttons, balloons and the human body itself. The study revealed that users better perceived stiffness when combining visual stimulation with haptics, even if the force was not applied directly on the user's fingertip. The interaction was better obtained in AR mode when users interacted with tangible objects layering the haptic stimulus on top of the physical surface rather than in VR, where no actual object was handled (Billinghurst et al., 2015).

Auditory interactions

Haptics-auditory can also improve the perception of materials and improve the object's *sense of presence*. De Pra et al. (2020) conducted an experiment recording the vibration and sound from the contact sound of a ping-pong ball with three different materials: wood, plastic and metal. Those recordings were then reproduced through high-fidelity headphones and a low-quality haptic display on a glass surface which users could interact with. The result demonstrated that people can distinguish clusters of materials by vibrotactile and auditory stimuli with more assertiveness on metal (by its characteristic sharp waving sound), followed by plastic and the less recognizable wood sound. The author deduced that more precision on the stimuli could contribute to a more engaging and realistic experience. The same findings were pointed out by Avanzini and Crosato (2006) that said that in *cross-modal haptic-auditory* interactions, audio could compensate for the lack of high definition on haptic devices. Moreover, Avanzini and Crosato (2006) stated that the buttons perception of virtual buttons is improved when sound feedback is added.

Virtually tasty

Our perceived experience with food and beverages is very complex and can involve all 5 human senses. Let's take as an example the experience of eating a triangle of nachos. The crunchiness can be elicited by visual cues of how the piece of food collapses, by audio presenting the sound of crumpling, haptics from the breaking, the corny smell released and by taste with stimulation of salty and sweet in the mouth. One of the main challenges in many explored areas of virtual experiences is taste (Ranasinghe & Do, 2016). While some research areas try to recreate artificial taste and flavour sensation by the use of chemicals, others seek to stimulate it by electro stimulations. Using chemical substances can indeed create rich experiences, but it raises several issues, such as manageability, transferability and scalability of these applications due to the need to have several chemical compounds involved. Electro-stimulation, on the other hand, is presented as an alternative to solve most of these problems. Ranasinghe and Do (2016) proposed a Digital Lollipop, where a wearable device was placed on the user's tong and electro-stimulated. The experiment was able to manipulate the sour taste on users' tongs similarly to lemon juice just by manipulating the electric current, frequency and polarization. Furthermore,

taste perception also can be influenced by other factors, such as the context where the taste experience is perceived. Narumi et al. (2010) conducted a study in this context, proposing that a possible solution would be improving the scene definition, stimulating the perception of different states in the user's mind through scanning and automatically generating a 3D scene in real-time.

Conclusions

Metaverse is not a novel concept; however, its market application, widespread and naturalness in the interaction are constantly evolving. Over the past two decades, there was a great development in technologies that enabled the Metaverse to activate its next application level. The current 2D web interactions are evolving into 3D content awareness. This virtual content can be accessed through different devices able to render stimuli over the five human senses.

We are seeing that mixed-reality technologies initially focused on visual-audio experiences for ludic interaction such as video games (Karis & Epic Cames, 2013). In the meantime, tech companies are developing their products for professional applications in the Metaverse due to the economic potential generated by it.

MX in the Metaverse can improve the realism of virtual experiences and improve the *sense of presence*. It directly impacts how we interact and act in mixed physical-virtual environments. It can improve the comprehension and enjoyment of physical products' digital representations. It allows new interactive levels between actual objects and virtual information, for example, changing the visual aesthetic of certain product surfaces by applying an unexpected texture and colour or perhaps adding haptic feedback exploring tactile experiences on materials to enhance some of their characteristics (Baumgartner et al., 2013). Furthermore, MX can improve the experiences in virtual environments and objects, adding new self-expression possibilities by representing the users' personality through virtual customised characteristics allowing a better *sense of presence* and ownership over virtual objects such as NFT-certified artworks.

To better understand what the factors to be taken into account by the designers developing MX in virtual environments are, It has been essential to create a framework (Figure 1) linking the actual physical materials' attributes to virtual ones involved in the MX. In this way, this current work presents an effective correlation between *material physical qualities* in the physical world, *material proprieties* that could potentially be defined by the designers in the virtual one, and *virtual cues* to be set to obtain the desired MX. However, human perceptions are extremely complex and could be stimulated not only by the cues listed among the presented cues and the relative case studies or, as we could see in the above-mentioned examples, but cross-modal (stimulating more senses at the same time) interactions could also blur sensorial perceptions suggesting more effective stimuli (Huang et al., 2021). These could be, tasting colours or haptically feeling an image (Baumgartner et al., 2013).

Adopting the point of view of the designers, we can affirm that to create a meaningful MX in the virtual environments, the following aspects need to be taken into account:

- designers need to be aware of the hardware devices to stimulate the MX possibly used by the users and its processing capabilities.
- the designer needs to great balance between detail richness and performance to ensure fluid experiences taking into consideration the required consumption of energy efficiency and connectivity.
- design for the Metaverse, particularly, involves constantly thinking about accessibility and easy usage. At the present time, we are seeing the chance to define primordial standards for interface interactions and feedback, taking into consideration a more inclusive perspective and so the needs of users not able to adopt all the five senses (Baumgartner et al., 2013). Therefore, designing cross-modals MX can produce more inclusive solutions by stimulating different sensorial channels. In this manner, some stimuli can compensate in case of users' sensibility deficit.
- the convergence of technologies we are witnessing creates an environment that allows new levels of interactions through which designers can trigger MXs. In this context, Designers need to make several choices in the virtual MX design, for example, which method and equipment to use to discover material proprieties, which device to use to render the experiences, which software to use to create them, which sensorial channel to stimulate during the experience and so on.

The focus of this article wasn't to explain in detail particular software or technologies because it is highly variable, and only designers can take into consideration their available resources to define possible paths. This condition is quickly evolving, having novel technologies rapidly spreading, such as neural rendering and 3D scanning on personal devices combined with the intensive use of AI to automatize time-consuming and highly-skilled processes, which are making the production of virtual materials and objects more democratic and widespread. This can stimulate non-skilled users outside the professional environment making content creation more intuitive and faster, leading to additional ways for common users to express themselves on social networks, sharing not only images and audio, but sensations (through the 5 senses) through sharing objects and virtual artefacts.
In the end, we can firmly affirm that further studies need to be developed to understand the influences of sensing virtual materials possibly in the development of novel devices to fully simulate new and always more rich virtual MX.

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Balancing authenticity and creativity: a VR system design for assisting ceramic creation

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Abstract

Culture-based product designers are facing the challenge of balancing authenticity and creativity: designers need to maintain tradition in materials, craftsmanship and cultural factors, while product design values innovation in form, function and user experience, which requires both indigenous knowledge and creative design methods. This paper describes our attempt to develop a VR system to help culture-based product designers learn indigenous knowledge and translate it into ceramic creation. The system includes a ceramic repository module, a design case library module, and a rapid prototyping module. The effectiveness of the VR system was assessed through a design workshop where eight participants were randomly divided into two groups, one working with the VR system and the other working with paper-based approach. Experts scored their design work by assessing authenticity through appearance, craftsmanship and culture, and creativity through aesthetics, technology and uses. Results showed that the VR group had a better general performance, specifically in terms of culture, and were more open to creative experimentation in terms of technology and uses.

Author keywords

Virtual reality; Culture-based product design; VR Ceramic creation; Culture heritage

Introduction

Cultural-based creative products support handcrafted, intangible cultural heritage tourism by attracting tourist interest and promoting the development of the tourism economy (Liyan, Xuanqi, Hesen, Yue, & Jian, 2019; Partarakis, Zabulis, Antona, & Stephanidis, 2020). To do so, designers must extract local design elements while avoiding deviation or stagnation to balance authenticity and creativity in the design process (Qiu, 2020; Wu, Zhang, & Xu, 2018), which means they need to maintain tradition in materials, craftsmanship and cultural factors, while product design values innovation in form, function and user experience. This requires a thorough understanding of both indigenous knowledge and creative design (Suib, Van Engelen, & Crul, 2020).

To meet this challenge, some studies have explored new ways of learning indigenous knowledge. Ch'Ng et al. (2020) investigated the process and method of using VR technology for cultural heritage learning and identified the positive significance of using VR technology for experiential learning. Zhang, Wan, Huang and Cao (2022) used VR technology to design a reading system for ancient Chinese books to help readers overcome cultural and language barriers through VR scenes. Some studies also explored new ways of creative design. Unfold design studio and Knapen (2010) create a ceramic design system working with AR named "l'artisan electrique" for users, even without ceramic creation knowledge, to create, influence or hack tools that further their design practice. Guan, Wang, Chen, Jin and Hwang (2021) created a VR-based pottery making system and found it enhanced student's creativity and learning engagement. Chen, Chang and Chuang (2021) used VR application for engineering design and found VR had marked effects on the novelty and usefulness aspects of creative performance on engineering design creativity. Yang et al. (2018) experimented with using VR drawing for design and explored the effects of VR on an individual's creativity and revealed VR's ability to boost creativity by maintaining stable focus or attention.

This research shows how we use VR technology to enhance cultural-based product design by immersing designers in a digital environment to learn about indigenous knowledge and creative design examples, using the example of Changsha Kiln ceramic creation in Changsha, China. The research aims to understand the potential of VR technology to support culture-based product design processes and revitalize intangible cultural heritage.

Design of the VR ceramic creation assistance system

The VR ceramic creation assistance system is designed based on the traditional ceramic creation skills of Changsha kiln in Changsha, China, which is a colored ceramic creation technique. The Changsha kiln ceramics were one of the main commodities traded along the maritime Silk Road during the Tang Dynasty. The system is developed using the Unreal Engine and is accessible through the Meta Quest2 , a VR headset, aims to provide an immersive and interactive experience in designing creative ceramic products from the Changsha kiln.

We reconstructed a virtual design studio scene in VR to provide a sense of familiarity, safety and privacy and eliminate negative experiences in VR environment, which contains three main modules (Figure 1.): a) *ceramic repository module*, which includes indigenous ceramic knowledge presented as scenes of appearance, techniques and cultures to clarify domain and relationship between each other to help designers use knowledge purposefully in the design process, (b) *case library module*, which contains design cases organ-

ized with narrative theory to enhance users' personal experience of the design process, and (c) *rapid prototyping module*, which is a modelling function in VR environment that makes it easier to review and modify design proposals. Users will be entrusted as a designer to help the Changsha kiln elf (a virtual character designed to guide the user) to finish its design by learning indigenous knowledge and creative design cases in ceramic repository module and design case library module, and further develop their own design attempts through the rapid prototype module.

Figure 1. Virtual design studio scene.

Ceramic repository module

The ceramic repository module includes a *virtual pattern scene* full of patterns from Changsha Kiln and *virtual roaming scenes* showing indigenous ceramic knowledge (Figure 2).

In the virtual pattern scene, each pattern contains knowledge related to Changsha Kiln. By clicking on a pattern, users can view the knowledge description it refers to in the form of text and pictures in the information panel. We organized and divided it into three layers for explanation to make the content of different knowledge more organized: (1) *appearance*, which includes the form properties of Changsha Kiln artifacts, such as material, decorative patterns, and shapes; (2) *craftsmanship*, which includes the techniques and production methods used in the ceramic creation of Changsha Kiln, such as underglaze painting, applique (applique involves adding low-relief clay forms to slurred, scored leather-hard surfaces for embellishment); (3) *culture*, which includes the local culture activities related to ceramic production in the Changsha Kiln, such as the custom of offering sacrifices to the kiln god and burning pagoda made with porcelain chip. We visualized the relationship between the knowledge it represents through the visual effects of the pattern, such as color coding for different layers and lighting effects that hint the connection between knowledge.

Virtual roaming scenes contains our reconstructed virtual environment of historical context related to the knowledge of Changsha Kiln. By clicking on a pattern in the virtual pattern scene with a shortcut key, users can explore and experience the scenarios it reflects and access more detailed information including indigenous cultural elements involved in Changsha Kiln-based design cases (one part of the design case library module). For example, users can observe how people build a pagoda out of porcelain chips, the way they scatter grains for good luck and the scene of people gathering around the pagoda to pray. Such immersive experience would help users gain an intuitive understanding of the knowledge related to Changsha Kiln.

Design case library module

The design case library module consists of four sets of case combinations. Each set contains existing cases and a Changsha Kiln-based design case. The existing cases include culture-based creative product design cases on the Internet, which are reviewed, classified and summarized by experts and presented in the form of text and pictures. They are used as design case references for users, and can be viewed at any time through the information panel (Figure 3).

The Changsha Kiln-based design cases were created by project team members according to inspiration from existing cases using the cultural elements of Changsha Kiln. They come with text explanations and interactive 3D models, but cannot be viewed at first. They are set in the story as the design that the Changsha Kiln elf wants to complete, which requires the user to follow the avatar's led to view existing design cases and to think and find out the indigenous cultural elements needed for product design in Ceramic repository module to unlock them. The indigenous cultural elements are hidden in specific virtual roaming scenes. In order to find it, users need to analyze existing cases and think from three layers (appearance, craftsmanship, culture, as indigenous cultural elements used to unlock the Changsha Kiln-based design case is set according to this structure), and actively explore in the Ceramic repository module. Each time a particular element is found, the user is prompted through the information panel. which makes the user clearly understand the selection of the Changsha kiln elements.

Figure 3. The existing cases (left), the Changsha Kiln-based design cases (middle), the user experience of ceramic repository module and design case library module (right).

Rapid prototyping module

The rapid prototyping module is a VR modeling system that allows users to quickly iterate and test their design prototypes. The system includes basic clay modeling, some basic shapes, and a variety of pre-designed components. Designers can shape ceramic products through clay modeling by mov-

Figure 2. Virtual pattern scene and information panel (left), Virtual roaming scene (middle), and the structure of ceramic repository module (right).

Figure 4. Rapid prototyping module.

ing the handle controller, and select the basic shapes and pre-designed components in the corresponding interface, and use the controller to place them in 3d space (Figure 4). Through the combination of shapes in space, the user can test their ideas about design.

Experimental design

We performed a one-day rapid design workshop to evaluate the feasibility and effectiveness of the VR ceramic creation assistance system. By analyzing design results, we were able to identify the effectiveness of the system in learning indigenous knowledge and promoting creative design.

Participant

The study recruited eight participants with similar design backgrounds, six with no prior knowledge of Changsha Kiln and two with basic ceramic creation experience. They were all students in cultural and creative design and were randomly divided into two groups (each group has one participant with basic ceramic creation experience): a control group that work with paper materials and an experimental group that work with the VR system (Figure 5).

Figure 5. Control group (left), and experimental group(right).

Experimental procedure

Both groups were asked to design creative ceramic products for tourists, based on the culture and techniques of Changsha Kiln. The designs were organized in a standardized format, including the name, function, and physicality (shape, color, and material) of the work, and presented in the participant's preferred method (sketching, modeling or physical prototype). The designs were then evaluated by three experts using an adapted scoring scale, to qualitatively and quantitatively assess the authenticity and creativity of the designs. The scale includes three terms used for authenticity and three terms used for creativity (Table 1.), adapted from the study of the authenticity of tourism crafts (Revilla & Dodd, 2003) and the research of creativity (Cropley & Cropley, 2008). Following the design activity, participants were invited to semi-structured interviews to gain insight into their creative process and to clarify experience with the VR system.

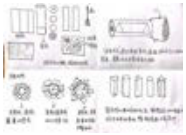
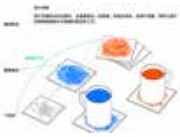
Result and discussion

The expert scores of the design outcomes (Table 1.) show that compared with the control group, the experiment group showed different preferences for product authenticity, the authenticity of the control group products was more reflected in the appearance and craftsmanship, while the experimental group focused more on the culture aspect of the product, especially the extraction of local ceramic customs and stories. The experimental group also had significantly better performance in creativity and were more willing to try new things in terms of technology and uses.

Table 1. Rating scale and scores (Full score of 5).

Dimensions	Factors	Interpretation	Control group	Experimental group
Authenticity	Appearance	Refers to the appearance of a product, such as shape, color.	3.5	3.5
	Craftsmanship	Refers to the crafts, materials used to create the product.	4.0	3.5
	Culture	Refers to the elements that reflect the local culture	2.25	3.75
Final score of authenticity		The mean of the three factors of authenticity.	3.25	3.58
Creativity	Aesthetics	Refers to the aesthetic effects on other people	3.25	4.0
	Technology	Refers to the technology used and how it is used	2.75	3.5
	Uses	Refers to the usage scenario and method of the product.	2.5	4.0
Final score of authenticity		The mean of the three factors of creativity.	2.83	3.83

Table 2. Design outcomes and explanations.

	Control group	Interpretation
1		This is a nail organizer for playing the lute, made with traditional Changsha kiln skills.
2		The refrigerator sticker made of Changsha Kiln skills and image.
3		The building blocks made of Changsha Kiln skills can be built freely to restore the shape and pattern of Changsha kiln products.
4		Changsha Kiln Capricorn fish image cup, trying to show the Capricorn fish in the water.
5		This is a kaleidoscope, can be customized Changsha kiln patterns, users can see the Changsha kiln patterns constantly changing.
6		The design of the coaster using heat transfer technology can present the brown spot pattern of Changsha kiln according to the temperature.
7		The pagoda shaped wind chime, which is composed of tiles from Changsha Kiln, which users can choose and place freely.
8		Changsha Kiln Capricorn fish image of tea bag, restore the legend of the Capricorn fish trying to swallow ships/

The VR scene enhanced the presentation of cultural activities, resulting in the experimental group paying more attention to culture aspect in authenticity than the control group. VR simulates highly detailed realistic environments through 3d perspective, which makes it easier to understand knowledge that is difficult to be transmitted in the form of pictures in paper documents (Yang et al., 2018), especially highly comprehensive knowledge such as cultural activities. For example, there is a local custom of using ceramic shards to build pagodas and burning them to pray for good luck. In VR environment, the construction method of pagoda is obvious, while it would have been confusingly complex in paper documents. It explains why the experimental group designed relevant schemes (Table 2, design No.7) while the control group ignored the extraction of such local customs.

Besides, learning in VR is more enjoyable and attractive to participants, which they concluded as "learning by roaming in an immersive environment". Compared with fragmented documents full of appearance and craftsmanship knowledge, exploring cultural activities in the VR environment is more impressive and contributes to the user's sense of discovery (Obeid & Demirkan, 2020), which made the control group more willing to do their design based on culture aspects of Changsha Kiln. In contrast, paper documents were regarded as materials to be used in the creative process by participants in the control group, which explained why the control group paid more attention to the extraction of appearance and craftsmanship.

The mechanism of unlocking design cases through exploration enhances participants' motivation and provides an opportunity for self-reflection and design critiques, which leads to a better creative performance. Participants in experimental group reported they tended to perceive surpassing existing design solutions as a challenge. In the process of gradually unlocking the design cases, they continue to criticize and reflect on the design cases, which promotes the construction of knowledge related to authenticity and the generation of new ideas. Strong motivation and self-reflection developed through design critiques was beneficial for enhancing creativity (Demirbas & Demirkan, 2007; Obeid & Demirkan, 2020).

The realistic restoration of space in VR environments enhances users' ability to understand space, and the introduction of rapid prototyping modules aids in the generation of more creative solutions (Pandey, Luthra, Yammiyavar, & Anita, 2015). Participants were able to test their solutions in 3D space more efficiently and were encouraged to try different structures, these extra bold attempts often gave birth to new ideas (Zhang, Wan, Huang, & Cao, 2022). For example, both groups used images of Capricorn fish for their designs (Table 2, design No.3 and No.7). The experimental group initially had similar ideas to the control group, but after many attempts through the VR system, he combined the legend of the Capricorn fish swallowing ships to design an interactive tea bag, rather than just extracting the image of Capricorn fish. The virtual pattern scene also directly stimulated one participant in the experimental group to design Changsha Kiln pattern themed kaleidoscopes (Table 2, design No.5). "The way you show patterns in the VR system reminds me of kaleidoscopes, that's why I made this design." As he claims.

Conclusion

This research explores the potential of VR technology in balancing authenticity and creativity in cultural-based product design process by enabling designers to immerse themselves in a digital environment to learn about indigenous knowledge and creative design cases. We developed a VR ceramic creation assistance system based on Changsha Kiln and conducted experiments to see how VR technology can help design ceramic creative product based on intangible heritage.

The results showed that the 3D perspective provided by VR enhanced the presentation of cultural activities, and the way of " learning by roaming in an immersive environment " changed designers' attitude towards indigenous ceramic knowledge, treating it as personal experience rather than material to be used in design process. Mechanisms that unlock design cases through exploration also promote original ideas by providing stronger motivation and opportunities for self-reflection and design critiques.

There are still some limitations to this study. The rapid prototyping module is too simple to enable more detailed visual effects, and better VR modeling methods have the opportunity to lead to stronger creativity. While our system is designed for a single user, the future should yield richer results through multi-user exploration and communication in VR environments. Incorporating an AI-based dialogue system is also a good way to generate more creative design.

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What is furniture in the metaverse for?

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Abstract

Since its beginning in the science fiction field, the Metaverse has been presented as the digital copy of the world. Neal Stephenson in *Snow Crash* (1992) imagined it as a virtual planet twice the size of the Earth, organized around the Street, an equator-like ring on which the activities align and develop on the surface of the Planet. In the novel, the Metaverse is populated by the digital alter-egos - avatars - of a small élite who find the exacerbated rituals and contradictions of a consumerist post-industrial society.

Snow Crash's Metaverse is a powerful metaphor for urban sociality, but, at the same time, it is also a dystopia. Duplicating the real world digitally, in fact, means facing and solving all its contradictions.

The literary model has inspired many social platforms that have taken the concept of doubling reality literally. In the leading platforms born as metaverses for social gatherings, such as Second Life, Horizon, Decentraland, VRChat, virtual architecture and design frequently model themselves on the real ones. Similarly, actions performed by people mirror the real world's. Given that the virtual world has neither gravity nor climate influences and the users do not have a flesh body, the needs in space are inevitably different. From the design perspective, this approach seems to waste opportunities: it roots in the usual rather than fully exploiting the potential of the new.

On the contrary, in metaverses born as videogames, architecture and design are accurately conceived to evoke a precise narrative and induce gamers to specific actions.

Some of the reasons for the normalization of metaverse spaces can be found in the ease of fruition. The users can approach a space with similar connotations and functions to the real one effortlessly. Other reasons deal with the background of people who are building the metaverses. The creation of the virtual world is open to professionals from different fields: neither design is conceived by designers nor buildings built by architects. Therefore creators often ignore the architectural and design culture and its basic methods. These untrained professionals could bring fresh air to the virtual architecture field. The mimetic model, however, seems to limit creativity so far. The essay aims to analyze from a spatial design perspective the reasons that fueled the frequent tendency of the mimesis of reality in a context entirely different in needs and potentials. Through case studies and literature, the research delves into the correlation between spaces, technologies, and actions in the metaverses born as extensions of real-life phases.

In the virtual world, actions are reshaped according to the connotations of the space and the technology involved. The more technology includes the real body in the virtual movement, the more concrete the actions become. Therefore, the crucial question is: what is the point of recreating the world in an infinite-potential platform if it is lived the same way as the real one? In a context with different potentials, actions should have different connotations to give additional value to what they have in the real world.

Keywords

Metaverse; spatial design; virtual worlds; skeuomorphism

Introduction

Since its inception in science fiction, the metaverse depicts a digital copy of the world. Neal Stephenson, the novelist who first used the word in *Snow Crash* (1992), imagined the metaverse as a virtual planet twice, the of Earth's size, shaped around the Street, an equator-like ring on which activities aligned and developed. In this virtual world, the digital alter-egos – avatars – of a small élite live the exacerbated rituals and contradictions of a consumerist post-industrial society. Stephenson's metaverse is indeed a dystopia, but also a powerful metaphor for an urban lifestyle behind which it is easy to recognize Las Vegas and its Strip (Dionisio et al., 2013, p. 8).

For decades, the metaverse debate only occurred among experts, notably computer scientists, and engineers (Dionisio et al., 2013; Damar & Turkey, 2021). However, successful platforms reached a broader audience in the field of social gatherings, such as Active World (1995) and Second Life (2003), and gaming, such as Roblox (2006) and Fortnite (2011), which enlarged in number in recent years. The pandemic brought on these platforms an increasing mass of users. Finally, the decision of Mark Zuckerberg to reshape his 2 billion-user company into a metaverse in January 2021 skyrocketed the attention of the media (Narin, 2021). Metaverse websites proliferated accordingly.

We analyzed these platforms from a spatial design perspective, wondering whether the multiplicity of these metaverses may shed light on the features of spaces and places of our future virtual life. This study summarizes our findings and tries to highlight exploited and unexploited potentialities of virtual space.

Definitions and misunderstandings

Today, the noun "metaverse" usually refers to a freely accessible digital environment that allows social gathering, gaming, and trade. According to the Merriam-Webster dictionary, the word derives from the blend of "meta-" and "universe" ("Metaverse," n.d.), literally "beyond the universe."

The singular form "metaverse," which is frequently used, expresses the idea of a single platform suitable for developing all aspects of virtual life; this form is flanked by the plural, "metaverses," which, in fact, represents the current situation of the many existing platforms.

Today, having a single metaverse platform is a utopic vision; the potentially achievable system closest to this concept is the interconnection of the many existing platforms through a single account. Its advantage would be to access every service and web space with the same information. Consequently, all the account activities and online purchases could be accessed anywhere. The existing platforms, however, have long histories behind and consistently different purposes, which hinders the possibility of, and their interest in, interconnecting.

Since the major protagonists involved in web3 – the latest evolution of the web, based on decentralization, blockchain technologies, and token-based economy – have different ideas of how to shape the metaverse, it is a priority to provide the reader with a definition of "metaverse" adopted in this study, which is: a digital system that allows the *synchronous presence* of many users and their interactions. In other definitions, synchronous presence is frequently challenged, but the most relevant ambiguity lies in the structure of the platforms (Evans et al., 2022). In fact, in addition to the digital worlds accessible in *virtual reality*, some systems allow the synchronous co-presence of users through *mixed reality* while equally satisfying our definition.

Because of its mediatic relevance, the metaverse developed by Meta, *Horizon Worlds*, deserves to be mentioned first. Launched in December 2021, it is one of the youngest among the most famous metaverses (Rodriguez, 2021), but it is not notable for its innovativeness.

When Facebook changed its name to Meta on 28th October 2021 (Mac et al., 2022), the metaverse gained momentum, and definitively left its earlier condition of elitist web reality unknown to the general public. This massive mediatic move originated significant misunderstandings: everything dealing with the metaverse is often associated with the company, both in its functional and aesthetic setting. Instead, *Active Worlds* (1995) and *Second Life* (2003) are the first created platforms corresponding to our definition.

Second Life is the most renowned because, in its early age, it gained significant interest from visionary brands, such as Adidas (Siklos, 2006), universities, and even political entities, such as Swedish Embassy (Bengtsson, 2011), which built their headquarters there. Unlike Active Worlds, which in 2022 looks like a ghost town (*Active Worlds*, n.d.), Second Life has had a constant number of users, which has recently, even increased. In October 2022, it had about 200,000 active users daily and 500,000 active monthly (Signorelli, 2021), more than double the 200,000 monthly users of Horizon Worlds (Horwitz et al., 2022).

The concept of Horizon Worlds is very similar to Second Life's; they both consist of a social platform focused on people gathering and virtual purchases. They both have no ludic purpose but a video game-like aesthetic, and the access to the virtual world is through customizable anthropomorphic avatars. Therefore, compared to Second life's approach to virtual reality, Meta's doesn't seem to add much.

On Meta's website, Horizon Worlds is described as an "ever-expanding social universe" accessible using the *Meta Quest* headset – Meta's hardware device for Virtual Reality (VR) – which involves customers in an engaging experience better than a two-dimensional fruition on the screen. In this respect, Horizon Worlds confirms the general trend of many social metaverses to enhance their attractiveness through VR technology.

Today the limited diffusion of headsets, due to their high price and the side effects caused by their prolonged use (Lawson, 2014; Kemeny et al., 2020), hinders the immersive use of platforms by many people who access the platforms mostly in 2D from computers or consoles. Indeed, according to Anand Agarawala, CEO of the metaverse *Spatial*, 80% of its customers use a computer or mobile (Levy, 2022). Also, Meta Quest has faced criticism, especially from its employees, who declined the CEO's invitation to hold their meetings in VR (Mac et al., 2022) because of its cumbersomeness.

Headsets are an open battlefield for the biggest technology companies. In addition to the Meta Quest, Apple is developing a device able to switch between VR and Augmented Reality (AR) (Charlton, 2022), Google has been working on AR viewers (Wall Street Talks, 2021), and Microsoft is developing its version too, *HoloLens*, focusing on Mixed Reality (MR) (*HoloLens 2*, n.d.). Along with the big companies, many other firms are also launching new headsets, such as HTC, PlayStation, and Valve Corporation, whose Valve Index is at the top of Tech Radar's ranking (Benetti, 2022).

The intensity of this competition is strongly connected with the development of the metaverse because the type of access profoundly influences its shape. Therefore, winning

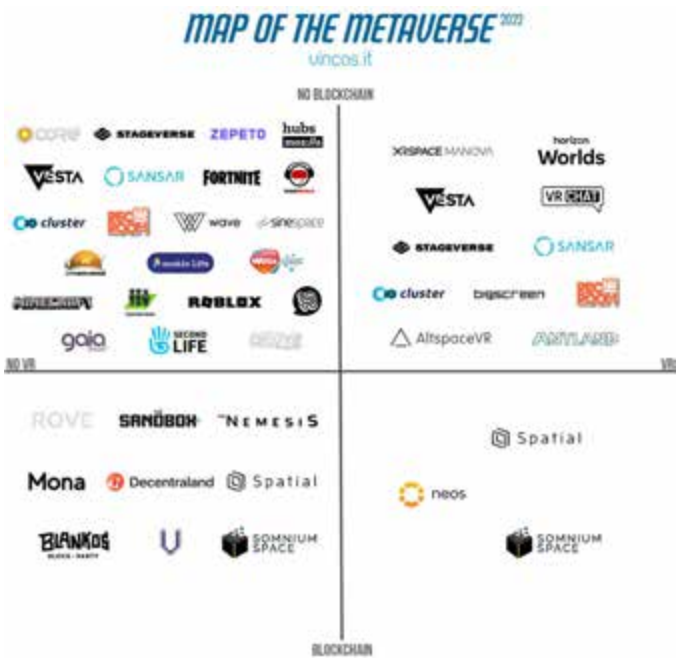

Figure 1. Map of the metaverse, Vincenzo Cosenza, 2022

the race guarantees dominance in a new market and the possibility to shape the users' experience of a new kind of web still under construction. The difference in approach between Meta and Microsoft may clarify the issues at stake: the former focused on VR devices and therefore is building a whole virtual world that allows the user to be isolated from his real surroundings and co-present with other users in the platform; the latter, which is working on MR, is designing a metaverse that preserves the direct experience of the physical environment while adding extra virtual elements in it, and developing the metaphor of teleportation technologically.

From games to social platforms

Matthew Ball, one of the greatest connoisseurs of the digital ecosystem and investor in the future of new technologies, identifies two main categories of metaverse: *game-like* and *non-game-like*. (Ball, 2022). *Game-like* metaverses are gaming platforms that developed thanks to an advantageous combination of user attendance, increased social purposes and decreased gaming reasons, and the farsighted response of the developers who intuited and accompanied the evolution.

Their primary purpose is to generate engagement through interactive narrative development; therefore, the narrative component of games lays the basis for all design choices. A notable example is *Fortnite*, which according to statistics, currently has 250.000.000 monthly active users, which makes it the most visited metaverse of all (Osservatorio Metaverso, n.d.).

Fortnite was launched in 2011 by Epic Games company, but began its exponential rise in 2017, the year in which a new game mode called *Battle Royale* was introduced; it allows the so-called Player versus Player (PvP) game instead of the traditional Player versus Environment (PvE) one (The Fortnite Team, 2017). This upgrade, brought many people to attend the platform to create communities rather than game-fighting each other. In this mode, Epic Games introduced live events, such as fight shows, movies, and concerts – emblematic cases were those of Marshmello, Travis Scott, and Ariana Grande – thus laying the foundations for an increase in engagement (Barbera, 2020).

Non-game-like metaverses are fundamentally social platforms, virtual spaces that allow people to meet and talk. They are frequently business-based and adopt both decentralized and centralized systems. This means that some are controlled by several figures, and some are owned and directed by a single company. Some relevant decentralized examples are Second Life (2003), Spatial.io (2016), Decentraland (2017); centralized ones are VRChat (2017) and Horizon Worlds (2021).

Gaming platforms and social platforms fundamentally differ in their aim. In the former platforms, architecture and design are accurately conceived to evoke a precise narrative and induce gamers to specific actions. In the latter ones, people can gather freely as if these virtual environments were a new contemporary cities. Therefore, the design of spaces focuses on the best conditions to induce social interaction. The challenge is shaping these new virtual meeting places effectively.

To study the spatial connotations of the platforms, we analyzed 55 popular metaverses, divided according to their immersiveness (VR or desktop view), belonging to a blockchain system, and primary purpose (gaming or sociality). Our survey focused on the spatial features of the sites, on their degree of adherence

Figure 2. Hoppin' World, https://hoppin.world

to the spatiality of the physical world (three-dimensionality, gravity, climate), with interest in understanding the reasons and purposes for their design choices and the exploited or non-exploited potential of virtual spaces. We identified three main subgroups: *copy-worlds*, generally called *mirror worlds* (Gelernter, 1991), *semi-copy worlds*, and *experimental worlds*.

Mirror worlds are virtual copies of Earth that could be envisioned as the immersive evolution of satellite mapping websites, but with the intent of a metaverse. Their structure and aesthetics is similar to *Google Earth* and its twin *Bing Maps*, but their primary aim is to be meeting places instead of documentarist 3D maps. Even if the photorealistic effect unites them all in a specific category, these metaverses have consistently different structures.

The most direct approach to mirror worlds is that of the blockchain-based *Earth2* (2020). This metaverse comprises a perfectly rendered terrestrial landscape where users can browse through different transportation. The platform replicates a land market. Users can buy a plot corresponding to a specific place on the Earth and build on it. Due to the absence of avatars, which will be introduced shortly following an agreement with Ready Player Me (A2Analyst, 2022), the aesthetic coherence is not compromised by any unrealistic element.

On the contrary, *Hoppin' World* (2020) is distinguishable for its cartoon-like avatars, similar to Horizon World's, contrasting with the realistic video environment in which they move. This platform allows users to explore places on earth through 360° videos uploaded by other users. Therefore, the landscape looks alive and populated by real people recorded on the clips. Unlike other metaverses, it is *not designed* from a technical point of view, as it does not stand on a geometric mesh.

Figure 3. Decentraland, https://decentraland.org/

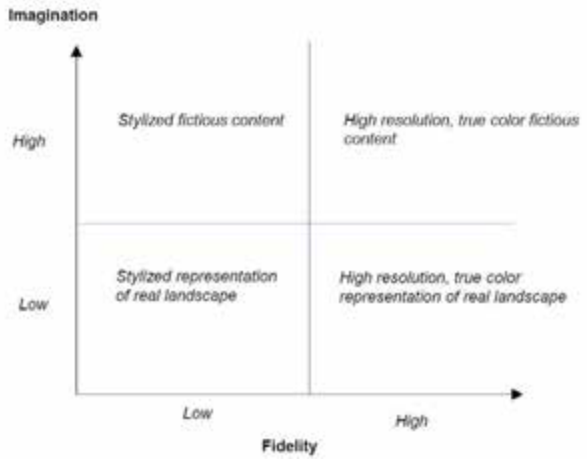

Figure 4. Designing Metaverse artifacts - Designing the Metaverse, Seidel et Al., 2022

Semi-copy worlds, instead, hold an intermediate position on design choices between mirror worlds and gaming metaverses. They are social platforms designed to recall some literal features of the real world but with a cartoon-like or video-game-like aesthetic. We can distinguish three main aesthetic threads: pixel art, Disney-like, and cyber-punk. The *pixel art* aesthetics derives from the first videogames design and has many examples in the gaming field; the most emblematic are Minecraft (2011) and Sandbox (2012). The *Disney-like* thread, instead, is based on a modification of archetypes typical of cartoons with very different levels of abstraction. Decentraland (2017), Spatial.io (2016), Cryptovoxels (2018), and ChatVR (2017) appertain to this aesthetic. *Cyberpunk* metaverses are instead hyper-realistic scenarios massively inspired by science-fiction literature and movies. Many platforms in this category make use of the powerful computer graphics engine Unreal Engine 5, such as Netvrk (2016), Bloktopia (2021), and Wilder World (2021).

Regardless of their aesthetics, semi-copy worlds host buildings with doors and windows, furnished with chairs, tables, and beds, as in real-life houses. In April 2022, even the first bathroom line for the metaverse was launched, "Meta-Loo," inevitably causing hilarity (Rowland-Dixon, 2022).

Each metaverse is clearly distinguishable aesthetic-wise. The following diagram illustrates the type of appearance through the parameters of *Imagination* and *Fidelity* (Seidel et al., 2022). Mirror worlds would be located in the lower right quadrant – low imagination, high fidelity – whereas semi-copy worlds would be located in the three other quadrants.

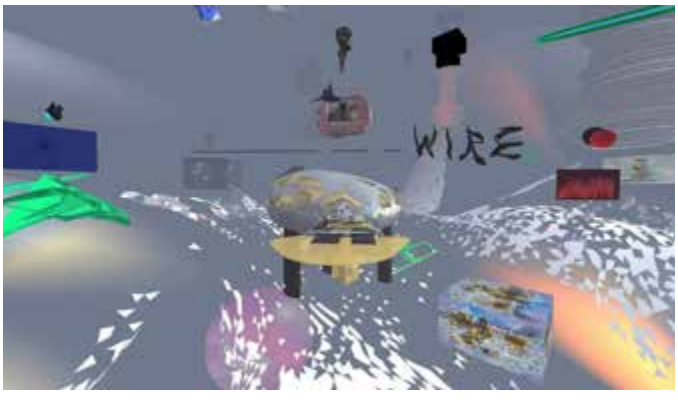

Figure 5. WIRE, Portrait XO, 2022, https://newart.city/

The third category of virtual environments we identified is *experimental worlds*. They constitute a small minority of non-game-like virtual worlds, designed without reality-mimicking, and experiencing virtual spatiality more radically. Unsurprisingly, these proposals challenging the physical world's limits deal with contemporary art and target people inclined to the unknown. For example, Bika Rebek from Some Place Studio, whose spaces look like extraterrestrial universes made of extra-large human-world elements and foams, put a different perspective on the design of virtual spaces (Rebek, 2022).

Similarly, Markéta Gebrian presents on NEOS VR platform the experimental project Bodily Metaverse of Lisbon, an artistic interpretation of Lisbon city center reshaped as an immersive virtual world. The VR environment enables "non-constructible and non-gravitational elements of architecture to be designed as floating floors, transposable elements, and teleportation features" and tests "the new opportunities that social VR brings to architecture design" (Gebrian, Florián, & Eloy, 2021, p. 133).

Frequently, virtual spaces corresponding to this category are not metaverses per se. Instead, they are worlds inside larger systems or independent platforms, such as New Art City, a brilliant example of a virtual space that doesn't mimic reality. It is a curated virtual gallery, whose exhibitions show free-floating elements in the space, with no perceivable limitation of distance nor connotations recalling the familiar human environment (*New Art City*, n.d.).

Skeuomorphism and comfortable habits

For decades, computer scientists and engineers have been working to produce a metaverse that could constitute "a compelling alternative realm for human sociocultural interaction." In a list of "four features that are considered central components of a viable metaverse," Dionisio and his colleagues put realism in the first place. The primary design effort – they state – should focus on shaping a "virtual space sufficiently realistic to enable users to feel psychologically and emotionally immersed" (Dionisio et al., 2013, p. 2). Therefore, from their perspective, there is no alternative to realism, as it provides effective foundations for the whole program.

The phenomenon of reality-mimicking is called skeuomorphism. The Oxford Dictionary defines it as "the use of symbols or other objects on a computer screen that look or sound like a physical object in order to suggest their purpose" ("Skeuomorphism," n.d.). While skeuomorphism is justified in video games by the presence of a narrative and gaming purpose, it becomes questionable in other metaverses as it shrinks the imaginative potential offered by technology.

Limitations that exist in the physical world do not exist in the digital one (Seidel et al., 2022). The metaverse is not subject to the rules of physics, therefore, devoid of gravity and climate problems. Natural phenomena do not obstacle construction, and there is no need to protect from rain: roofs are not needed, neither sheltering from cold or heat nor walls, if not as a visual limit. There is no need for furniture or urban and architectural elements to "live" in the metaverse.

In a world where the body does not feel fatigued, there is no need to sit or lay down to rest; food has no meaning, and no action is physically dangerous. From this point of view, the metaverse looks like the new paradise for advertising and sales: it is an audiovisual world in which the possibilities for action fall fundamentally on what you see, hear and possess; the only physical action allowed is moving in a certain direction, walking

or flying, and at most, in some metaverses, winking. In many platforms, much of the world can be reached by teleportation, a connotation that efficiently exploits the fluidity of the virtual, making the road connections ephemeral.

As much as one may use the metaphor of "living in the metaverse," it is hard to perceive its spaces as lively ones. As discussed in the book *Lost Zone. Hiking the dawn of the Metaverse*, some virtual worlds are likely to look – and be – abandoned since they don't respond to real needs (Belosi & Rafael, 2022). Exploring Active Worlds (AW), these authors moved across an abandoned land with all the connotations of a post-apocalyptic scenario, even with intact buildings. AW is the oldest metaverse, but the spaces that are currently visible, built in the last twenty-eight years, do not differ from the skeuomorphic design approaches of contemporary worlds. General users have built the urban structures; therefore, the scenario represents a non-curated accumulation of undefined and undefinable cultures. The authors encountered streets, cities, private and public constructions, cult buildings, and natural landscapes, an entire world that looks like a memorial of a lost society.

The continuous accumulation of these buildings recalls the *Junkspace* theorized by Rem Koolhaas (2006): a space resulting from careless planning that is transformed with the expansion of urban areas and characterizes contemporary cities. According to Koolhaas, Junkspace creates apparent unity but is actually a dividing space as it defines collectivity through the lack of well-defined shared rules; it is detached from the individual, an absent space which people can only perceive as an autonomous evolution: Man is only a witness, a "reluctant participant" (Koolhaas, 2006). In Koolhaas' opinion, Junkspace may transform the world into an immense public place without limits, language, and form. So it seems to have happened in the ruins of Active Worlds, and may happen to other metaverses built on the same approach.

Belosi & Rafael (2022) also raise the problem of the inconsistency of the metaverse, which looks, in their opinion, like a "literal simulacra of the real world." Although many professionals share this point of view, there is a general difficulty in implementing a more visionary approach. Bjarke Ingels, the founder of BIG Architects, showed an experimental method of conceiving architecture in the metaverse. He was the first to design a virtual building: Viceverse, the headquarter of the digital agency Vice Media in Decentraland. Ingels described as an "architect's dream" the absence of physical constraints, budget, and law regulations, which is verifiable in his virtual work that stretches the construction in an otherwise physically impossible way (Brandoli, 2022).

Virtual architecture is the ideal dimension also for Zaha Hadid Architects (ZHA) studio, which designed the general layout and all the buildings of the state of *Liberland* on Mytaverse as a meeting point for crypto companies and events. (Massoni, 2022) Both *Viceverse* and *Liberland* are architecture projects that look like IRL buildings in their concept phase, so before static and budget calculations, but they are still human-based buildings. Architects must still carry out a commission; consequently, experimentalism is limited by the client's vision. Moreover, even visionary studios like these seem resistant to abandoning the canons of architecture in favor of creating completely innovative experiences worthy of the possibilities of contemporary virtual technology.

Unlike BIG and ZHA, George Bileca, CEO of Voxelarchitects, a metaverse architecture studio, stated in *Domus* magazine that mimicking the real world gives newcomers "a chance to adapt to this space by offering them a reassuring environment" (Signorelli, 2022). In supporting the skeuomorphic trend in the metaverse, Bileca sounds more pragmatic and determined to favor a perspective of comfort for the users. But is comfort in the metaverse really given by chairs and bathrooms? And also, is comfort the best concept to pursue in designing it?

One main reason for the skeuomorphic approach is the ease of welcoming virtual people in an environment with known functions. Still, other factors could have influenced this process. The search for ease may come from the designers themselves, who are not trained to imagine non-human spaces and may find the mimic approach a more straightforward design method. Indeed, in web3, professionals from different fields approach art and design without appropriate education. The creative economy in the metaverse can provide equal opportunities for professional and emerging architects and people with entirely different backgrounds (Matoso, 2022). Therefore, coders or computer engineers can fill the role of urban planners and architects of the metaverse. Moreover, in many virtual platforms, such as Minecraft (a game-like metaverse), and Active Worlds (a non-game-like metaverse), the users are allowed to build structures on their own, which adds variety and stylistic indefiniteness (Matoso, 2022).

Lights in the cloud of troubles

The analysis conducted on the spatial features of the most popular active metaverses led us to understand that they depend on three main factors: the development of the technology adopted, the aim pursued, and the design culture of creators.

As far as technology is concerned, in addition to the constant development of computer graphics and programs, the choice of the technology of use is predominant for constructing these worlds. VR technology is one of the possible directions. For now, however, VR devices, as well as being prohibitive from an economic perspective, cause motion sickness (Lawson, 2012), so many users of the metaverse choose to enter screen mode. In our survey, 31 metaverses out of 55, more than half, are accessible only through the screen, which leads us to think that these platforms do not estimate VR as essential for development. The elitism and cumbersomeness of current headsets hinder projects based on immersive use, which can only grow by introducing lighter and more easy-to-use devices.

From a spatial point of view, the common thread of most of the investigated metaverses is the inclination to simulate the real world. Although the levels of interpretation and the aesthetics adopted vary substantially, the tendency toward realism is dominant. Not only have architecture and cityscape been replicated, but also the real estate market, which frequently leads the aim of many metaverses to speculation on lands and propriety prices (Schreier, 2011).

The aim of the single metaverses inevitably leads their design approach and justifies spatial choices. In game-like metaverses, whose purpose is creating involvement in the game, the design follows a specific narrative and fosters identification. Instead, in non-game-like worlds, which do not respond to any declared need, except social encounters and trade, the design of spaces becomes a unique tool to create value.

Figure 6. Wiami, Wilder World, https://www.wilderworld.com

Still, in many cases, spatial research is limited to trivializing archetypes and a set of clichés. In contrast, mimesis could be an inspiring approach to conjure up scenarios that lead to reflection as an exercise to visualize the future, for example, in the Solarpunk direction (Pintarelli, 2020). The metaverses we defined as cyberpunk have great potential to evoke science-fiction scenarios and make cinematographic environments experienceable.

Aside from experimental metaverses, whose approach exploits the absence of physical limits to create a spatiality detached from the real one and leads users to new cognitive experiences based on art and space research, the lack found in the most significant number of cases is that of references to visual culture. The opportunity of the variety of visual and design cultures, an enormous wealth of metaverses globality, often seems neglected.

Being the virtual worlds created by professionals from fields that often have nothing to do with the design culture, and given that architects and designers entered the sector after the creation of platforms, the methodologies and references typical of spatial design research still need to be integrated. Therefore, the creative potential that the virtual world allows, both for the absence of gravity and physical phenomena and its narrative and interpretative possibilities, could be exploited much more to add value to users' experience.

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Craft in the age of robots

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Abstract

Through a series of robotically fabricated drawings, the work investigates the confluence of a creative analog medium like painting and the possibilities for custom production enabled by industrial automation. A six-axis tabletop robot is programmed to execute the toolpath of parametrically-designed linework using a 3D-printed actuator that holds a soft brush pen. Instead of working on a flat bidimensional target surface, the soft brush navigates the 2.5-D space dissolving the fully controlled digital inputs into unique ink marks. A bespoke Python script in Grasshopper is developed to optimize the digital-physical translation in which software variables push the brush on the paper incrementally in predetermined ways. As a result, the final appearance of the programmed paths remains uncertain due to ongoing negotiations between the digital procedural drawings and the robotic mark-making exploration in the physical space. Each drawing reflects an extent of craft practice as it represents the unique manifestation of non-repeatable digital and physical relationships in which two-dimensional marks on paper have three-dimensional implications. By adopting a digital fabrication tool traditionally rooted in delivering efficient repetitive tasks, it is possible to establish a culture of technology that empowers designers to deviate from the predictability of the outcomes and find space for debate.

Author keywords

Robotic mark-making; digital craft; robotic drawings; digital fabrication.

Introduction and scope of the work

The recent influx of digital manufacturing tools across various trades has set the stage for convergence between design and other industries. This opportunity to integrate creative professions with innovative implementation sequences allows makers, product designers, and architects to participate in a broader interdisciplinary context (Timberlake & Kieran, 2003). Similar file formats enable different possibilities in the realm of additive manufacturing, numerical control machining, and robotic execution of recursive tasks. However, in the design field, there is still a tendency to view technological development as an external factor, particularly in digital applications (Picon, 2022). To overcome this, designers should leverage the culture of technology to reframe their agency when working with adjacent disciplines.

The research featured in this paper is situated at the intersection of computational design, digital fabrication, automation, and craft, confronting an old form of analog expressions like painting and the opportunities for custom production afforded by industrial robotics.

Some argue that automated technologies can depersonalize the creation of objects, taking away the human element and transferring the necessary skills to machines (Boza, 2006). Rather, the project endeavors to investigate the concepts of technology and craft "getting the most out of the machines" (McCullough, 1996) by reorienting tools and processes through the bespoke materialization of digital media.

Painting is used as an application case since, traditionally, learning to paint has meant understanding how to hold the brush, test the pressure on the canvas, observe the resulting brush strokes, and build confidence in the dexterity of sequential gestures. The analog process relies on the maker's embodied skills to achieve consistent outcomes (Pye, 1968), and its success depends on their ability to craft the desired outcome. As a counterpoint, in this research context, a disembodied tool is used to extend the capabilities of human hands fostering a process of re-learning how to paint within a digital ecosystem using a retired automotive welding robot. The craft-oriented approach of the project aims at unbundle automation from the serial repetition of identical copies (Carpo, 2017) through the production of parametrically-designed linework drawings with a soft brush. The brush encompasses the 2.5-D space by retracting and pushing against the target sheet of paper, following a scripted set of rules. This procedure creates one-off ink marks that can only be loosely captured in the digital simulation. Drawing iterations are collected into a sketchbook (Figure 1), an everyday object deployed for annotations and hand sketches, as a learning device (Rowland & Howe, 2001) that

Figure 1. The sketchbook filled with robotic drawings and hand annotations describing the process.

conveys evidence of material iterations to discover unexpected insights into technique and materials (Sennett, 2008).

Elements of innovation: from machinery precision to craftwork

In the state-of-the-art of design representation, new disciplinary approaches are being explored in education and practice. One example is the use of robots or cartesian plotters for making digital drawings, which is becoming a common practice in technology-focused higher education institutions (Johnson & Vermillion, 2016). In the research field, Carl Lostritto has developed a custom Python-based workflow that effectively materializes the craft of hatching with computational lines using an automatic pen plotter (Lostritto, 2016). The Material Artifact Studio, led by Marcus Farr, also employs a similar tool for augmenting drawing processes (Farr, 2020). Rhett Russo has suggested the application of CNC tooling for transferring generative drawing information onto physical media such as textiles (Russo, 2010). Curime Batliner, in the exhibition *Drawing Codes*, displays a visual art project that uses an industrial robot to layer multiple line systems with ink on paper (California College of Art, 2017). Furthermore, a compelling point of view is offered by the multimedia artist Sougwen Chung, who works in conjunction with AI-enabled robotic arms trained to follow her drawing style and gestures to create collaborative outcomes (Chung, 2020).

The common thread of these experiments carries the qualities of materials, machine timing, data structure sequencing, and design accuracy, where the intricate complexity of the drawings challenges human abilities to produce comparable outcomes by hand. However, unlike the method discussed in this research, in these precedents every aspect of the line work is controlled with a predictable translation between concept and execution. Instead, the primary interest of the presented investigation lies in the uncertainty and unpredictability of each creative effort, giving digital data expressive capacity through materiality, with the potential to translate two-dimensional intelligent drawings into three-dimensional artifacts.

Methodology: robotic mark-making

The research process involves the definition of an experimental digital fabrication workflow consisting of the following routine: algorithms-aided digital modeling to develop the linework, geometry translation into a programming language, 6-axis robotic implementation of the exported toolpaths, procedural iterations, and evaluation of the outcomes.

Figure 2. The tooling setup with five tabletop ABB robots equipped with 3D-printed pen holders.

Five ABB tabletop robots are used to make the material drawings (Figure 2). Each robot is equipped with a simple actuator, a 3D-printed pen holder that keeps a soft brush in place perpendicular to the industrial arm's end, namely the sixth axis. A plywood board serves as a reference surface for the physical workspace and is leveled by taping clay underneath the four corners. The target drawing area is given by 96g square of paper in a 6″x6″ wire-bound sketchbook.

The design outcomes result from the mathematical re-sampling of data using Grasshopper, in which the generative rules are destructured into base elements of geometry and ultimately implemented with inkwork (Figure 3). Drawing types seek three-dimensional complexity inspired by phenomena in the physical world, such as those listed below.

Fillings

This method involves dividing two parallel spline curves into segments of equal length, then projecting points onto the outer side of the curves and parametrizing them by a polar rotation. The process generates a series of blended lines that can vary in density depending on the input values used.

Folds

The script is inspired by motion efficiency studies conducted by Frank and Lillian Gilbreth (Smithsonian Institution, n.d.). It creates line patterns that mimics the biomechanics of the arm, including straight segments, joints, and rotation nodes.

Fields

The software interprets the behavior of magnetic spin forces interacting in a particle field to compute field lines through points in space. It generates the drawing layout procedurally, starting from a set of vectors on a grid.

Flowlines

Looking at Durer's hatching techniques (Durer, 1973), the script simulates water flow on a double-curved topography using parametric controls. The topography is divided into a grid of points, and all the normal directions are extrapolated relative to the surface. The flow lines are calculated by comparing the normal vectors to the point projections along the z-axis. The steeper the topography gradient, the smaller the angle between the two vectors, and the shorter the flow line.

Before exporting an executable script, the three-dimensional parametrically-designed digital drawings are scaled within a bounding box described by the values (x, y, 0.25 mm). The x and y dimensions are the size of the destination paper template, while the fixed z value represents the maximum depth the physical brush will push onto it. This results in the soft brush navigating the 2.5D space, dissolving the precise digital inputs into unique ink marks. Every ink trace intelligently conveys meaning and multiple types of information, such as the subtle relationship between the digital 3D world and the physical 2D drawings. Since the digital lines do not lay on a flat surface, the robot's speed and directionality of each toolpath affect the lines' appearance. Dense linework can merge into blended ink patches, and overlapping lines enhance the readability of discernible surfaces without compromising the visual clarity of each individual layering sequence.

A bespoke Python-based Grasshopper plug-in is developed to optimize the translation from digital to physical. In addition

to generating cartesian machine language code with accurate robotic joint configuration, the script detects the point or line closest to the top surface of the drawings' bounding box. This approach allows for calibrating the workspace and adjusting the robot's tool center point (TCP), which is the brush tip. The initial TCP, or calibration depth corresponding to the pen's length, is 178.75 mm. At each drawing attempt, the teach pendant, or robot controller, prompts the option to regulate the TCP accurately to the tenth of a millimeter. Progressively, the input number is reduced, responding to the wear of the pen tip and ink discharge. The tool settings, number of iterations, and file information are annotated in the sketchbook after each drawing. This methodical approach adds layers of knowledge about the process and deducts speculative findings from such observations. The final work demonstrates the development of new forms of drawing conveyed by an industrial robotic arm, where data and custom digital scripting are a means to pursue the materialization of craft through automation.

The research underwent two stages of optimization and review, using students' outcomes to validate project intentions and results. Between the summer and fall of 2022, the possibility of producing robot-informed parametric drawings was offered in the context of the DigitalFUTURES consortium (DigitalFUTURES, 2022), an international group in education with a focus on computational design and digital fabrication, and the Association for Computer Aided Design in Architecture (ACADIA, 2022). Both experiences were an opportunity to share the idea of amplifying the meaning of data by translating matter into computational artifacts with a wider audience. Such artifacts engage the organization of linework in a painterly manner, using mathematical functions to construct new material wholes.

Results and discussion

Leonardo Da Vinci argued that the act of painting enables the mental conversation, *il discorso mentale*, in which an image formed in one's mind helps reflect on the details to be included or excluded in the final drawing. He believed that focusing on those visual elements was more important than practicing the technique. According to Leonardo, artists do not learn to paint, but they paint to learn (Neumeier, 2012). A similar approach comes to mind while generating drawings using computation. The outcomes document the various attempts, repetitions, parameters, and circumstantial variables such as ink level, paper texture, and environmental humidity that play concurrently with the designers' whim. Different tools and software settings are used to achieve each robotic iteration, which reflects the programmed lines' length, density of target points on the generated toolpath, and pattern overlays. The nuances between sequential implementations are captured by repeatedly executing the same script on different pages (Figure 4). These observations can only be made by actively engaging in actual making (Figure 5).

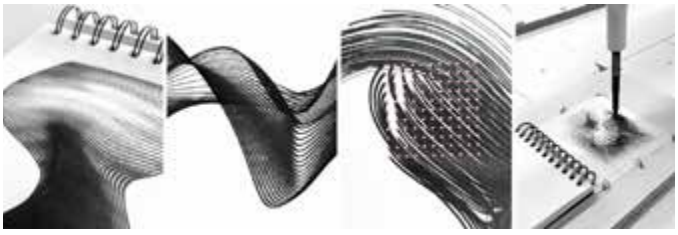

Figure 3. Sequence of linework-ink-based drawing types: Fillings, Folds, Fields, and Flowlines.

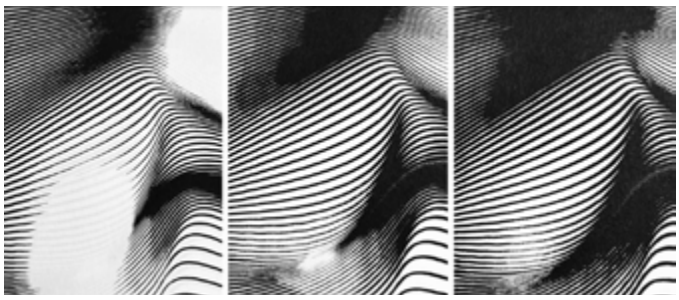

Figure 4. Drawings iterations obtained executing a script multiple times with different tool configurations.

The recurring theme of the geometric line is inspired by Tim Ingold's philosophical description of these kinds of entities. Unlike concluded objects like blobs, lines are a metaphor for interaction with the external world. They do not resolve the continuity of things or build a unified whole from disparate parts. Instead, their role is to foster a principle of movement where intricate connections form alliances of the base matter (Ingold, 2015). The dimension of motion, connected to the machine's run-time, in fact, pervades the drawings.

A methodical exploration is pursued to share different reflections on the successes and failures of this type of work.

Figure 5. Long exposure photo depicting the robotic mark-making process.

Procedural artists like Sor Lewitt, Vera Molnar, Bridget Riley, and Darel Carey are used as references to help build discipline toward a critical and diligent use of technology. Sol Lewitt's instructional wall drawings highlight the ambiguity of lines as fundamentals of geometry that exist vividly as mental constructs and less so as elements of nature. Exemplary works are the *Wall Drawing 86* (1971), in which ten thousand lines cover a wall surface evenly as an upfront conveyance for his ideas, and the etching on paper *Straight and not Straight Lines* (2003) that portrays lines as unique and individual manifestations of the human touch. This approach uses seriality and repetition as drivers to conceptualize geometric rules and relationships into base components of human thought. Vera Molnar's drawings' variations depict a pioneering agenda toward generative design aesthetics. Her collection of plotter drawings conveys a kinematic orchestration of lines controlled by rigorous arbitrary ordering systems. Among others, it is worth mentioning *Segments Inclinés A* (1984) and *Interruptions* (1968-69), where the artist begins with a grid of straight lines of equal length, and applies random rotations to each line, resulting in a densely complex pattern. The pattern suggests the presence of various forces that disrupt a regular structure, introducing an element of chaos. Bridget Riley's optical illusions, such as the paintings *Current* (1964) and *Winged Curve* (1966), require the viewers to shift their gaze across the canvas to understand the portrayed play of emotions within the abstract linework and, therefore, encourage them to think of 2D lines as an opportunity to build 3D spatiality. The robotic mark-making work also reflects contemporary visual artist Darel Carey's procedure to manipulate the perception of wall surfaces, as displayed in the art piece *Topographical Space No.1* (2016). The application of black tape to create large-scale line patterns determines a uniquely crafted experience of the space, which delivers an illusion of apparent motion.

Using a soft brush pen to negotiate agency with a robotic arm allows for finding a breakpoint between the upstream simulation and the downstream implementation. The work doesn't seek the manifestation of tooling precision but instead emphasizes subtle differences between iterations, drawing nuances, and variability of results. Additionally, zooming into the drawings augments the layers of readability of the pieces and accentuates a perceptible ink texture (Figure 6). A closer look outlines the individual ink traces, independently from the cohesive image, and brings attention to the directionality of the toolpath that generated them.

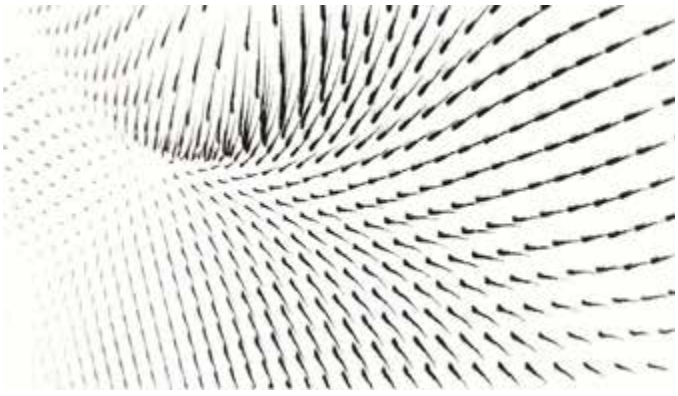

Figure 6. Zoomed in documentation into one of the robotically-implemented drawings using a soft brush.

The illustrated design tactics treat data, time, motion, actuators, and ink equally as materials.

Conclusions

In the robotic mark-making process, information gains expression through a custom workflow that merges computation and making in the presence of digital tools. Tension is discovered between the procedural aspect of the drawings and their visualization in the physical space that transcends technology itself. While the geometric control is manageable through input-output digital variables, the final appearance of the programmed paths remains uncertain. Through a planned loss of digital precision, each drawing is the unique manifestation of non-repeatable digital and physical relationships in which two-dimensional marks on a sheet of paper have three-dimensional implications.

While informed simulations offer a sense of determinacy, making physical iterations allows for exploring unknown domains and questioning established computational design rules. Recognizing their limitations and identifying gaps in their reach emphasizes material unpredictability. One intriguing realm of exploration for digital fabrication and intelligent making is understanding variations within the indeterminate regions of possibility, such as transitions, boundaries, and ink blends where points of shift occur. These conditions can be triggered by various factors, like circumstantial environmental forces, and reveal unexpected behaviors, leading to new knowledge.

Design customization involves fabrication tools, design variables, and material features. By adopting a precise fabrication technology, it is possible to diverge from the predictability of the outcomes and find space for debate. Robotics invites a sense of precision and control, but it also opens up new realms of exploration in the indeterminate areas given by temporal variability that interact with physical surfaces.

The potential to expand these processes to the third dimension and to the scale of larger components for interior design or architecture is a fascinating possibility that remains open for development. Ultimately, investigating the craft of robotically generated drawings represents an attempt to realign tools from other disciplines through the approach of designers in an advanced territory of making.

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Digital files and additional material

For supplementary information regarding video tutorials, Python coding, and Grasshopper definitions, please do not hesitate to contact the corresponding author.

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Light It Up: designing electronic textile with a light as a design material

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Abstract

We are living in the era where digital futures are emerging and the technological development is rapid. Digital transformation is also happening in designing with soft materials, as the digital technology is integrated with fibers, yarns and fabrics. Therefore, the role of the textile and clothing designers changing and they are dealing with e-textiles and interactive materials. This paper explores a way to support textile designers in designing interactive artefacts. The aim of the research is to study and identify characteristics of technology as a tangible design material that designers could use along with other conventional materials, even if they are not technology experts. In this research, we are interested in developing better means for designers to prototype interactive and physical artefacts, allowing them to focus on their design vision, aesthetics, and normal practices used in their specific profession. Our goal is to identify characteristics of technology as a design material. We report of two workshops with altogether 17 design student participants using a fixed functionality electronics and a non-programmable microcontroller. We present the designers' overall experiences with the process as well as the resulting interactive prototypes. We discuss on the characteristics of ready-to-use technology that ideally would support the design, as well as integration of interactive technologies from the design education point of view. Our findings show that removing the need to do the actual programming allows the participants to focus on their design and to scope their concepts more tightly. Design students had positive opinion and experiences from the workshop as they managed to produce a functional porotype within three hours. The process forced them to work with the limitations of the technology and to process the idea how to integrate technology and light in their design. The paper contributes to the understanding of adoption of technology as a design material, and adds on to HCI education discourse which typically has emphasized the programming skills.

Author keywords

Prototyping; e-textile; design material; workshops; design process; design education

Introduction

We are living in the era of interactive technology, which is intertwining in our life in all sectors. The early days of technology development focused on exploring different solutions from the engineering perspective. In the last decades, the user experience viewpoint has gained more attention in the technology development. This has opened many different design opportunities in designing interactive products. For a long time, graphical user interfaces (GUIs) have been a standard interaction paradigm for people to interact with technology. However, new form factors and interactive materials are emerging. Materials are an important factor when designing and experiencing interactive artifacts (Fernaeus & Sundström, 2012). As interactive products take new physical and tangible forms, software and hardware can be perceived as a material for design instead of being just computational and processing units. This perception is argued to enable new opportunities towards designing interactive artefacts, including textiles (Hallnäs, Melin, & Redström, 2002). The familiar set of conventional gadgets, like smartphones and smartwatches, are being complemented with various different kinds of unconventional interactive products (Döring, Sylvester & Schmidt, 2013; Li, Häkkilä & Väänänen, 2018). Among these, textile interfaces are emerging (Cheng et al., 2017; Devendorf & Lauro, 2019; Freire, Honnet & Strohmeier, 2017; Häkkilä, Colley, Roinesalo, Lappalainen, Rantala, Väyrynen, 2017; Nilsson, Satomi, Vallgårda & Worbin, 2011; Perner-Wilson, Buechley & Satomi, 2010; Schneegass & Amft, 2017).

Electronic textiles, i.e. e-textiles, are made of textile materials with integrated electronic components. When e-textiles are developed, it is important to have knowledge on textile design process. However, to develop this further requires expertise from the field of human computer interaction (HCI) (Kettley, 2016). The designer needs to have at least some understanding of the programming and possibilities of the technology. When teaching the design of e-textiles, teachers with expertise on various fields are needed, as the domain falls in the intersection of design and technology. As a field, e-textiles need interdisciplinary development teams. Teachers with wide expertise can ideally share their methods and knowledge from applications, software and technologies, as well as learn from each other. This gives also the students a fruitful learning environment (Harjuniemi, Johansson & Pyrstöjärvi, 2019). De-

signing new form interactive devices requires more than just useful functions and intuitive interfaces. They need to have well-designed forms factors, be aesthetically pleasing, and fulfil cultural and social meanings (Devendorf et al., 2016).

In this research, we are interested in exploring the ways of teaching technology to textile designers. Our target was to 1) create positive experience on technology, 2) make it easy to present ideas via rapid prototyping, and 3) give the designers freedom to concentrate more on their design than to get stuck with coding problems. While we believe that learning to code could offer designers several benefits, in this paper, our focus is on enabling and supporting designers to follow their typical way of working when designing interactive artefacts, not in teaching coding to designers. We present design workshops with designers in training using microcontroller and electronics to prototype their design ideas. This paper marks the first stage in our research towards exploring technology as a design material for physical interactive artefacts.

Prototyping interactive products

The design process in a design discipline starts from researching the given problem, and then, generating concepts to solve the problem. A concept is chosen for the further development, where it matures to the production, and is finally launched to the market (Morris, 2016; Travers-Spencer & Zaman, 2008). During the recent years, we have witnessed a rapid growth in the number of microcontrollers in a form of physical and tangible computing toolkits. Microcontrollers such as Arduino or LilyPad Arduino come with an integrated development environment (IDE) and off-the-shelf electronic components, bypassing complex low-level electronic knowledge and lowering the barrier for integrating interactive technology into physical products. While designers can use these microcontrollers to create art pieces and prototypes of interactive products (e.g., Grant, 2019), it still requires skills and effort to create functional prototypes. For instance, the designer needs to consider how to embed and hide, or highlight, the conductive threads and microcontrollers in the designed object.

We have used Arduino and LilyPad in our previous courses and recognized these challenges. Because programming was new to the design students, they worried about learning and utilizing the skills which effected their ideation process. Also, the programming being an abstract, more mathematical task differs from working with the physical design materials the designers have used to, and may thus feel uncomfortable for them. In this research, we wished to further explore and identify characteristics of a prototyping technology that would allow the designers to perceive it as one material among other design materials they were working with during the design process.

Design Workshop with Design Students with Light Up board

In the workshop, we used Bare Conductive Light Up Board (Figure 1) as a probe to explore designers' preferred characteristics and expectations of technology as a design material. The Light Up Board is a microcontroller with six (6) built-in LEDs and six capacitive touch sensor electrodes. The board itself is not programmable. However, the board comes pre-programmed with six different light modes: touch on/off, dimmer, proximity, candle, spin, and dice. The behavior of the LEDs can be changed to different light modes by connecting different electrodes together.

Figure 1. From the left: 1) The Light Up Board is quite small. 2) Participant P3 testing the touch sensors on the Light Up Board using copper tapes. 3) Participant P6 testing her prototype after integrating the Light Up Board with her custom-made touch sensors and other components. 4) Participant P1 testing material to create a flame-like feeling from the Light Up Board.

We chose the Light Up Board for this design workshop for several reasons. The board includes both input and output elements, i.e., capacitive touch sensing and LED outputs, offering degrees of freedom for our participants to decide on interaction and feedback of the board. Light and LEDs are one of the most common output modalities in physical computing (Devendorf et al., 2016). Turning a single LED on/off is typically the first step in designing and building physical computing. We believed that the configurable light behavior would encourage our participants to focus on the material and the physical design and, at the same time, still offers a possibility to explore interactive aspects of the technology.

Methodology and analysis

Participants

We conducted two workshops with 17 participants (15 female and 2 men, aged 24-44 years) in total. Here, 13 participants (P1-P5, P7-P14) were Master students majoring in interior and textile design, the participant P6 was an experienced textile designer, and 3 participants (P15-P17) Master students in industrial design. The recruitment was done at an e-textile course, where the teacher distributed the advertisement to her students. Eight (8/17) of the participants had studied the basics of Arduino programming before, and responded that the programming was the most challenging part when they had to work on technology-related design projects.

Workshop setup

The two workshops were both three and a half hours long and were organized as part of an e-textile courses at the university. For the course, the participants' task was to design and build interactive prototypes with the theme of well-being and happiness (P1-P5), or a delightful item in the context of dinner party (P7-P18). The themes were given to the participants before the workshops. The participants had the freedom to use any technology for their final design. Only for the course´s first technology workshop, the participants had to explore and use the Light Up Board. Information about the workshop and used technology was sent to participants beforehand. We also had a short introduction about the board and capacitive touch sensors at the workshop. The participants were provided with plenty of Light Up Boards, soft design materials (e.g., plastic sheet, felt, fur, fabrics), different wiring components (conductive thread, copper tapes, conductive ink, crocodile clips, tin foil), and electronic tools.

Workshop procedure, data collection, and analysis

First, we asked the participants to fill in an ideation form by drawing and writing down the design ideas they were planning to create. After that, we introduced the Light Up Board

and gave introduction about the capacitive sensor: the techniques are as simple and straightforward as more crafty techniques of connecting conductive ink, conductive thread, or copper tape directly to the electrodes, as introduced by Strohmayer and Meissner (Strohmayer & Meissner, 2017a; Strohmayer & Meissner, 2017b). The participants were then asked to revisit the ideation form to describe how they planned to use the Light Up Board.

After the initial introductions, the participants had two hours to work on their prototypes. They had the freedom to use all materials and tools provided and as many Light Up Board as they wished (Figure 1). We observed and took notes of how the participants used the board and problems they encountered. The participants presented their prototypes to other participants at the end of the workshop. After that, we conducted a semi-structured group interview with the participants. The interviews were recorded, transcribed, and analyzed with an inductive thematic approach (Braun & Clarke, 2006). In addition to the workshop, we also did a follow-up study on how the workshop influenced the participants' final design (P1-P5, P7-P17) for the e-textile course, which they exhibited at the university in the end of the course.

Findings

Overall, the participants had a positive opinion and experience integrating the Light Up Board into their designs. Although the board had limited features, it still helped the participants to explore and demonstrate the interactive features in their designs and functioned nicely in the rapid prototyping workshop (Figure 2).

Figure 2. Interactive prototypes the participants created during the workshop.

It was a positive observation to see the participants enjoying the prototyping process. *"This was a fun experience for myself [...]. That was quite simple after getting to know it a bit. And I liked it, it was fun."* - P11. Positive experiences were regarded important for the e-textile studies and future projects. *"At the starting point I didn't have any experience for this kind of e-textile things, and I felt a bit nervous. But I realized that the user interface was quite a simple and even easy, and that gave me a little sparkle for the future. So I could call this as very well working package."* - P8. *"This might give a push for those people who otherwise would see this difficult."* - P7.

Material for ideation

The participants appreciated the simplicity of the Light Up Board. The plug-and-play feature allowed a prototype to be created quickly, which was important in the ideation phase in the design process when one explores and try-outs different ideas. The used time constrained forced designers to conduct fast prototyping. Having a working prototype after a half a day was also considered to be rewarding. *"I think it was easy and especially fun. I feel like it didn't make you feel like you used a shortcut even there were something done already for you. I think was, this kind um, nice, especially for fast prototyping... And we didn't have much time but still we experienced a lot, failures and successes."* - P14. However, the limited functionality of the board could restrict the idea generation. It was seen to work the best when the technology matched with the design. Participants also saw having a tangible prototype early in the process to ease the communication to others, and to be another benefit. The participants considered the Light Up Board and Arduino to complement each other.

Exploring materials and interaction possibilities

The participant P2 reported using the Light Up Board to test one of her ideas in practice. She also highlighted that the board helped her to realize where she should pay attention in her final design: *"I got to test my idea in practice with the board. I now know that in the final design, I need to have something to diffuse light to spread it to a wider area."* - P2. Furthermore, the board offered opportunities for the participants to explore different materials, e.g. conductive thread, and various interaction possibilities. Knowing that the board would always work allowed the participants to explore new materials to create touch sensors and to test whether they would work with the technology (Figure 1).

Focus on design and communicating the ideas

Bypassing the actual programming the Light Up Board allowed the participants to focus only on a few aspects when they created their prototype, particularly when developing a design concept and connecting the design with the board. This was considered as an advantage: *"for me, the coding part on a computer, then getting [the board] to work together with the code, put it into an actual prototype, and having functions work as they should and also [the design to] look good... this is a difficult combination of things. Working with [the Light Up Board] feels more certain. I don't have to focus on too many things... and it works more reliably"* - P1. Configuring the board to show the desired light pattern by using different wiring patterns was also considered simple and straightforward with the instructions.

The Light Up Board allowed the participants to communicate their design ideas in high fidelity, in a form that was close to a final product, without having to do any programming. The participant P2 show-cased a great example for using the board to communicate an interactive function in her design. P2 used two Light Up Boards to demonstrate remote touch between two *Secret Message Rocks* (Figure 3, left). Although the Light Up Board did not provide a wireless or a remote connection between the boards, a simple crossed wiring between two of them was enough to communicate the design idea and present the interactive feature of the rock.

Figure 3. Examples of the participants' final designs for the e-textile courses using the Light Up Board. Left: P2's Secret message. Right: P16's Spots of usage.

Problem solving

Although the Light Up Board did not require programming, it still helped if the participant had acquired knowledge and understanding about the technology. *"There was a problem with my prototype. I think the fabrics touched each other and created a short circuit. I moved it a bit and it's now working"* - P1. Thus, the participants knew how to fix the occurring problems. Our experience was that this was harder with programmable boards, where a teacher was needed more often.

Preferences for design

We observed that the participants first decided what function they would use or tested how it would looked like (Figure 1). The process then continued on to integrating the board with other materials and diving into the aesthetic details with the design (Figure 2). We also observed the participants spent a good amount of time choosing materials for their design, especially the materials to create the touch sensors, to cover the board, and to diffuse the light (Figure 1, right). The interview after the workshop revealed that it was important for the participants that their prototypes worked properly and were aesthetically pleasing. The participants discussed the properties of the Light Up Board as a material for design from two perspectives: physical properties and interactive functions, described in the following.

Physical properties

The participants considered electronic components in general to be *ugly*. Most of the participants' comments about physical properties of the Light Up Board were directly related to aesthetics, and in particular, how the board provided them freedom in design and allowed to create nice looking prototypes. The participants were fond of the *small size* of the board, which made it easier to hide. They also preferred an organic and conventional look and feel for their prototypes. They appreciated that the board allowed them to use different materials to create touch sensors in different form factors and to place them at various locations, depending on the design idea.

Interactive functions

The participants appreciated the different light modes the board offered. The configuration to select a light mode was simple and easy to understand. The participants would have preferred to have more interaction possibilities. Currently, the Light Up Board allowed one light mode to be active at a time. The participants wished to have multiple light modes (P2), movable LEDs (P5), different LED colors, and others sensors and output actuators (P1). However, the participants' preference was not to add more sensors or actuators to the existing Light Up board, as *"adding more [sensors and actuators] to the Light Up Board would make it to lose its simplicity. You already have Arduino if you want to do all those things"* - P1.
Final art pieces for the E-textile course

The participants continued developing their prototypes for the e-textile course, where they had to present their final prototypes that demonstrated the design concept and interactive features (Figure 3). In the exhibition piece by P2, one rock showed a hidden message when the other rock was touched. P16's piece was a scale model of an interactive table cloth that lighted up from below revealing decorative pattern of spots. In total, five designers used the Light Up Board in their final design piece.

Conclusion

In this paper, we have addressed the digital futures in the area of e-textiles and design education, and presented our exploration study of technology as a design material. We conducted two workshops with design students using the non-programmable but configurable Light Up Board as the ready-to-use technology. Our findings show that removing the need to program a microcontroller allowed the participants to focus more on their design. The board also facilitated the ideation and validation of design ideas in the rapid prototyping process. Overall, the designers liked the technology and got positive experiences in the very beginning of designing and making of e-textiles. We reported on the characteristics of ready-to-use technology that would be an ideal material for design. This research contributes in making technology more accessible to designers with limited technical background, and allowing them to start building prototypes of interactive artefacts. In this research paper, our studies were limited to textile designers. However, we believe that the results can generalize over other design disciplines where the designers work with physical material and do not have technology courses as part of their education. As future work, differences and similarities between different design disciplines in prototyping interactive products should be investigated.

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Strategy for knowledge transfer in AM as a hybrid process chain towards a transition from prototyping to commercialisation

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Abstract

Additive Manufacturing (AM) has gained considerable footprint as one of the key components in making the 4th industrial revolution a reality. Unlike traditional subtractive manufacturing processes which account for ~ 95% waste of material, AM provides almost unchallenged and sustainable manufacturing capabilities to drastically improve manufacturing efficiency due to its nature of adding material as opposed to removing it. Thereby, reducing life-cycle material mass and energy consumed. The ability to produce functional 3D parts with customized and complex geometries directly from CAD model data is particularly attractive. While metal AM processes such as laser powder bed fusion (L-PBF) are already producing customized metal parts in applications such as dental implants, the full benefits of the technology have not been fully realized. This necessitates a global drive to learn best practices in AM towards new avenues for impact in teaching and learning, and in accelerated lab-to-market transition. The key to this is understanding inputs and outputs of fundamental AM process parameters. This knowledge will help designers and potential end-users of the technology to quickly identify parameters which are most influential to structural integrity of parts produced. Considering that very little research has been performed on knowledge transfer among AM researchers, business and higher education, this paper is aimed at capacity building in AM technology by helping inexperienced users in higher education understand the technology better. Thereby, contributing to the inclusive global drive for an accelerated transition from prototyping to commercialization. The method used involves a standard systematic triangulation of the literature to categorise and describe fundamental process parameters which influence structural integrity of parts produced by the L-PBF. The findings of this work yield new knowledge in three domains. Firstly, the influential input parameters of L-PBF are identified as powder-specific, laser-specific and machine specific parameters. Secondly, various post-processing solutions which are often used address the drawbacks associated with the technology are mapped out as thermodynamic, mechanical, and chemical post-processing treatments. Thirdly, the L-PBF is conceptualized into a framework which can help reshape the role of designers by identifying AM as a hybrid process and knowing what to look for when looking to make functional parts using technology. In this way, the paper contributes a novel skillset and attitude required to convert digital capabilities such as AM into valuable tools and methods.

Keywords

Additive manufacturing; Laser powder bed fusion; post-processing solutions; hybrid manufacturing.

Introduction

Broadly, additive manufacturing (AM) is defined as a canopy term of manufacturing technologies used to join material layer by layer to make three-dimensional (3D) products from computer aided design (CAD) models (Gibson et al., 2015; Sreenivasan et al., 2010; Wohlers & Gornet, 2014). The technologies were previously known as Rapid Prototyping or Rapid Manufacturing technologies (Atzeni & Salmi, 2012; D. L. D. Bourell et al., 2009; Doubrovski et al., 2011), because they were historically limited to production of prototypes and casting inserts. However, a more recent definition for AM according to the ASTM F2792 is "a process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies" (ASTM International, 2013). In this way, the AM techniques remove traditional manufacturing constraints by enabling a range of benefits without the need for part-specific tooling to make customized parts with complex geometries in one piece. Thereby, providing almost unchallenged and sustainable manufacturing capabilities to drastically improve manufacturing efficiency.

The interest to optimise AM technologies has been growing exponentially over the past couple of decades. In particular, there is a growing interest in the potential of metal additive manufacturing (MAM) technologies such as laser powder bed fusion (L-PBF) (Costa et al., 2006; Rombouts et al., 2006). Hence, the focus of this work is on L-PBF. A typical L-PBF process starts with pre-processing at the control centre where a 3D CAD model of a part to be printed is well-defined, then sliced by a computer program into layers (20-100 µm thick), with a 2D image generated for each layer. The digital information is used to drive the movement of the laser inside the machine chamber with controlled atmosphere of inert gas, where the actual building takes place. In the chamber, the

building process is cyclical and consists of three steps which are repeated until the end of the construction process. Firstly, a re-coater (roller) applies an even coating of metal powder in line with the prescribed layer thickness. Secondly, the powder bed is exposed to a laser beam. The absorption of the laser radiation causes the metal powder to heat up above the melting temperature of the metal, forming a melt pool. This causes the fusion of the exposed areas of the current layer. Thirdly, the molten layer is rapidly cooled in the range of 12000 – 40000 °C/s (Chastand et al., 2016; Gokuldoss et al., 2017; Liu & Shin, 2019), depending on the amount of energy supplied. The process is then repeated with a new layer of powder coated on the previous layer until a desired part is built from thousands of individual layers in succession.

Although the AM technology has been around for over 30 years with functional parts already applied in industries such as the aerospace, automotive and biomedical, the full commercialisation has not been realized. The widespread implementation of AM technology is hindered by process inherent attributes that result in the as-built parts not meeting industry requirements. In this work, the as-built condition refers to parts as they come out of the AM machine. It is at this point where the consideration of AM as a hybrid process for making functional parts becomes critical due to the incorporation of conventional subtractive manufacturing technologies to obtain a part which can be regarded as qualified for application. The key towards meeting specific industry requirements is understanding the influential input parameters, attributes of the as-built condition and suitable post-processing solutions. In contributing towards a higher technology readiness level for metal AM, this paper is a knowledge transfer contribution which addresses three categories of AM as a hybrid process (inputs, outputs and the integrity engineering). Thereby, contributing to the inclusive global drive for capacity building in higher education towards an accelerated transition from prototyping to commercialisation of AM technology. Understanding the AM technology in line with the strategies presented in this paper will effectively help smaller companies and end-users develop their own innovative designs and products towards a successful participation in digital futures.

Approach

The first part of the strategy was to identify key focus areas of the AM process chain. The schematic diagram showing this approach is shown in Figure 1. The approach follows a standard systematic literature inclusion/exclusion criterion which according to (Tranfield et al., 2003) ensures quality and scientific reproducibility.

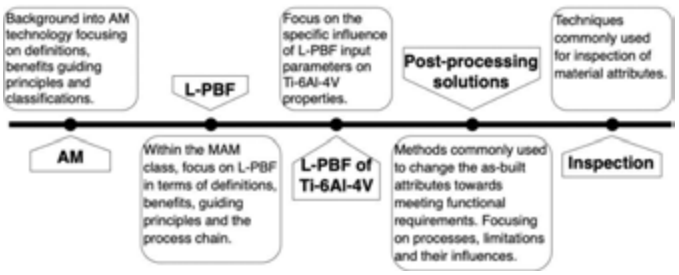

Figure 1. Schematic diagram showing strategy used to identify key aspects of AM for this work.

Since AM is broad and includes different techniques and materials, it was important to identify key areas in terms of definitions, classifications, foundations, and guiding principles. The second part of the strategy was to show the criterion in selecting the relevant literature. This meant identifying a combination of relevant keywords which were used as search terms. Table 1 shows these search terms and the reasoning behind each search term combination.

Table 1. List of chosen literature search terms and the respective reasons behind the choices.

Database search terms	Reasoning
Additive manufacturing (AM)	AM is a canopy term referring to a variety of techniques. It was important as a general broad understanding of the technology, particularly in comparison to subtractive manufacturing technologies.
Metal additive manufacturing (MAM)	AM is well-known for processing polymers. Hence, it was important to highlight focus on MAM.
Laser powder-bed fusion (L-PBF)	The focus of this project was on LPBF as one of many MAM techniques.
L-PBF/SLM and Ti-6Al-4V	L-PBF is used for processing many materials. Hence, this search term was important to specifically combine the technology with Ti-6Al-4V.
Ti-6Al-4V attributes (microstructure, porosity, residual stresses, and surface roughness) AND LPBF/SLM	These were the core search terms of this project. Combining each of the four attributes with the technology helped narrow and focus the research project into specific functional attributes.

The specific material chosen to explain the L-PBF is Ti-6Al-4V. The triangulation shown in Table 1 was intended to identify correlations in terms of the main structural aspects of the material, such as microstructure, porosity residual stress and surface roughness. This was done to understand what is known and established from the core contributions, highlight the extent to which consensus is shared, and provide a detailed audit trail back to the core contributions to justify the links between the correlations. A summary of the literature timeline and the types of literature contributions used in this work is shown in Figure 2 (a) and (b) respectively. The number of articles per year as shown in Figure 2 (a) is an indication of the database search output and not necessarily a reflection of the number of articles selected for this work. A significant number of these articles were excluded in this work following a successive screening by title, abstract and full article reading.

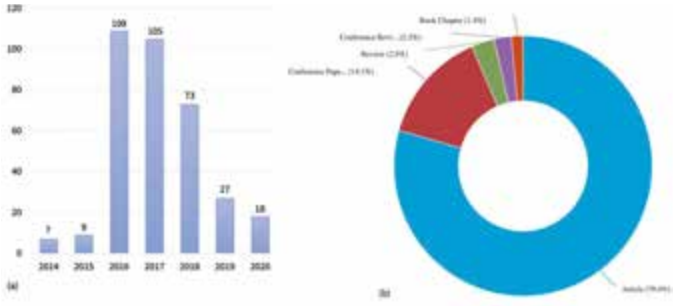

Figure 2. Literature timeline of articles which were screened for this study.

As shown in Figure 2 (b), majority of articles which contribute to the body of knowledge on AM are journal articles (roughly 79%). This can be seen as confidence boost in the quality of work presented in this paper. This is based on the high requirements for journal article publication.

Findings

Influential L-PBF input parameters

The influential L-PBF input parameters are classified as either powder specific (characterized in terms of particle-size and shape and powder flowability), laser parameters (characterized in terms of spot size, power, exposure strategy and scanning speed) and machine-specific parameters (characterized in terms of building path, layer thickness and system atmosphere) as shown in Figure 3. Although this is the case, it is important for the end-users of the technology to know that these parameters do not independently influence variables of L-PBF. This means there is no one possible set of processing parameters for a given material property. It is rather a collective influence of these parameters which needs to be considered. Generally, only about 10 % of L-PBF input parameters have about 90% impact (Schmidt et al., 2017).

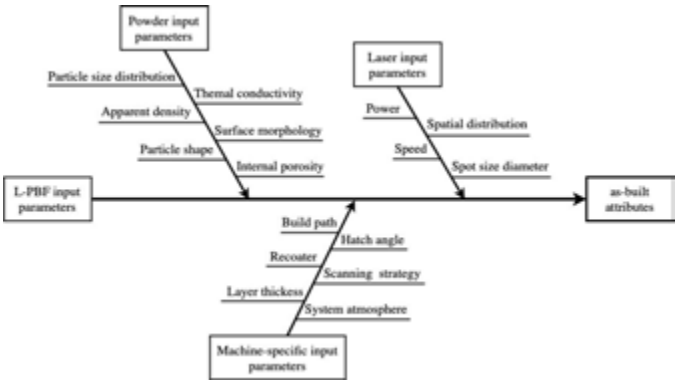

Figure 3. A schematic diagram showing a summary of L-PBF input parameters.

Different combinations of input parameters shown in Figure 3 have been widely explored to optimize the attributes of as-built parts. For instance, (Thijs et al., 2013) suggested optimum process parameter of 200W, 1400 mm/s, with scan spacing 105 µm for aluminium alloys. (Brandl et al., 2012) used 250W, 500 mm/s, 150 µm scan spacing, with 50 µm layer thickness to achieve defect-free parts. Table 2 gives an indication of how the optimized parameters for Ti-6Al-4V compare to the commonly used L-PBF input parameters.

Table 2. Summary of common process parameters compared to optimized process parameters for Ti-6Al-4V (Kasperovich et al., 2016; Kumar et al., 2018; Majumdar et al., 2019; Vilaro et al., 2011; Xu et al., 2015; Zhao et al., 2016).

Input parameter	Common usage range	Optimized
Laser power	80 – 280 W	~200 W
Laser scan speed	200 – 1200 mm/s	~500 mm/s
Layer thickness	20 – 50 µm	~30 µm
Particle size range	15 – 45 µm	~37 µm

With optimized process parameters, better L-PBF outputs can be expected such as global part density in the range of 99.0 – 99.9 % (Kasperovich et al., 2016; Kasperovich & Hausmann, 2015; Xu et al., 2015; Zhao et al., 2016). Additional process parameters shown to be effective include the preheating of the building platform to minimize residual stresses.

Output parameters of L-PBF

The L-PBF outputs refer to the characteristic aspects of a specific material in the as-built condition. The consensus of more than 90% of the selected literature studies reported that the L-PBF as-built Ti-6Al-4V inherently consists of martensitic microstructure, high porosity, high residual stresses and high surface roughness as shown schematically in Figure 4, and that these are not suitable for most industrial applications.

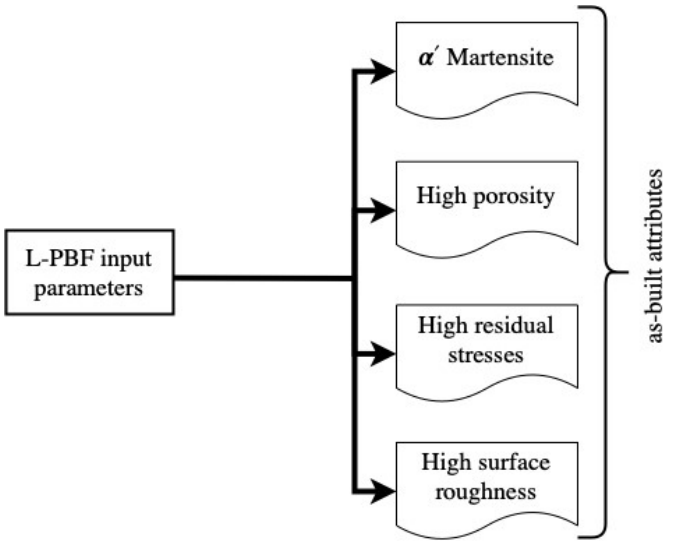

Figure 4. Schematic diagram showing typical L-PBF as-built attributes of Ti-6Al-4V.

The key when conceptualizing the L-PBF outputs is to understand the influential features of these attributes and how they affect material properties, which in turn determines whether the specific industry requirements are achieved or not.

Integrity engineering

Post-processing is inevitable for LPBF as-built Ti-6Al-4V parts because the minimum post-processing required to obtain the as-built part involves mandatory processes such as powder recover, stress relief heat-treatment, part removal from the build plate and the removal of support structures. Beyond the mandatory post-processing, the requirements for additional post-pro-

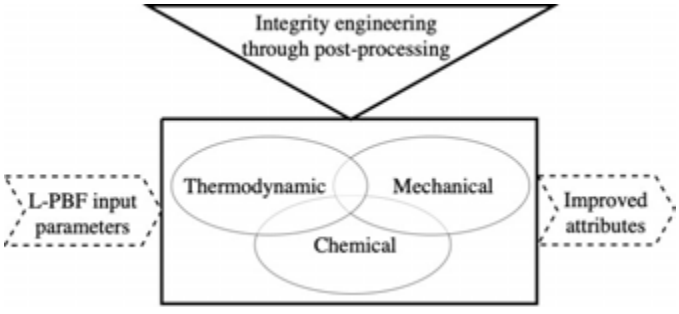

Figure 5. Schematic diagram showing where the integrity engineering fits within a typical AM process chain.

cessing solutions are material and industry specific. These can include a combination of thermodynamic, mechanical, and chemical treatments as shown schematically in Figure 5.

Thermodynamic processes are those that involve significant heat, such as heat-treatment strategies and Hot Isostatic Pressing (HIPing). Mechanical and chemical processes are surface treatments intended to improve surface finish and related properties. These categories are linked to each other through integrity engineering to emphasize that no single one is enough to achieve all material specific requirements for industry application. The choice and succession of application is often limited by availability and costs. The indication of how these solutions are used to address issues related to the four as-built attributes follows in the discussion section.

Discussion

Influential L-PBF input parameters

There is no consensus in terms of which parameters influence specific L-PBF as-built attributes. As such, the general recommendation is that a thorough optimization of L-PBF is the key to obtaining favourable as-built products. Such favourable products are dependent on specific industry requirements. This means designers would typically need to clearly define their design requirements and choose AM where it provides the most competitive advantage. Hence, understanding a proper balance of the input parameters shown in Figure 3 would need to be considered for each design requirement.

The paper brings awareness to designers to have some level of understanding of the impact of raw materials on their design requirements. In the current work, this means understanding for instance, the origin of influential parameters and be able to control such parameters to best fit the demands of their design requirements. For instance, it is important to understand that powder characteristics are a direct result of the technique used to produce that powder. Although there are several powder production techniques, the common ones include gas atomization (GA), rotary atomization (RA), plasma atomization (PA), water atomization (WA) and plasma rotating electrode process (PREP) (Anderson et al., 1991; DebRoy et al., 2018; Sames et al., 2016; Seki et al., 1990). All these powder production methods are capable of producing powder particle sizes in the range 10–60 µm (DebRoy et al., 2018), which is the size typically used in L-PBF. However, the quality of such particles is determined by characteristics such chemical composition, particle size distribution, shape, surface morphology, humidity, flowability, apparent density (packing density), melting temperature, thermal conductivity, and amount of internal porosity. Although the impact of each of these characteristics can be dissected further, ultimately, all powder characteristics determine the energy absorption characteristics of the powder-bed, porosity in parts and the surface morphology of final part. Generally, optimum properties are achieved as a result of good powder processability, which is in turn achieved by smooth particle surface morphology and uniform particle size distribution (DebRoy et al., 2018; Yadroitsev & Smurov, 2011). The main trade-off in the selection of powder size is cost vs surface finish. Smaller powder particles may cost more as a feedstock (than a larger size range) due to the cost of producing such particles.

The most influential of the laser-based inputs are scanning velocity and power input as they play the critical role in the degree of melting achieved, which can either be no melting, partial melting or complete melting (Hanzl et al., 2015; Mahamood et al., 2013; Zaeh & Ott, 2011). Understanding this offers designers an opportunity to select appropriate laser parameters to achieve optimum material properties. For instance, based on the study by (Shi et al., 2016), high velocity means low melt-pool temperature, while low velocity means the laser spends longer time at a specific spot, which means higher melt-pool temperature achieved. This trend was also shown by (Li & Gu, 2014), who observed a decrease in temperature of the melt-pool from ≈1500 to ≈1050 °C and a thermal gradient decrease from a maximum of ≈15 to ≈13.5 °C/µm, given an increase in scanning velocity from 100 to 400 mm/s during their study of parametric analysis of thermal behaviour during SLM processing of Al6061. (Li & Gu, 2014) also studied the influence of laser power on the melt-pool and reported that increasing laser power causes an increase in the size of the melt pool and the maximum temperature. The authors reported this after seeing an increase in the melt pool from 64.3 x 55.8 x 33.7 to 209.2 x 140.4 x 81.2 µm and an increase in maximum temperature from ≈60 to ≈1800 °C as well as temperature gradient from ≈10 to ≈22 °C / µm given an increase in power from 150 to 300 W (Li & Gu, 2014).

Machine-specific input parameters are perhaps the most influential on material properties of L-PBF parts (Seifi et al., 2016). Since there are so many L-PBF machines, the extent to which these characteristics influence material properties of L-PBF parts is machine-specific. The key is choosing the correct combination and understanding their influence on specific materials and the costs involved. For instance, different machines have specific patented scanning strategies associated with several advantages such as reduction of temperature gradient in the scan plane by distributing the process heat, which results in reduced residual stresses (Sames et al., 2016). Additionally, some scanning strategies have the advantage of having no major stress build up in one direction and so the anisotropy in fabricated components is reduced (Shipley et al., 2018).

Output parameters of L-PBF

The L-PBF outputs are often considered important if they play a significant role in determining the structural integrity of parts. For instance, two influential features of the martensitic microstructure are the acicular the α' laths (typically 300–500 nm thick) and the columnar prior-β grains (typically wide and long with the mid-length average width of about 103±32 µm) (Agius et al., 2018; Kumar & Ramamurty, 2019; Simonelli et al., 2014). Generally, the tensile properties associated with this type of microstructure are high ultimate tensile strength (UTS > 1000 MPa), high yield strength (YS > 900 MPa) and a low elongation at fracture ($\varepsilon < 8$ %). In terms of the influence, the acicular α' structure is responsible for retarding the movement of dislocations and cracks, thereby influencing strength associated with this microstructure. On the other hand, the prior-β grains are responsible for the anisotropic behaviour (in both tensile strength and elongation at fracture) usually associated with this type of microstructure.

Regarding porosity, the two types of pores common in L-PBF as-built Ti-6Al-4V are lack-of-fusion pores (typically 100-150

µm long and gas-entrapped pore (typically 10-100 µm) (Agius et al., 2018; D. Bourell et al., 2017). The global porosity in these parts typically ranges between 0.1–0.5 vol% (Agius et al., 2018). Considering that the requirement for global porosity in parts to qualify for application is less than 0.05 vol%, it is evident that porosity is higher in the as-built condition. Hence, the need for post-processing solutions.

Generally, residual stresses are classified according to the scale at which they occur, which can either be microscopic or macroscopic (Kandil et al., 2001). The microscopic residual stresses are usually more localized with minimal effect on mechanical properties. On the other hand, the macroscopic residual stresses typically vary over a very large distances (across the dimensions of the part) and as such, are typically associated with detrimental effects on material properties. The macroscopic residual stresses are inevitable in L-PBF processing due to high thermal gradients inherent to the process. The measure of how detrimental the residual stresses are is often depended on whether the stresses which occur in parts are either compressive or tensile residual stresses. Compressive residual stresses are generally beneficial, while tensile residual stresses are detrimental. The stresses referred to in this paper are the tensile residual stresses, as these are inevitable due to the temperature gradient mechanism (TGM) inherent to the L-PBF process. The residual stresses observed in the as-built parts are typically reported in the range 100 – 500 MPa (Vayssette et al., 2018). These stresses are higher than the maximum requirements in industries such as the aerospace for instance, which specifies a maximum of 100 MPa residual stresses for parts to qualify for application.

Surface roughness is commonly defined by mathematical parameters such as arithmetic average roughness (Ra), ten-point height roughness (Rz) and maximum height of the profile (Rt) (Gadelmawla et al., 2002). The Ra, calculated as the average value of several measurements carried out over a constant length, is the most universally accepted roughness parameter for general quality control. The Ra values of L-PBF as-built Ti-6Al-4V usually fall between 5–40 µm (Kasperovich & Hausmann, 2015; Palanivel et al., 2016; Townsend et al., 2016; Vaithilingam, Prina, et al., 2016), and this is too rough for most industrial applications. The detrimental effect of high surface roughness is an increased influence on fatigue crack initiation. Even though there is no consensus about the parameters which influence surface roughness the most, the poor surface quality of L-PBF parts is predominantly linked to three factors as, open pores and other defects on the surface, partially melted powder adhered onto the surface and the staircase effect.

Integrity engineering

Since the as-built microstructure does not always meet the industry requirements, the problem-solver of the martensitic microstructure is post-processing through annealing heat-treatments. These heat-treatments are usually carried out for two reasons; to decompose the α' martensitic microstructure into a dual-phase $\alpha + \beta$ matrix and to change the size and morphology of the prior-β grains. The common types of heat-treatments explored for this reason are sub-transus (≤ 980 °C), super-transus (≥ 980 °C) and duplex anneal heat-treatments. The latter which involves two annealing temperature stages combined with specific holding times followed by two stage cooling methods. An important consideration is that the heat-treatments carried out in AM are not typical. Therefore, depending on the type of heat-treatment, holding time and method of cooling, a variety of microstructures can be achieved.

If porosity is below the minimum specification, there is no detrimental effect on mechanical properties. This is because the smaller number of pores present in the part (microscopic) the denser a part is, which in turn means better quasi-static properties. However, if porosity is above the minimum specifications, the potential problem-solver is hot isostatic pressing (HIPing). Compared to the range of 0.1–0.5 vol% global porosity typically seen in the as-built conditions, a typical HIPing procedure can reduce porosity in parts produced by L-PBF to the range of 0.01–0.05 vol%, which is less than the minimum allowable global porosity of 0.05 vol%. A HIPing procedure is often specified along with functional requirements, but the procedure is alternatively available in standards such as the ASTM F2924-12A. The process has a combination effect whereby the pressure used enables the closure of internal pores and cracks to increase material density while the inherent heat-treatment effect influences microstructure refinement. Subsequently, both quasi-static and dynamic mechanical properties are improved.

Despite the efforts to reduce the residual stresses by input parameters such as base-plate pre-heating and re-scanning strategies, the residual stresses seen in the as-built parts still fall in the range of 100–500 MPa. Residual stresses in this range are a problem because they are still higher than the maximum allowable stresses of 100 MPa for most parts' application. Since residual stresses are a result of thermal gradients, the most effective way to reduce them is through high temperature stress-relief heat-treatments. In L-PBF parts, this is preferably carried out as a mandatory process before parts are removed from the baseplate to avoid the possibility of warping (Yang et al., 2017). These heat-treatments are specific to the material used and typically carried out at temperatures much lower than the recrystallization temperature so that the microstructure is not affected, but high enough to enable the desired atomic mobility. For instance, an effective reduction in residual stresses in Ti-6Al-4V produced by L-PBF is typically achieved after heat-treatments ranging between 480–650°C for 1–4 hours, followed by either furnace or air cooling.

The improvement of surface conditions of parts produced by L-PBF is crucial for most industry applications, particularly for parts designed for load-bearing applications because the crack initiation at the surface is minimized. Several surface treatment techniques in the literature have proven to be effective in reducing surface roughness (Vaithilingam, Goodridge, et al., 2016) thereby, improving the mechanical properties, in particular, improving dynamic properties. For instance, the reduction of surface roughness in L-PBF Ti-6Al-4V parts is typically achieved by mechanical and/or chemical polishing post-processing treatments. The operating principles and parameters of both treatments (mechanical and chemical) are widely known to the research and manufacturing communities and involve well-established standards and each with advantages and disadvantages towards achieving desired

surface finish. Overall, mechanical treatments such as machining work best on flat surfaces. For complex, high-quality near-net parts, the polishing and chemical milling treatments become the ideal post-processing solutions to achieve desired surface finishes and geometrical tolerances.

Understanding AM as a hybrid manufacturing process

The process using AM to produce functional parts which qualify for industrial application needs to be considered as a hybrid manufacturing process because the AM parts in the as-built condition fail to meet most industrial applications. Hence, post-processing solutions are deemed essential to link the as-built parts with industry specific functional requirements. This is achieved by integrity engineering through the post-processing solutions discussed in this paper. An overview of a typical L-PBF hybrid process chain is shown schematically in Figure 6 to show the process chain of how to get to an AM part which can be considered as qualified for application. In summary, the process starts with input parameters which include the actual building process to obtain the as-built parts. The as-built parts are then post-processed to improve material properties. This is followed by inspection and validation to check whether functional requirements are met or not. If met, the parts qualify for application and if not met, the process repeats from post-processing or with new parts printed from scratch.

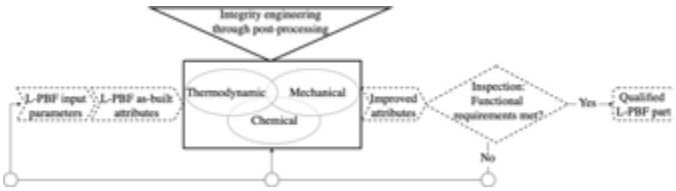

Figure 6. Schematic illustration of a typical L-PBF as a hybrid process chain to qualify parts.

Since there is a significant range of post-processing solutions available, some important considerations are as follows. The important parameters to consider when conducting thermodynamic processes include the type of heat-treatment, temperature, holding time, cooling method and pressure. The important parameters to consider when carrying out mechanical processes include operating speed, contact pressure and lubrication. The important parameters to consider when conducting chemical processes include the type of electrolyte concentration, applied voltage, temperature, and time of treatment. Authors in the field of AM have described and reported improved quality of L-PBF parts because of such post-processing approaches. The attempts have been successful in meeting specific functional material properties such as porosity (Fousová et al., 2017), tensile properties (Ter Haar & Becker, 2018), fatigue life (Chastand et al., 2016; Edwards & Ramulu, 2014; Kasperovich & Hausmann, 2015), surface finish (Kumbhar & Mulay, 2018; Strano et al., 2013; Townsend et al., 2016; Vaithilingam, Goodridge, et al., 2016) and geometrical accuracy (Umaras & Tsuzuki, 2017).

The importance of post-manufacture inspection included as part of Figure 6 is that it ensures the final, finished part meets all the required specifications. A variety of inspection methods exist and are often categorized as either destructive or non-destructive tests (NDT). Destructive methods are those which involve parts being destroyed to obtain material information and include standardized techniques such as tensile, compression, shear, metallography, hardness, fatigue, and fracture toughness tests. Since these tests are destructive, they are not performed directly on the finished parts. Instead, on representative test samples which are built and post-processed in the same conditions as the final part. Therefore, these types of tests are often regarded as precursors to the NDT as quality control techniques and statistical evaluations of product batches (Slotwinskic & Moylan, 2015). On the other hand, the NDTs are often used as inspection methods to detect and evaluate flaws (irregularities or discontinuities) in traditional manufacturing. While NDT techniques are well-developed and standardized for inspection of parts produced by traditional manufacturing processes, their inspection capabilities, and acceptance criteria for AM parts has not been fully established (Taylor et al., 2016). Nonetheless, some of the NDT methods have been investigated and shown to be applicable for inspection of AM parts. Although some of these methods have been widely investigated for inspection of metal AM parts in recent years, one of the major limitations of their use has to do with complex geometries typically produced by AM (Sharratt, 2015). Such geometries pose a challenge when it comes to the NDT techniques such as ultrasonic, eddy current, and radiographic test methods for instance. This is because accessibility to surfaces is not necessarily guaranteed for complex parts. Nonetheless, besides its limitations relating to detectability, sensitivity, accessibility and ease of use, x-ray computed tomography (XCT) remains the promising technology for examining parts of complex geometry (Sharratt, 2015). The key benefit of XCT is its ability to evaluate multiple criteria at once and to image the interior of samples or parts.

Conclusions

To give more insight and confidence in AM technology, quality assurance and life span of parts must be carefully investigated to understand the technology. This involves integration of three factors: technology, skills, and industry requirements. Currently, such understanding is not widely available and most of the time the focus on these factors is usually separated as opposed to being integrated. The work presented in this paper contributes to such understanding. Therefore, three conclusions can be drawn from the findings of this work. Firstly, it is important to consider the L-PBF as-built attributes as a collective that determines structural integrity of parts produced. Secondly, the paper summarises a body of knowledge through a technical review of the L-PBF processing of Ti-6Al-4V and highlights a definitive need for post-processing solutions to address the as-built issues predominantly seen in these parts. Thirdly, the paper proposes a strategy for understanding AM as a hybrid process instead of the common practice of using the technology as a prototyping procedure which ends with non-functional parts in most industries. The strategies presented in this paper are intended as knowledge transfer in higher education and aid the new end-users of the technology to quickly identify influential parameters of the various stages of AM as a hybrid process. Thereby, making it easy to know what to look for when designing for AM.

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Speculative tinkering on circular design materials through 3D printing

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Abstract

Despite the spread of new circular materials and digital technologies, designers' awareness of how to practically implement them is not fully achieved yet. Therefore, new ways to foster digital craftsmanship skills and experiential knowledge should be implemented. This contribution aims to reflect on digital technologies, especially 3D printing, in speculative design approaches with circular materials through the development of the materials library from the FiberEUse research project. This "materials and product library system" is an adaptive experiential tool that goes beyond merely collecting physical materials samples. It also includes possible products, speculative applications, and non-textual content, merging physical and virtual learning experiences. Its physical section comprises a materials library with flat samples of the materials and a product library with applications or cut-offs of some meaningful details of products.

By analyzing the library's development path, three incremental phases emerge in terms of interaction with circular materials and 3D printing for speculative approaches: experiencing materials, technology, and products. The first phase aims to preliminary explore the potential and qualities of materials through traditional craftsmanship skills. The second phase deal with the first experimentations with the technology, understanding the limits and influence on the expressive-sensorial qualities. The third phase is oriented toward new applications, investigating the possible outcomes from a formal point of view. As a synthesis, the tinkering process emphasizes the active role of experiential tools in spreading the use of circular materials and digital technologies, helping acquire new skills through an experiential approach. It also adds a further level to the exploitation of materials libraries, paving the way for new possible uses, i.e., distributed replication, participation, and implementation. As a result, materials libraries assume a more active role in the experiential knowledge transfer even during their development, representing a practical path to building new skills. Hence, a new model of materials libraries may emerge as a replicative learning and speculative design tool.

Author keywords

Circular economy, Materials library, Additive Manufacturing, Materials experience, Experiential learning.

Introduction

Fostering new responsible ways of production and consumption is becoming increasingly important from an environmental, economic, and social point of view. Among those, Circular Economy (CE) models have demonstrated to help in encouraging sustainable practices by preserving the resource flows and values as long as possible (Reike et al., 2018). Considering the design and production of new goods and products, switching to sustainable materials and technologies is recognized as a possible strategy for implementing cleaner practices, as well as circular economy practices for design (Sumter et al., 2021). Among those, the use of new waste-based or recycled materials and digital technologies, i.e., 3D printing, is gaining attention within the design research and practice, helping to establish new bottom-up, collective, and practical design experimentations or tinkering activities with materials (Despeisse et al., 2017; García-Ruiz & Lena-Acebo, 2022; Parisi et al., 2017; Rayna & Striukova, 2021; Veelaert et al., 2020). Within this context, digital fabrication tools have mainly been studied at the intersection with CE, resulting in different strategies and approaches to put its principles into practice, i.e., through repairing, distributed economies, upcycling, and recycling initiatives from local waste streams (Colorado et al., 2020; Despeisse et al., 2017; Mikula et al., 2021; Oyinlola et al., 2023; Ponis et al., 2021; Sauerwein et al., 2019; van Oudheusden et al., 2023). Moreover, the discipline of material design is demonstrating its crucial contribution to spreading the use and knowledge of new materials linked with digital technologies, especially by experiencing materials and envisioning them into concrete artifacts through speculative design approaches (Clèries & Rognoli, 2021; Galloway & Caudwell, 2018; Kretzer, 2021; Pedgley et al., 2021). However, designers' awareness of using these new circular materials and sustainable technologies is not fully achieved yet (Pedgley et al., 2016; Romani et al., 2021). Therefore, new ways to foster digital craftsmanship skills and experiential knowledge should be

implemented in the next years. A possible way is represented by experiential tools, especially materials libraries, aiming to facilitate the knowledge transfer of unquantifiable practical contents, i.e., expressive-sensorial qualities and skills (Akın & Pedgley, 2016; Nimkulrat, 2021; Wilkes & Miodownik, 2018).

This work analyzes the use of digital technologies, such as 3D printing, in speculative design approaches linked to real exploitations of new circular materials. The analysis is based upon a reflective practice approach focused on the design and development path of a "materials and product library system", the materials library of FiberEUse, a research project on composite materials from recycled glass and carbon fibers. This new library merges a physical and a virtual learning experience through different media, i.e., physical samples, product cutoffs, and visual supports. It allows speculating on new possible applications by experiencing and tinkering with its different content. After introducing the case study, the work briefly detects three incremental phases of interaction and engagement with circular materials and 3D printing: (i) experiencing materials; (ii) experiencing technology; and (iii) experiencing products. Each of them is linked to a part of the materials library, as well as physical contents and possible interactions with the experiential knowledge. The experiential approach to the materials library helps in envisioning and speculating on new plausible applications through a practical approach. A fourth phase is then outlined as a possible way to foster the transfer of new digital skillsets and attitudes amongst designers and practitioners, which means (iv) experiencing the path to the materials library development. The tool assumes an active role in transferring these new digital craftsmanship skills as a participative learning and experiential tool to be locally replicated, modified, and implemented, including the development process in the learning activities.

Methodology

This work relies on the approach of Reflection-in-action, or reflective practice, in the research area of materials design (Clèries & Rognoli, 2021). Practical experimentations and projects are used as inquiry tools to reflect on practical issues and create new theoretical knowledge (Goldkuhl & Sjöström, 2018; Reich, 2017; Schön, 1992). As part of the Research Through Design (RTD) methodology, the role of design experimentations, artifacts, and products is to conceptualize and generalize through reflections to be collected during and after the practical inquiry itself (Friedman, 2008; Horváth, 2016). From literature, similar practical approaches in design research have been theorized by different scholars. Each approach usually emphasizes different aspects linked to the use of artifacts and practical inquiry tools within the design research discipline, i.e., as "designerly ways of knowing", tacit knowledge and reflective practice, or deriving embedded rules from prototyping (Cross, 1982; Friedman, 2008; Schön, 1992). In this work, the development of the Materials Library is considered a Reflection-in-action activity since it could be seen not only as a product to be properly developed and designed but also as a research path to be analyzed to build new knowledge. Hence, the whole design process of the tool may be seen as a practical inquiry that helps in understanding the use of speculative design approaches linked to the knowledge of digital technologies and new emerging materials, such as 3D printing and waste-based materials. Nowadays, Materials Libraries are seen as wider systems whose aim is not only to support materials selection by showcasing physical samples and sharing technical data.

In this work, Materials Libraries are intended in two different ways: as experiential tools to foster and speculate on the use and knowledge of emerging materials and technology or as practical design experimentations to generalize some theoretical knowledge. The first meaning is briefly resumed through the selected case study and represents the aim of this tool as a product and/or system. The second one corresponds to the methodology of this contribution, allowing for reflecting on the possible speculative experiences that may be encountered by interacting with Materials Libraries and digital technologies. The authors were directly involved in the design path of the library, resulting in a first-person approach to the design experimentation. In this way, the reflections during and after the inquiry were used to theorize on the topics of this contribution. In detail, reflections were collected by considering the structure and taxonomy of the tool during its use in a demo presented at the Milan Design Week 2021, as well as internal workshops to the project's partners, i.e., waste suppliers and designers of the products.

Speculative tinkering with materials

Using materials libraries creates a possible path to envision new applications and physical artifacts through an experiential approach. In other words, these tools represent a valuable option to foster speculative design approaches. According to Galloway and Caudwell, Speculative Design represents a meaningful way to ask new questions and generate plausible scenarios to tackle complex issues in design research (Galloway & Caudwell, 2018). In addition, speculative approaches may also be exploited in the research areas of materials design and Design for Additive Manufacturing, leading to practical experimentations and interactions with emerging materials (Bauer, 2019). To this end, designers and researchers are directly involved in the process of tinkering and experimenting with new materials formulations and process parameters, creating a range of physical output that materializes their practical work. From literature, this approach to materials is also known as Material Tinkering, a "practice of direct, creative, and iterative experimentation on materials" emphasizing the physical act of manipulating matter (Parisi et al., 2017; Rognoli & Parisi, 2021). During the experimentation process, the different material samples may foster the generation of new alternative scenarios and words, as well as applications, resulting in speculative actions (Rognoli et al., 2021; Rognoli & Ayala-Garcia, 2021). The tinkering activity is, therefore, embedded with speculative design approaches, defining proper "speculative tinkering" practices. Within this context, speculative tinkering is meant to envision new applications and scenarios through the iterative manipulation of emerging materials and technologies, often including other socio-ethical topics such as sustainability.

Case study: FiberEUse Materials and Product Library System

The case study focuses on designing a Materials Library to showcase materials and possible applications from the recycling and reuse of glass and carbon fibers from waste and products at their end-of-life, such as construction structures, wind blades, and aerospace components. The practical exploitations within the library also want to foster the integra-

tion of new waste-based materials through examples in real contexts, for instance, from industries or design practitioners. The new Materials Library is meant to spread the knowledge related to these new solutions, including different contents and materials samples. The experiential tool developed within FiberEUse widens the concept of materials libraries by including materials samples, new products, possible applications, textual and non-textual content. The "Materials and product library system" is divided into two main parts, the Physical Library and Virtual Library, merging the concepts of tangible/virtual fruition, as well as local/distributed use (Romani et al., 2022). This tool can be used during the different phases of the design process, making more accessible the knowledge of emerging materials and technologies through flat samples, cutoffs, pictures, renderings, and numerical data. The virtual part is visible at https://fibereuselibrary.com, while the physical one can be freely used on request. Only the physical part would be considered for the sake of this work, which is divided into two main parts. The first one, the Physical Materials Library, collects flat materials samples according to the finishing, kind of waste, and concentration (Fig. 1a). The second part, the Physical Product Library, showcases cutoffs and parts from physical products using the new materials. The Physical Product Library (Fig. 1b) was developed through a new spatial taxonomy, resulting in different three-dimensional tetrahedral structures, where each sample is defined by a position within a four-variable coordinate system. Each structure represents a different waste, material, and process, i.e., glass fibers, carbon fibers, and different 3D printing processes, and the vertexes are linked to the four selected variables of the structure. In this way, different variables, such as process parameters, finishing, or shape complexity, may be compared and experienced through the physical parts, which are linked to a specific position of the spatial system, allowing comparisons and qualitative assessment. Each sample of this section is then part of a specific tetrahedral structure, and it is represented by four different coordinates, one for each selected variable of the specific spatial structure. For instance, a sample of the structure "3D printed glass fibers" has a defined layer height, number of perimeters, surface finishing, and shape complexity, corresponding to the four variables at the tetrahedron vertex (Romani et al., 2022). Hence, the system allows to showcase and compare different combinations of the four variables, showing more possibilities in terms of new applications to envision.

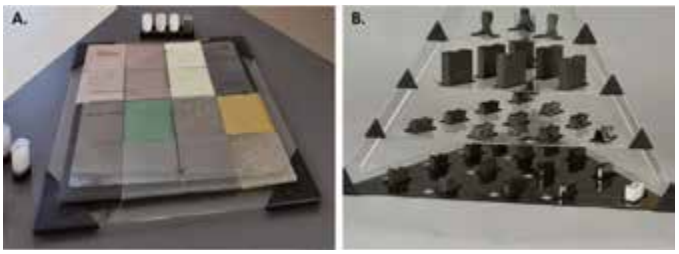

Figure 1. Tangible part of the materials library (physical part): (a) insight of some structures of the physical material library and (b) physical product library.

Experiencing Materials Libraries

Considering the interaction, tinkering with circular materials and 3D printing, three different incremental phases to foster speculative tinkering emerge from the analysis of the library's development path and final design. As shown in Fig. 2, tinkering with materials through 3D printing results in: (i) experiencing materials; (ii) experiencing technology; and (iii) experiencing products. Each phase is linked to a physical part of the materials library and specific technical and experiential knowledge, progressively envisioning new plausible applications.

Figure 2. Incremental phases in interacting, experiencing, and tinkering with circular materials and digital technologies through materials libraries.

Experiencing Materials

The first step in fostering speculative tinkering deals with materials and their preliminary exploration through tinkering activities. The phase of Experiencing Materials (Fig. 2, phase 1) aims to begin the exploration of their properties and qualities by interacting in an immediate way, trying to reduce the mediation and influence of external tools or processes. Hence, the first attempts to investigate their physical properties and expressive-sensorial qualities are usually performed by directly handling materials and tuning the first formulations. To this end, more traditional approaches and techniques from crafts are generally used. Although the influence of processes cannot be removed as a variable in shaping and interacting with materials, crafting helps in limiting their influence, focusing on the variations of the materials themselves. Experiencing materials also means interacting with them not only in structured ways but also encouraging fuzzy interactions, structuring the tinkering activity by narrowing down the practical activity, i.e., focusing on a specific material or a specific set of qualities. This phase helps in detecting some possible paths to organize iterative tinkering, as well as paving the way for the next steps. Considering the case study, this phase resulted in the production of some sets of flat samples, which were then selected to be part of the Physical Materials Library. Hence, this section of the Materials and Product Library system represents the final output of this phase, and their users can experience the results of this tinkering activity. They can also begin their path with these materials, starting their speculative path by understanding the materials as they are and acquiring some basic experiential knowledge to be used in their envisioning path.

Experiencing Technology

The second phase in fostering speculative tinkering focuses on the experimentations and practical trials with the technology, considering the impact of the process in shaping materials. The phase of Experiencing Technology (Fig. 2, phase 2) wants to continue the exploration of the previous step by experimenting with the influence of the manufacturing process through hands-on activities. The experimentation may be performed through sampling, trying to define some set of samples that highlight possible modifications on the qualities, either seen as opportunities or limits to their real implementation. In this case, digital processes can progressively replace traditional prototyping techniques, which can be used to support further investigation and tinkering, i.e., finishing and post-processing. In this case, tinkering with the

process by tuning the possible settings allows the practitioner to work in two different ways. First, it helps in defining the optimal parameters to obtain meaningful samples, which can then be used as a reference for developing new applications. Furthermore, they can also help detect different expressive-sensorial qualities that cannot be completely predicted by the user, usually experienced with a trial-and-error approach. Trials that are generally seen as errors have the great potential to foresee alternative ways to use the technology to reach new results, enlarging the ways to process the material and, consequently, the possible uses in real exploitations. Bearing in mind the case study, the first layers of the Physical Product Library represent the output of this phase, which means the biggest and simplest three-dimensional samples of that library section. They represent the synthesis of this tuning experimentation by showing the main combinations between process parameters, materials formulations, physical properties, and expressive-sensorial qualities. Also, in this case, the user directly handles the results of this practical activity, adding some experiential knowledge to what they previously experienced on materials.

Experiencing Products

The third step in fostering speculative tinkering is oriented toward speculative design and real implementations. The phase of Experiencing Products (Fig. 2, phase 3) aims not only to continue the previous tinkering and explorative paths but also to encourage possible experimentations, projects, and exploitations of the physical and experiential contents. At this point, the experimentation is mainly linked to digital technologies and tools by designing and developing possible applications and physical artifacts, representing the first trials of real implementations. New products, artifacts, or even some cutoffs or parts allow the designer to investigate the possible outcomes from a formal point of view, making tangible some crucial aspects to consider during the design process of new products. In detail, fields of application, technical features, possible geometries, and different aesthetics are analyzed by materializing them within plausible products. Showing some plausible examples, as well as some real products or work-in-progress concepts, should not be intended to limit the range of use and applications of the analyzed materials and technologies. Contrarily, it aims to further stimulate the development and design of different artifacts by materializing some ideas, which could then be considered as references for new projects. Furthermore, it aims to encourage the investigation of new possible features, geometries, and aesthetics to be achieved by exploiting the showcased materials and technologies. In this case, the final layers of the Physical Product Library resume the output of this final step, increasing the shape complexity and introducing some applications as a reference for future works and speculative approaches. The user can use them as a starting point for exploitations in real contexts through their design and professional activity.

Experiencing the Path

A possible fourth phase emerges as a potential experiential and speculative tool from the analysis of the case study, as shown in Fig. 3. As a matter of fact, the materials library of the case study helps in encouraging speculative approaches to sustainable materials and technologies by sharing the experiential knowledge to facilitate their use in real contexts. However, it also represents a way to showcase some results obtained using digital tools and skills, promoting their use. For this reason, the library may be used to foster the transfer of new digital skillsets and attitudes amongst designers and practitioners. According to the previous analysis, experiencing the path (Fig. 3, phase 4) for the materials library development allows the users to acquire these skills through a practical and experiential approach, which means taking part in the process of building the tool itself. From this perspective shifting, the tool acquires an active role in transferring new digital craftsmanship skills and is not just representing a passive knowledge transfer tool to be used in its final version. This approach paves the way for new possible uses of this tool, i.e., distributed replication, participation, and implementation, since experiencing the path adds a further level to experiential knowledge transfer. Moreover, first-person practical activity focused on the library helps in acquiring the skillset to pursue speculative tinkering on possible exploitations through hands-on activities, taking part in the process of envisioning new artifacts by directly participating in the fabrication path. Thinking about possible ways to replicate or create new versions of the library considered as a case study would be a possible way to foster this speculative hands-on approach amongst designers and practitioners.

Figure 3. Contribution of experiencing the path in developing a materials library in spreading digital tools and skills for speculative tinkering.

Conclusion

This contribution reflected on the use of digital technologies in speculative approaches linked to new circular materials from waste, fostering new projects and real exploitations. The analysis was performed through a reflective practice approach to the design and development of the materials library of FiberEUse. Three different incremental phases in fostering speculative tinkering emerged from the analysis, linked to a specific part of the library, which means: (i) experiencing materials with traditional crafting tools to explore physical properties and expressive-sensorial qualities (*tinkering with materials*); (ii) experiencing technology with hybrid approaches to understand its potential and limits (*process influence*); and (iii) experiencing products with digital crafting tools to envision new applications through tangible examples (*speculative design*). A further step was then added as a possible fourth phase, which means (iv) experiencing the path by transferring digital crafting skillsets through first-person hands-on activity in participating in the development of the tool (*knowledge transfer*). These reflections should be furtherly enriched by considering additional case studies, circular materials, digital technologies, and users. However, materials libraries may assume an active role in fostering speculative tinkering through digital technologies such as 3D printing and in transferring new digital craftsmanship skills thanks to its potential use as participative learning and experiential tool to be replicated, modified, and implemented. Their meaning is, therefore, also in experiencing the path

to obtain them, and not only in their final design, paving the way for a new way to interact with materials libraries, circular materials, and 3D printing. Further work should be done to assess the use of Materials Libraries in different contexts, i.e., in didactic activities, during the design process, or define how to evaluate the outputs from the speculative tinkering, for instance, the feasibility and technology readiness level of the envisioned applications and artifacts.

Acknowledgments

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Flaws as features: new perspectives for developing an additive manufacturing design language

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Abstract

In spite of some noteworthy niche-successes, many stakeholders would say that additive manufacturing (AM) has underperformed in relation to the early hype surrounding it (Wanke, 2019) or has lost its momentum (Killi & Morrison, 2020). The reasons for this underperformance are multiple: high costs per unit, unreliability when compared with established mass production methods and possibly a wrong understanding of the technology, amongst others.

In this paper I propose that the lack of analysis and the failure to grasp which are the real new possibilities at hand through AM are one of the main reasons behind the failed delivery of the 3D-printed utopia many announced at the beginning of the hype. In particular, I propose that the failure in developing a unique design language emerging from the actual properties of AM has stopped it from happening while trying to emulate mass production.

Manual and mass production are very well understood and established, to the point that they define our default tracks from conception to development to production. AM first entered the scene as a part of these tracks, being called "rapid prototyping" of an implicit mass production later down the line. Ever since, the new AM palette has struggled to define a space on its own as a method to deliver proper end products.

Some specific expensive niches were immediately successful in making use of 3D-printers, in what many expected to be no less than the start of the next industrial revolution (D'Aveni, 2013). Yet outside these niches AM is starting to resemble nuclear fusion, a promised all-success which somehow never arrives.

Every material combined with a production method will have qualities, properties, and limitations. Artisans have explored metal, clay, glass, and wood for millennia and developed design languages not only suited but emerging from them. Similarly, smart additive manufacturers should reflect both on the possibilities and flaws of the tools at their hands, developing a new, unique design language emanating from their materiality. Within this matrix, AM's "flaws" (filamented textures, rough and dusty surfaces, chaotic extrusion...) are possibly the most neglected aspects, still understood as elements to be ashamed of rather than creative possibilities.

Within this paper I analyse some notorious flaws of the AM palette and propose new perspectives to integrate them as possible features and advantages in this yet to be properly developed design language.

Author keywords

Additive manufacturing; 3D print; AM; crafts; AM limitations; design language; innovation.

Additive manufacturing limitations

Step 1: buy a 3D printer
Step 2: print a 3D printer
Step 3: return the 3D printer

Popular meme text

This meme would make perfect sense if 3D printers were the almighty machines which some utopian visions would like us to believe are our near future. *"The smell of freshly baked whole wheat blueberry muffins wafts from the kitchen food printer. The cartridges to make these organic, low sugar muffins were marketed..."* (Lipson & Kurman, 2013).

In reality we are not only very far away from such a thing. Arguably, we will never have similar Star Trek technology in our kitchens.[1][2]

"Additive manufacturing" is an unusually self-explanatory name, but it wasn't the first baptism attempt for the technology. "3D printing" is catchy and intriguing but confuses more than clarifies regarding the method. "Rapid prototyping" clearly defines the proposed function without dealing with the technology itself. AM is a paradigm shift in relation to these iterations in terms of clarifying its goal (not only prototypes) and by describing how it works (by adding material). As opposed to casting, carving and material removal techniques, AM works in a step-by-step increasing manner, making non-microscopic layers or filament traces unavoidable almost by definition (Wanke, 2019).

Smooth surfaces have always been a proxy for craftsmanship and quality. Mass production democratised smooth

1 As far-fetched as it may seem, this is no strawman of some AM enthusiasts' line of argumentation. In 2014 Horizon, the EU research & innovation magazine, published an article called "What does the future hold for 3D printing?" quoting Marcel Slot stating that "the ultimate goal of 3D printing is a Star Trek-style replicator. Deighton, B. (2014). What does the future hold for 3D printing? *Horizon, the EU research & innovation magazine*. Retrieved 22.12.2022, from https://ec.europa.eu/research-and-innovation/en/horizon-magazine/what-does-future-hold-3d-printing

2 For a realistic overview of the 3D printed food landscape see Killi, S., & Morrison, A. (2020). Could the food market pull 3D printing appetites further? In (pp. 197-203). https://doi.org/10.1201/9780367823085-36

finishes, a parameter which otherwise required high skills and time dedication. Just imagine how devoted and skilled would you need to be to produce a smooth piece of wooden furniture with crude 18th century tooling, where even sandpaper would have been time saving science fiction.

AM has dramatically increased its quality, yet its filamented, hairy, support-structure scarred, layered roughness will remain one of its characteristics. No foreseeable technological development could provide casting or extruded-like surfaces and even if this occurred such technology would unlikely become a common, mainstream or desktop tool. No matter how optimistically utopian our 3D printed near future gets to be described in the opening chapter of "Fabricated: the new world of 3D printing" (Lipson & Kurman, 2013), AM's ugly duckling is here to stay. But is it truly ugly or have we failed to identify its species?

Material aesthetics in crafts

> *"By chance, a piece of titanium in the firm's material sample pile caught the team's eye. On an uncharacteristically overcast Los Angeles day the metal square was nailed to a telephone pole in the office parking lot; it went golden in the grey light and the team was smitten."*
>
> Guggenheim's Museum blog (Mendelsohn, 2017)

Aesthetics in crafts emerge from their materiality. Bilbao's Guggenheim architectural concept asked for an innovative curvy solution at large scale, but once titanium was serendipitously selected as the quotation tells, the novel material changed the original design as well. Material, shape, size, and light reflections became an inseparable entity.

Artists and craftsmen have gotten their hands dirty with the mediums at their disposal. Centuries of crafty experimentation have left us with virtuoso techniques which embrace their materiality. Being born with crafty techniques already established as "tradition", we may miss the fact that the different mediums and their belonging aesthetics may be very different, even contradictory, from one another. There is certainly no absolute good/bad in arts, but in art school the different techniques must be learned and more often than not will be criticised as poor. Even more interestingly, similar criteria could lead to "good oil" and "bad watercolour" technique evaluation. A classic critique almost every fresh art student will suffer comes from not deploying watercolour's fuzziness. There are plenty of counterexamples, yet classic academic watercolour technique is about learning to use its watery mess for the appropriate purpose. Wash, blending, backrun, tilting and almost every other watercolour technique makes reference to a somewhat chaotic possibility of the medium (Van Leuven, 2017). We learn these elements as academic craftsmanship and therefore will likely fail to realise that this is a fine example of using what could be considered a flaw (the messiness of watercolours) as a high-quality feature instead. We don't see a chaotic blend of uncontrolled, overlapping, dripping, watery blueish waves on paper. On the contrary, we enjoy a beautiful depiction of a cloudy sky, masterly achieved in three skilled strokes, some paper tilting and a sponge intervention.

Similarly, every other traditional crafting technique emerges from its materiality, developing an aesthetic on the way. Weavers, painters, sculpturers, potters and photographers have a language of their own. One of the latest additions to the family are the digital artists, who have seen their medium emerge and grow in a single lifetime. Yet even within this brief episode different schools and aesthetics were born and became aesthetically appreciated on their own. Early digital visuals were constrained by heavy pixelation, very limited colour palettes and short memory availability. Only 20 years later these technical limitations were a thing of the past yet "pixel art" became a thing, an established style, which some creators voluntarily use as an expressive tool, similar to the recent revival of stop motion animation (Costa, 2014).

Computer adventure games were very popular in the 90s and made extensive use of pixel art aesthetics (they didn't have any other choice). Ron Gilbert, the creator behind the popular "Monkey Island" game series, made phenomenal use of the comedic possibilities of clumsy pixelated imagery and animations. In the following decades his creations achieved cult status, which motivated him to create a new episode to his pirate saga. "Return to Monkey Island" became one of the most anticipated releases of 2022, yet Gilbert didn't deliver a nostalgic pixel art product, crafting a modern, smooth, cartoon-looking environment instead. Fans were divided about it, to put it mildly (Troughton, 2022). Pixelated, 256-colour graphics had become something emotional to defend, in a similar reactionary manner to Star Wars fans demanding unspoiled analogue versions of their childhood movies instead of the "digitally enhanced" versions George Lucas produced for the 25th anniversary re-release, a discussion which reached a religious tone (Lyden, 2012).

If you are a watercolour afficionado, pixel art connoisseur or Star Wars fan, the previous, crude descriptions of these aesthetics in terms of materiality and limitations almost certainly provoked an emotional reaction in you. This story and analysis are therefore not only about materials and aesthetics but also about the emotions they induce. We will come back to this topic later.

From prototypes to end-products

> *"A prototype is always more expensive than anything."*
>
> Wes Anderson (Anderson, 2009)

As previously mentioned, 3D printers were firstly known as "rapid prototyping" machines, and in many environments they are still called that way. This is a very senseful name since in most product development processes AM plays its most relevant role at the prototyping phase.

The answer to the question why didn't we start crafting end-products immediately when AM manufacturing technologies became available could require a whole book on its own. The factors which played (and still play) a role range from industrial patents, to technological limitations, to production economics, to plain cultural biases and tradition-based resistance to update our production methods (Killi, 2017). For the purpose of this paper economics, tradition and cultural biases are the most relevant parts of the matrix to analyse.

Regarding economics, in high-end projects where there are no budget constraints, quite often AM can provide unbeatable solutions. Boutique clients looking for an extra 0,1% efficiency regardless of the price tag are good AM customers. Accordingly, new generation rocket nozzles and customised, record-beating bicycles are now mostly produced through AM (Attanasio, 2022). These high-end, flagship projects can certainly make

the AM community proud, yet such successes don't move us towards a democratic, accessible AM utopia at all. They will remain luxury niches and as much as they are inspiring, they are of little interest for the purpose of this paper. Let us have a look at the accessible budget area instead.

Wherever a mass production effort can be implemented and makes economic sense, unless currently unforeseeable technological jumps occur in the AM methods, almost by definition mass production will be more efficient than AM. AM enthusiasts may react to this with counterarguments such as less transport costs and fewer CO2 emissions if locally 3D printed, less material waste due to topology optimisation and more efficiency due to customisation. These arguments can be perfectly valid within specific, well-defined niches. Such niches have a "sweet spot" which differs from the numbers of traditional mass production and are far less common than AM supporters -including myself- would like to admit. Furthermore, the idealised vision of a locally produced, efficient and tailored part tends to forget the time, effort and amount of iterations usually required to produce a successful 3D model (Killi, 2017).

Once a suitable niche is identified, namely, when there is need for customised parts in a middle-range production volume where the price of the part allows for the development process, then AM makes perfect sense as end-product. This has already happened in objects which are small, expensive, and benefit from customisation, such as hearing aids (Killi, 2013). Beyond these very narrow spaces AM still struggles to establish itself though.

The previous analysis regards mostly industrial production. What happens at the other end of the spectrum instead? Could the crafts not be interested in AM as well?

Machine-made crafts

> *"The greatest dilemma faced by the modern artisan-craftsman is the machine. Is it a friendly tool or an enemy replacing work of the human hand?"*
>
> Richard Sennett (Sennett, 2008)

In his extensive crafts' analysis, Sennett reflects on the introduction of machine production. The cold, mass-produced perfection, opposes handwork's irregular but warm soul. He quotes an Encyclopaedia article on glassblowing: *"imperfect, handmade glass has virtues: these are irregularity, distinctiveness, and what the writer refers to vaguely as character"* (Sennett, 2008).

Yet, as we have seen before, AM is certainly not a good example of mass-produced perfection. Firstly, AM's output does not come in mass volumes. Secondly, irregularities, layers, filaments and support-structure scars are quite a quintessential trademark of it. [3] Could AM be too irregular to be accepted as a valid industrial end-product and at the same time too precise to be discarded as a legit craft? Looking at both ends of current market's spectrum -crafts and industrial production- it would seem this is the case. Yet I would like to argue this should not necessarily be AM's future, appreciated only by techy makers and figurine collectors. The fact that we have insofar failed to accept and embrace AM's character does not mean that it doesn't have one.

At BIT's 2018 World Congress of Smart Materials, Dr. Brando Okolo reported that one of the early concerns regarding the 3D printed PEEK prothesis they were producing was to reduce the surface roughness. Their parts were manufactured with top-quality, extremely fine filaments, yet the results were nowhere near the smoothness of standard casted pieces. It was only after a surgeon asked them not to polish them because a rougher surface increases biological adhesion, that they realised this was a feature rather than a flaw (Philipp et al., 2018). This possible advantage has been previously mentioned (Reeves, 2013) and is now being integrated as one parameter to manage in order to optimise prothesis tolerance and adhesion (Shilov et al., 2022). Similar analysis have been carried out, for instance, aiming at make smart use of SLS' natural porosity to develop sound-absorbing objects (Zieliński et al., 2022).

Figures 1 and 2 show a simple earring design oriented in slightly different angles on an FDM printer. [4] The different orientations result in different surface patterns. If consciously used as an aesthetic element, the ugly duckling output of the cheapest desktop 3D printer may turn to have a character. Furthermore, in this case a "silky" a character that could not be produced either by hand or through mass production.

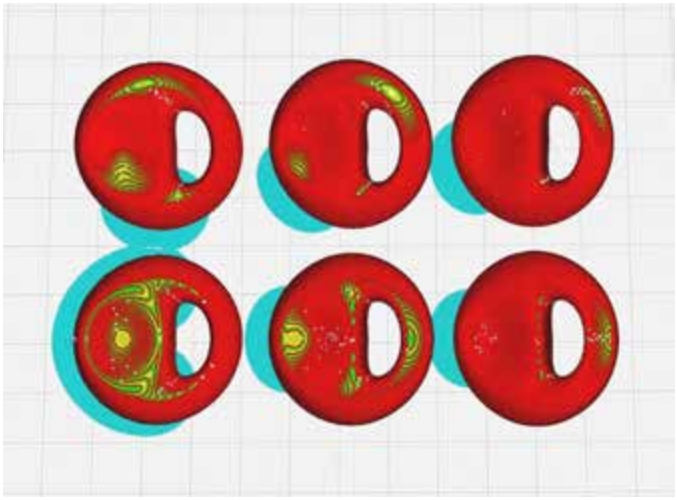

Figure 1. Simple earring with different orientations at the printing bed. Design and photo: Ricardo Simian, 2022

The ceramics department has been more open to embrace the new materiality which 3D printers can offer. Maybe because each clay 3D print ends up being truly unique no matter how reliable your materials and hardware are? Extruding ceramics almost looks like a living process, where minuscule bubbles and irregularities in the mix can lead to notoriously divergent results, if you manage to get to the end of the print at all. Plenty of artsy examples on this regard can be found on Pinterest and similar platforms. It seems like clay artists have less of an issue in accepting this machine as an extension of their hand instead of a replacement.

3 In his 2018 book Stephen Hoskins dedicates a full chapter to AM crafts and craftspeople, yet without mentioning a single time flaws, irregularities, imperfections nor shortcomings of the technology. On the contrary, the whole analysis focuses on case studies where AM methods are used to produce complex designs, suited only to CAD modelling and high-end design boutiques. Hoskins, S. (2018). *3D printing for artists, designers and makers* (2nd ed.). Bloomsbury.

4 FDM stands for "fused deposition modelling", the AM method where material is extruded through a nozzle. This technique encompasses a large range of applications, from small plastic desktop printers to large concrete-pouring machines and is one of the most widespread AM methods. Savini, A., & Savini, G. G. (2015, 18-19 Aug. 2015). A short history of 3D printing, a technological revolution just started. 2015 ICOHTEC/IEEE International History of High-Technologies and their Socio-Cultural Contexts Conference (HISTELCON)

Figure 2. FDM earring printed in different orientations.
Design, 3D print, and photos: Ricardo Simian, 2022

Figure 3 shows a 3D printed clay cup alongside the original 3D model. The modelled overhanging circular rings of the 3D model become irregular blobs and waves in reality, producing a semi-regular, not entirely predictable pattern. Through this production methods, can't we aim to enter the realm of the character-producing irregularities and distinctiveness which the Encyclopaedia praises on traditional glass blowing?

Jibbe van Schie's project "Woven translations" (Figure 4) interlaces ceramics and textile tradition through a self-assembled, multicolour clay 3D printer. *"My ceramic printer makes use of a process similar to the way tapestries are woven. Every colour is present at all times yet an image is created by bringing one of the colours to the surface"* (Van Schie, 2022).

Gartner's hype cycle explains that every emerging technology will experience an early peak of inflated expectations, a trough of disillusionment and a slope of enlightenment before reaching a plateau of productivity (Steinert & Leifer, 2010). AM has followed a very messy hype cycle and different actors will passionately argue that we find ourselves in entirely different points of the curve right now. I would argue that different niches have experienced almost independent curves, each field learning on its own time what must be learned to reach a plateau of productivity. Many fields, including AM crafts in general,

Figure 3. 3D printed clay cup with semi-regular patterns alongside the 3D model which was fed into the printed. Design, 3D print, and photos: Ricardo Simian, 2022

Figure 4. Woven translations designs by Jibbe van Schie.
Design, 3D print, and photos: Jibbe van Schie, 2022

have certainly not yet achieved that goal, otherwise the crafts market would look different today. Embracing the materiality which naturally comes out of 3D printers and developing aesthetic values may well be an important part of this long, raising slope of enlightenment.

The provided examples regard FDM-made objects, yet the analysis of the flaws and possible uses of them as advantages is not only limited to this technique. As previously mentioned, SLS provides rough and layered surfaces by nature, while SLA for most models require support structures which must be removed, leaving scars behind.[5]

It could be easy, and tempting, to reduce the mentioned shortcomings of AM to FDM only, or to wish that future developments will make them disappear altogether. SLS, SLA and all other AM methods have their unique finishing trademarks, which makes them inherently different from traditional mass-produced objects. It is true that AM's quality has increased since its origins, yet within any foreseeable development the basic elements of it -be it extruded textures, layers, or granular-sprayed surface roughness- are here to stay. Further research and analysis are required to discuss all of AM's existing techniques to the depth provided for FDM within this paper.

Additive manufacturing as an artistic tool

> *"I am not looking for the perfect print, actually, when the print is done I am not that interested in it anymore."*
>
> Sigrid Espelien (Espelien, 2022)

Norwegian clay artist Sigrid Espelien, currently PhD fellow at the Oslo National Academy of the Arts, goes beyond the use of AM as a method for artistic production to elevating the printing process into an artistic ceremony. *"Sometimes I think about it like watching a fire, because you don't know... when you are always printing new files you don't know how the printer will move and this collaboration with the machine -because you have to work together- becomes a very intimate process"* (Espelien, 2022).

In a techy field, where speed and efficiency are taken for granted as goals, Espelien's appreciation of the slowness of the 3D printing process is refreshing. Who could have thought that the romanticized vision of the artistic craftsman blowing glass, weaving on a loom or turning ceramics could be applied to the interaction with a 3D printer. *"It feels like a very sacred moment, or that I am actually finding a way to get closer to*

5 SLS stands for "selective laser sintering", a layer-by-layer, powder-based AM method. SLA is the abbreviation of "stereolithography", also a layer-by-layer process using photochemical reactions to solidify liquid resins. Ibid.

Figure 5. Photogrammetry from Bjørvika's Palèhaven shopwreck archeological excavation site, 3D printed in clay with the permission from the Norwegian Maritime Museum (detail). 3D print and photo: Sigrid Espelien, 2019

the landscape... because I can see it from the inside... I'm also thinking about how can I share this experience with people, the printing in itself, because is something that people feel distant from" (Espelien, 2022). Figure 5 shows a detail from one of Espelien's artistic readings of a landscape through AM.

This emotional appreciation and understanding of the printing process brings us back to the aesthetics question posed before. Once an object, and the production process behind it, are experienced as emotional, the discussion regarding its validity ends. The questions emerging from the artistic evaluation of an object or action may lead to a different, and endless, rabbit hole, but they shift the whole debate to a different dimension, away from the technical and ethical complaints aimed at AM as a production method listed before.

The archetypical debate on tradition vs innovation, man vs machine -of which 3D printers seemed to be doomed to become yet another iteration- entirely dissolves if AM becomes tradition. Clay turning was once a technological innovation, as opposed to the traditional approach for vase production by rolling a "clay rope" (Sennett, 2008). Clay 3D printing, and FDM 3D printing methods in general, brings us back to a filament/rope deposition method. Could this be treasured as a return to an ancient tradition? Maybe yes, but only if the crudeness of FDM's production methods is not only acknowledged but also emotionally embraced, as Espelien proposes.

Conclusions

Much attention has been given within the AM community to the technical improvements achieved, each of which moves us closer to the 3D print utopia, where high-quality mass production has become a daily, possibly even home-desktop reality. This is very understandable for an emerging technology struggling to define a niche for itself. Even more, it is the least we should expect from a set of technologies which have been introduced to the public as nothing less than the next industrial revolution.

Failure to deliver this dreamt utopia must not be necessarily understood as going back to the drawing board and restarting from scratch though. All the contrary.

In a recent conference at Stanford University Peter Thiel pessimistically stated "they promised us flying cars, and all we got was 140 characters". The backlash didn't wait, arguing that indeed we didn't get flying cars but we have now things like the internet and smartphones instead, and when offered the choice between those most people would choose our pocket-sized supercomputers before heavy hardware constantly speeding over our heads (Pooley & Tupy, 2022).

Similarly, 3D printers will likely never be the magical, multi-purpose, home sci-fi machines which would solve all our needs. Actually, if we think better of it, even if such machine could be produced the annoyance of having to shop products would only be replaced with the annoyance of having to shop printing cartridges and printing files. Plus dealing with the maintenance of the machine. Not a great step forward I would say. Independently from that, we didn't get such machines, but we got a new way of producing things, with an entirely new set of proprieties, pros and cons. We can either complain about them not being what we dreamt of, or we can start making wise use of them as they are.

One of the main focuses in the AM environment are developments in delivered quality, meaning machines are getting better in producing what customers would like to receive and we appreciate every improvement. This fact alone shows that there are evident issues and flaws in current AM. I propose shifting the attention from the ideal quality customers would like to see -which has been shaped after mass-production standards and aesthetics- to the qualities that AM spontaneously provides instead, developing new design paradigms from them.

One key element of making good use of the new available possibilities regards developing an idiomatic aesthetic which emerges from the technical possibilities of the technology, embracing its flaws as an intrinsic part of it. Once this process takes place flaws can become possibilities, features, or even character.

A further step on this line goes directly into artistic territory, when the production process itself acquires a value which goes beyond the industrial link between idea and finished object.

Further technological developments may arrive in the AM world, and they will be certainly welcome. In the meantime, there is space for further applications of the tools we have at hand today, something that is more likely to happen if we understand them precisely in that manner: tools in our hands.

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Designing smart product-service systems for smart cities with 5G technology: the Polaris case study

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Abstract

This paper explores the issue of the role of design and digital prototyping in the development of product-service systems in the smart cities, particularly concerning the spread of wireless connectivity technologies such as 5G and their use for innovative orientation and displacement purposes in urban contexts.

The first part of the paper reviews the technical and scientific literature to recount the main technological developments in smart cities with particular attention to the introduction of 5G to navigation systems. The second part analyzes a short collection of use cases to build smart systems for navigating, guiding, and orienting people in complex spaces. The collection and analysis of the cases help to identify the role of design (in the development of product-service systems for smart cities. The third part recounts Polaris, an interdisciplinary project involving design and computer science to develop an indoor navigation system designed for a smart university campus and smart cities. The project aims to realize tangible outputs that demonstrate the great potential offered by 5G, an intangible technology, which needs appropriate communication to future users. To do this, an advanced product/service has been designed, developed, and implemented capable of fitting into citizens' living spaces and environments, adapting, and supporting the end users who "inhabit" them. The conclusions present a critical discussion on the opportunities and limitations encountered when the design is faced with the conception and implementation of project outputs to foster the acceptance of technology.

Keywords

5G Technology; Smart Cities; Smart Direction; Internet of Things; Prototyping; Digital Fabrication

Introduction

Old-world cities are urban conglomerates, resulting from the stratification over time of cultures and inhabiting structures of various types and natures. Over time, the general needs have changed, evolved, and reconfigured, but only since the last century, at the end of the great world conflicts and thanks to the spread of large-scale self-aware medicalization, the implementation of security systems, and the creation of social, artistic, and cultural networks (Li et al., 2016), it's unimaginable that there should be large empty spaces to be designed and built from scratch to respond to the new modern demands. An estimated 70 percent of the global population would be urbanized by 2050 (Lierow, 2014); a percentage that rises to 80 percent when considering just the European scale, which faces a prediction that 97 percent of buildings will have to undergo extraordinary maintenance or heavy renovation within the next 30 years (Beson et al., 2020). A transformation of this magnitude can be supported by the Internet of Things (IoT), which allows us to modify and transform the way we interact with our surroundings. Through the appropriate use of IoT, indoor and private spaces in homes already have acquired *smart* characteristics due to a multitude of small, low-cost, connected computing devices that can detect, process and report environmental data to cloud/internet services. However, this enabling dimension offered by technology (meant in its more confined digital dimension) when scaled in the urban dimension, clashes with a reality oversaturated by buildings and infrastructure built according to logics no longer in line with the needs of the present and even less with the ones aimed at for a more sustainable future. Hence the need to create demonstrators of possible smart solutions for Smart Cities, which are places where traditional networks and services are made more efficient with the use of digital solutions for the benefit of its inhabitants and business (European Commission, 2023).

Smart Direction in a Smart Campus

University campuses can offer a functional response to this kind of need, as they appear to be of particular interest for simulating and testing the effectiveness of projects aimed at scaling in Smart Cities (Min-Allah & Alrashed, 2020). Indeed, university campuses imitate cities in many ways: they generally extend over a large urban area, are composed of many different types of buildings (administrative buildings, laboratories, classrooms, residences, bars/restaurants) and popu-

lated by different types of people/users (Longo et al., 2021). At the same time, they turn out to be more controllable and manageable places at the level of actors involved and from the point of view of readiness for technology adoption, even when not fully mature. For this reason, recent studies and test-level applications have already been carried out to transform these places into Smart Campuses, particularly with: smart parking systems (Mohandes et al., 2019; Nagowah et al, 2019), microgrids (Alrashed, 2020), smart libraries (Antevski et al., 2016; Chan & Chan, 2018), classroom monitoring and occupancy estimation systems (Longo et al., 2020; Tse et al., 2021), and other sustainable solutions (Villegas-Ch et al., 2019; Ceccarini et al., 2021). To infuse these places with intelligence, it isn't enough to equip them with advanced technology, but it is necessary to develop a meaningful design around its use. This is where the service dimension plays a crucial role, not least in making the technology usable (Brettle et al., 2020), because the more it evolves and becomes performant, the less comprehensible it is if not linked to concrete and tangible results that demonstrate its effectiveness. This is especially relevant when it comes to 5G technology (Pujol et al., 2020), on which the main innovations in Smart Cities are expected to be based; however, its markedly intangible dimension makes 5G difficult to understand for the general public, which often sees it as an invisible enemy to be opposed. This widespread idea is difficult to eradicate, despite its lack of support from any scientific evidence, which on the contrary fights to prove exactly the opposite with analyses and reports commissioned by the governments (Camera dei Deputati, 2020). In particular, in the Italian landscape, evidence-based arguments do not turn out to be effective, where a large segment of the population (and therefore of the potential 5G users) does not place trust in this type of narrative stage. Thus, the demonstration of possible applications of 5G, through *use cases* of related services and products, assumes a relevant role in promoting faster and more functional technological development, as well as in countering the latest social resistance to this technology.

In this framework comes the Polaris project, developed by Polifactory and AntLab at Politecnico di Milano, which aims to propose an indoor navigation system capable of guiding users within complex buildings and structures, orienting them in horizontal and vertical movements in search of spaces located in different areas or levels. Polaris is the result of collaborative and interdisciplinary work, in which researchers with expertise in Design and Electronic and Information Engineering worked in synergy to create an efficient and functioning solution both at the level of system architecture and from the perspective of user interaction. The phases of conception, development, prototyping and verification, presented in the following sections, offered relevant insights identified in the final conclusions.

Smart Direction case studies toward bounding project requirements

This part presents the qualitative analysis of case studies as a strategy for State-of-the-art mapping and is used to support the designing part of the final solution. The case study method enabled the identification of "the "what" is being observed and the "how" it is being detected and the reasons why, in order to understand the role of design in the development of product-service systems for Smart Cities (Cohen, 2015). For their identification, desk research was conducted in order to collect tested product solutions or prototypes for navigation in the city. All projects stuck at the concept stage were not considered because the parameter of technical feasibility was given priority. The result are six case studies of projects that share a digital or service dimension, and sometimes have proprietary hardware that is functional in optimizing the use of the entire system. A summary of the six selected projects can be seen in Figure 1.

Figure 1. Chart summarizing information about the six case studies investigated.

More in detail, the first case is Dynamic Street (01), a signaling pavement made of hexagonal modules, equipped with light actuators. The grid modules can take different configurations and also host a plug and play element, i.e., a vertical structure equipped with accessory functions. This is an innovative project that, starting with a static non-wearable element, allows the spatial rearrangement. However, the lack of smart elements for transmitting and receiving data, does not allow the individual user to set customized paths to reach a specific touchpoint. The second example deals with the implementation through augmented reality of the Google Maps app (02) for outdoor walking navigation. To take advantage of this functionality, the user needs a smartphone compatible with Google's ARKit and ARCore, through which the association of the real environment with the digital one previously scanned by a Google Car takes place. The project is very interesting, especially in terms of reaching a touchpoint, but at the same time it has limitations in use because it only works outdoors and requires constant use of the smartphone with the camera on, which results in high battery consumption. Indoor Map (03), the third case study, enables the creation of detailed interactive and customized maps of interiors of public-use buildings to help visitors locate and reach points of interest. The interesting aspect revolves around the proprietary software that makes it possible to build a new map by following a few simple instructions, without the need for intervention by specialized technicians. Unlike the previous one, this case study works only in indoor environments; moreover, it works only after the user sets an itinerary. Beeline (04) is a navigation device for cyclists and motorcyclists, which displays a kind of compass that points to the destination previously set via a paired smartphone. While this solution promotes immediate directional readability, it doesn't optimize the navigation route, which in any case cannot be changed except via smartphone. The patent filed (05) by Amazon of a wearable device for identifying items inside the multinational corporation's warehouses is the fifth case study. Through haptic feedback, this solution lets the workers know if they are pointing their

hand to the correct stall. The interesting aspect of this system is that it uses a series of sensors located in the warehouse to locate the picker, who can move without consulting a screen and thus have maximum prehensility. The latest example is Garmin Varia (06), which is a bicycle radar that can signal the rear approach of vehicles from 200 meters away. The product also has a function for group pedaling, in which it bypasses the presence of other cyclists in its slipstream. This last example is interesting because it combines spatial feedback with the promotion of road safety.

Case study observations

The presented navigation systems are structured through three different needs, sometimes in combination: reaching a point, exploring an area or avoiding something. Remarkably, in terms of connectivity, none of the selected cases employ 5G technology, which, however, could be implemented to increase system stability and reduce data transmission latency times. Therefore, 5G should be considered as a concrete possibility for the scalability of the analyzed projects, as well as a solid base on which to structure proposals for new solutions useful for indoor navigation. Thanks to the outcomes of this reconnaissance, it was possible to conceive, design, prototype and test an indoor navigation system based on the use of 5G technology with the goal of simultaneously guiding multiple users to a customized touchpoint (unlike the 01 case), without the constant use of their smartphones (02 & 03 cases) as well as other personal (04 & 06) or corporate (05) devices.

Polaris: the Smart Direction System

Using the insights gathered from this reconnaissance, the Polaris indoor navigation system was designed and fabricated at Politecnico di Milano throughout "Base 5G" project, and then installed and tested on its Leonardo Campus, in order to provide a tangible demonstration of an intangible technology (Capdevila & Zarlenga, 2015). Polaris makes it possible to guide users within complex structures by orienting them in horizontal and vertical movements to search for spaces located in different areas or levels. This is possible thanks to a system consisting of a series of devices placed in the environment, the anchor nodes, capable of locating users as they move through the location. Such devices communicate via 5G technology with a control center that implements machine learning algorithms to continuously track users and, based on the users' location, controls beacons that guide them to their final destination. These beacons of light, the effector nodes, are also connected to the control center via 5G technology. Researchers from the area of Design and the area of Electrical and Information Engineering collaborated among themselves in the creation of the entire system, realizing: the logic at the control center, the technological infrastructure of the array devices (anchor and effector nodes), the study of their design according to versatility in different installation environments, the production by additive manufacturing of the necessary components, and the subsequent assembly.

Polaris system operation

Polaris is made up by a series of IoT devices spread throughout the indoor space interconnected through 5G technology. After an initialization phase in which the user signs in to the smart direction service, the system locates and tracks the user's position in indoor spaces through anchor nodes and returns navigation information to him/her through light indicators placed in the environment (effector nodes); hence, the person can be guided to his/her final destination without having to continuously observe a map on the smartphone. The anchor nodes operate through Raspberry PI4 equipped with BLE and WiFi communication interfaces to enable location and tracking of the user on the move. They scan Bluetooth Low Energy beacons sent by the user application, send messages to the control center through the communication system regarding the current location of the user(s). The effector nodes are composed of Raspberry PI0 and LED arrays, displaying navigation directions for users on the move. They receive commands from the control center to activate/deactivate the LED interfaces, on which specific indications are generated and recognizable by each user. The nodes are connected via WiFi technology with 5G CPEs. The 5G CPEs leverage 5G connectivity to connect the field network (anchors and effectors) with the control center. The control center receives messages from the anchor nodes notifying the current location of the users to be tracked, calculates the location of the users, works out the best path for each user based on his or her final destination and other context information, then commands the turn on/off of the effectors.

The service design part of Polaris

The architecture of the Polaris communication system is realized through a modular product to be placed in spaces, and an application through which to access the overall service. Polaris activation requires initialization through a user interface, which consists of an application installed on the personal smartphone.

The app allows users to register for the smart directions service by indicating their required destination and if needed other contextual information. The Polaris app can be integrated with the one for accessing university services (Figure) by then importing information from the associated database (calendars, exams, student/faculty profile, academic platform, floor plan of classrooms and common spaces, etc.) to which it then adds the smart indoor navigation system. The app allows the user to select his or her destination through three search modes: a *default* search (the user knows his or her destination), an *automatic* search (the user has an event saved on his/her calendar scheduled at a certain location), and finally a *suggested* search (when the user is looking for a particular type of service along the way).

Figure 2. Some screenshots from Polaris' Smart Direction app.

The product design part of Polaris

As mentioned before, the hardware part of Polaris consists on a modular product to be installed within the spaces to be navigated. The final design of the installed object (Figure 3) was designed for maximum flexibility and adaptability to very different spaces as well. Indeed, instead of making different objects for the anchor and effector nodes, the choice was made to design a structure of interconnected tubulars via tetrapod-shaped hollow joints, at the ends of which to place and orient the number of anchors and effectors necessary for the system's operation. In this way, we designed a product capable of adapting to the different layouts of buildings, and of being able to be flexibly fixed according to the material and architectural constraints. Thus, the density and type of hardware nodes to be placed in the space can be optimized. All nodes are designed to allow maximum accessibility to internal electronic components for updating and maintenance. The use of interconnected tubular elements to make up the entire system occurred to facilitate the wiring of all elements and can be sized in length to suit specific space needs. The usage choice of a connection via tetrapod joints was guided by the need to be able to provide directions both in architectural interiors with orthogonal grids and with more organic layouts. Attachment of the structure can be to ceiling, wall, stand/ground, and in all cases by means of screws/dowels or clamps, depending on the characteristics of the support and whether or not irreversible action can be taken on it.

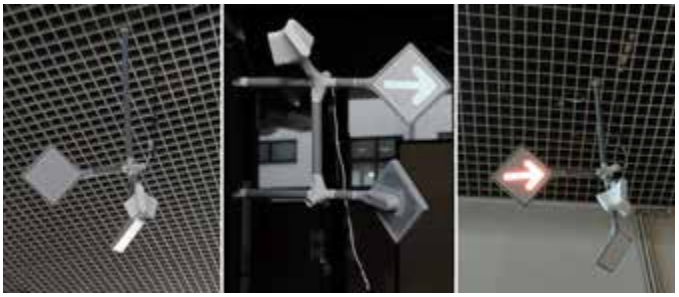

Figure 3. Polaris installed and tested at Building 11 of the Politecnico di Milano, Campus Leonardo, covering an indoor area of about 500 square meters on two floors.

All of these design choices were made with the clear goal in mind of making a working prototype through the technologies available in the university makerspace. Therefore, the product development phase was made by relying on the constraints of FDM and SLS 3D printing and laser cutting technologies. The design aspect, however, was developed to make the product also manufacturable by more traditional manufacturing technologies, such as injection molding, to facilitate the possible industrial scalability.

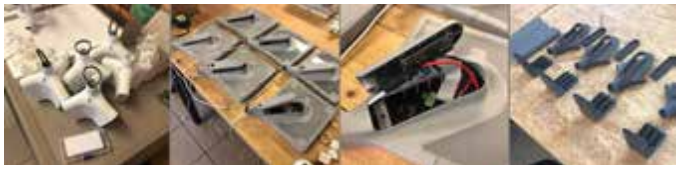

Figure 4. Polaris' prototyping phase.

The content of the pop-up indication on the LED matrix was also the subject of design, to ensure good readability of information, taking into account multi-user. The control center, recognizes the number of users searching for a different destination simultaneously and, thanks to machine learning, assigns a different color or symbol to each user upon login.

Conclusion

This project was positively evaluated by the grant committee as being able to comprehensively address and solve the challenges of both implementing a new technology in a working prototype and managing simultaneous multi-user navigation with a product/service that doesn't force users to use advanced information through a smartphone screen. During this experimentation, it was possible to see how, in the development of technologically advanced devices, a design-driven approach takes a central role due to the designer's ability to manage complexity and become an interpreter and translator of languages and processes. An advanced system architecture has taken a flexible and functional form to the needs of different indoor spaces and especially the users with whom it interacts. The developed service and app put usability at the center, as a technology must be immediately understandable and able to respond to user needs effectively through interactions that avoid slowing down people's lives in order to be accepted (Arthur, 2009). Hence, we can state that the outcomes of this challenge have shown how important is that the designers be recognized as a possible enabler of techno-innovation due to their distinctive interpretive ability and sensitivity.

Acknowledgments

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Fantastical Reality: designing virtual urban space through extended reality

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Abstract

The rapid advancements in Extended Reality (XR) technologies and their integration into the urban design process bring the definition of 'space' and its production to the forefront, where a new type of designable space that accompanies, surrounds, and complements physical urban interventions emerges: the virtual space. XR technology has opened up new avenues for creating virtual content in urban contexts. However, despite the potential for XR to fundamentally alter how we create and experience urban environments, there is a lack of literature on how to use XR to create immersive and accurately placed virtual experiences that complement our physical urban realities.

This work aims to address this gap in the literature by exploring the potential of XR technology, specifically AR, for designing virtual urban space. The study follows a Research through Design approach (RtD), materializing findings through an experimental project in the form of a mixed-reality application that augments the city of Tampere, Finland. The developed application introduces virtual urban space as a space for cultural and artistic co-creation, offering the public a tool to reshape and envision their city through the lens of Augmented Reality (AR).

This work offers insight into the latest tools and software development kits (SDK) used to augment large-scale urban areas. It proposes a solution for accurately placing virtual content in urban environments, and presents considerations for designing virtual urban space, as well as current technology limitations and future research avenues.

Author keywords

Virtual Space; Urban Design; Extended Reality; Augmented Reality; Visual Positioning Systems

Introduction

In today's world, ever-evolving technologies have seemingly swept the globe, blurring the line between what is real and what is not. This sensitive interplay between the physical and the imaginary has touched upon many aspects of our everyday life and has, in some cases, formed a new framework for understanding the world around us; creating novel ways to experience ordinary things.

Recent technologies have made it possible for different realities to exist and merge with the one we live in and interact with. The term Extended Reality (XR), an umbrella term that comprises Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), but is not limited to these three, has come into existence and people are slowly escaping everyday life into this newly emerging form of reality that can be designed, adapted, and harnessed to improve the way we experience our surroundings (Liu et al., 2017).

XR technology has opened up new avenues for the creation of virtual content in urban contexts. However, despite the potential for XR technology to fundamentally alter how we create and experience urban environments, there is a lack of literature on how to use XR to create immersive and accurately placed virtual experiences that complement our physical urban realities.

This work aims to address this gap in the literature by exploring the potential of XR technology, specifically AR, for designing virtual urban space. The paper begins by reviewing the existing literature on XR technology and its use in urban design and envisioning future urban scenarios. It then presents a case study in Tampere, Finland that showcases the potential of using XR in designing virtual urban experiences while presenting the latest tools that facilitate this process. Finally, the paper discusses the opportunities XR technology offers and provides suggestions for further research in this area.

Background

The use of AR for Urban Design: Definitions and Justification

AR systems are those that allow real and virtual objects and information to coexist in the same space and provide real-time interaction. They allow the user to view the real world with overlaid virtual objects and enrich the user's experience and perception of reality with additional information. However, AR does not replace the real world as in the case of Virtual Reality (VR) (Redondo et al., 2017). According to Klopfer and Squire (2008), AR could be defined as "a situation in which a real-world context is dynamically overlaid with coherent location or context-sensitive virtual information" (p. 205). It is the synthesis of computer images in the real world (Zachary et al., 1997). And it can be identified by three basic features: 1) It combines real and virtual environments, 2) It is interactive in real-time, and 3) It provides accurate three-dimensional registration of real and virtual objects (Azuma,1997). Mobile

Augmented Reality (MAR) provides the aforementioned features without constraining the individual's location to a specially equipped area. It can be used anywhere, allowing the user to access AR experiences and add layers of information to any environment anytime through mobile devices (Höllerer and Feiner, 2004).

AR and VR share some similarities in terms of immersion, navigation, and interaction (Redondo et al., 2017). Unlike VR, which completely immerses the user in a virtual environment, AR allows users to experience the real world through a virtual overlay (Bower et al., 2014). It is important to highlight that the main goal of a VR system is using technology to replace rather than complement reality and create a new immersive environment, while the main goal of an AR system is to enhance reality by overlaying it with virtual content in a complimentary non-immersive way that enriches the user's perception of the real environment (Billinghurst et al., 2015).

In a discipline such as Urban Planning and Design, in which spatial and contextual information are core components of professional practice, Squire and Klopfer (2007) suggest that AR applications hold a particular promise and provide enormous potential for enhancing the design process due to their ability to connect academic content and practices with our physical, lived worlds. Potts et al. (2017) mention a shift and a direction toward the integration of AR in planning and designing public spaces in the physical world, and emphasize the possibility that urban planners will need to engage in both, the physical and the virtual placemaking process in the future.

Augmented Reality in Urban Design

The introduction of Augmented Reality applications into the architecture and urban design study and practice has provided a new channel of interaction with the built environment and produced a need for a new set of skills and a higher level of digital proficiency alongside traditional paper-based design and analysis skills to be developed in order to utilize these tools to their full potential (Indraprastha and Shinozaki, 2009).

Billinghurst et al. (2015) expand on the significance of augmented reality (AR) in the fields of architecture, urban planning, and urban design by pointing out that while 2D plans can show a building's layout in great detail, it would be challenging for the client to visualize the building through 2D drawings. Physical models, 3D renderings, and interactive flythroughs can therefore provide a solution to this problem, but they are scaled-down representations of the final space. These might not accurately portray the building's final image, including its final scale and placement within the urban context. The use of AR allows users to view full-sized 3D virtual models of future buildings placed in their intended contexts. (Calabrese and Baresi, 2017; Redondo et al., 2017). This allows AR to be utilized as a planning tool, placing different variations of the same building on-site and allowing for stakeholders' feedback, collaboration, and participation in the design process.

In addition to serving as a tool for visualizing future projects and urban development scenarios, Mesárošová et al. (2015) present an example of an application used in Urban Planning education called "Visionary Cities" created by AR Group Manusamo&Bzika. Through AR, the application provides the possibility to view and explore cities and concepts that were never built and remained as sketches, such as projects done by Archigram (A neo-futuristic avant-garde architectural group formed in the 1960s (Sadler, 2005)).

Envisioning Future Urban Scenarios Using XR

In today's world, there is a need for new urban visions that address pressing urban issues, concerns, and transformations such as overcrowding, social inequality, environmental degradation, climate change, urban gentrification, increased refugee influx, increased surveillance, technology and the smart city discourse in urban planning, etc. (Sevilla-Buitrago, 2013; Leorke, 2020). Augmented, virtual, and mixed reality can be powerful and effective tools that support the conceptualization, visualization, and communication of imagined urban futures.

A study by Shawash and Marji (2020) explores the potential of Mobile Augmented Reality (MAR) technologies as a tool for public engagement with ecologically sustainable urban regeneration projects. They present two urban development scenarios for envisioning a greener version of the city of Amman, Jordan by virtually reintroducing the city's enclosed and dried-up water stream and proposing sustainable water management solutions through an interactive table-top AR model of the site. The study envisions "what if" scenarios of the city's only water stream, and uses AR to present this vision to the public, engaging them in the dialogue of imagining a greener, more sustainable future for their city.

A study by Thibault et al. (2021) proposes a fictional city, one that utilizes augmented city technologies "to produce creative and playful spaces for citizen–urban interventions" and places the people in the center of the place-making process. The proposed model uses the city as a resource for activities and initiatives that allow the people to shape their environment and envision shareable alternate scenarios, strengthening their right to be represented and to use the city. Residents can explore, create, and modify the city's virtual augmentations, and develop a sense of ownership over its public spaces (Thibault et al., 2021). The authors suggest that the required technologies that allow us to interact in unprecedented ways with the urban environment seem to be available and what is needed is to combine them in the right way.

The Challenges of World-scale AR

Calabrese and Baresi (2017) explore placing urban design proposals and student projects in an outdoor urban context in the city of Milan. They attempt to enhance the accuracy of placing virtual design interventions by detecting specific 3D models and using beacons (small, wireless transmitters that use Bluetooth technology to send signals to other nearby devices). However, the proposed solution adds additional complexity to the average user and requires the detected 3D object to be always in view.

Rohil and Ashok (2022) explore the use of building information modeling (BIM) software along with AR visualization to present two types of urban planning scenarios: the creation of new structures and the recreation of existing designs. They offer a more recent overview of the workflow and possible tools that can be used to integrate AR into architecture and urban design. Nevertheless, the presented results showcase a proposed design floating in space rather than being placed in its designated location and in the correct orientation and scale, and little is discussed on the potential of utilizing visual positioning systems (VPS) for enhancing placement accuracy and designing compelling virtual experiences.

Although many studies attempted to explore and use AR in the context of urban design and to augment urban space,

very few address the accurate placement of virtual content in urban areas. Whether the AR layer presented proposed buildings, urban development proposals, image/video overlays, creative 3D models, etc., its placement in the real world has faced challenges due to GPS and localization inaccuracy (Blum et al., 2013; Calabrese and Baresi, 2017; Redondo et al., 2017; Rohil and Ashok, 2022). The introduction of AR elements in urban contexts, whether marker-based AR (detecting a certain image or QR code through a device's camera to place virtual content) or marker-less AR (using a device's camera to detect vertical and/or horizontal planes or 3D objects in the surrounding environment to place virtual elements) or even location-based AR (utilizing specific location coordinates to load virtual content in specific areas), the placed virtual content in a large outdoor setting would shift, jitter, disappear, get misplaced, and move with the user's movement as they attempt to explore it.

Moreover, manual placement of large-scale virtual elements using a device's input (e.g., touch screen), such as buildings, urban furniture covering an entire street, indoor virtual content, etc. is inefficient and poses additional challenges and limitations to the users, especially if they are new to the technology and are not aware of the designer's decisions regarding optimal placement.

Another important consideration when designing XR experiences is the user's point of view (POV), which holds substantial implications for the design, perception, and overall efficacy of the immersive environment.

Utilizing a first-person perspective, or world-scale AR, enables users to perceive and engage with the urban environment from a human-scaled perspective, resulting in a more immersive experience. In urban XR experiences, the first-person perspective facilitates a more profound understanding of spatial relationships, architectural scale, and the experiential qualities of the built environment. This can offer insightful information on how people will use the built environment and how it will affect their perception of the area. This POV, however, can be constrained in terms of the quantity of data that can be concurrently displayed on the screen, which can make it harder to assess the design as a whole.

Alternatively, users are able to observe the complete area from a bird's eye view when using the third person perspective, such as in Tabletop AR, which offers a more objective and thorough view of the urban environment. the third-person perspective positions the user as an external observer, detached from the immediate context, and often overlooking the virtual environment from an elevated or distanced vantage point. This POV provides users with an overarching view of the urban fabric, enabling a more comprehensive understanding of the spatial structure, urban patterns, and connectivity. However, it may be less realistic and not as effective when expressing how people interact with the built environment compared to the first person POV and may reduce the sense of immersion and personal agency within the XR environment.

It's critical to consider which POV to use depending on the nature of the project and the desired feedback. For instance, first person POV might be more effective for assessing the pedestrian experience of a brand-new public space, while third person POV could be used for assessing the effects of a major development on the local urban fabric. The POV can also affect the usability and accessibility of XR technology for various users, the level of depth and accuracy necessary in designing the experiences, and the techniques used for evaluation and feedback.

The case study discussed in the following sections presents an example of utilizing XR technologies in co-creating virtual urban space. It explains the used tools and solutions for creating accurately placed, immersive virtual content in the city.

Methodology

This study draws on a comprehensive review of literature in the fields of XR technology, urban design and planning, as well as Human-Computer Interaction (HCI) and follows a Research through Design approach (RtD); "an approach to conducting scholarly research that employs the methods, practices, and processes of design practice with the intention of generating new knowledge." (Zimmerman and Forlizzi, 2014, p. 167). This work materializes insights and knowledge through an experimental project in the form of a mixed-reality application that augments the city of Tampere, Finland. The developed application introduces virtual urban space as a space for cultural and artistic co-creation, offering the public a tool to reshape and envision their city through the lens of augmented and mixed reality. To investigate the use of XR technology in designing virtual urban space, the presented case study involved observing and documenting the design process, the performance of the mixed reality application prototype, as well as users' reactions to it.

The ideation and development of the application prototype were done in the following steps:

1) Literature search on the use of XR in urban contexts as well as current challenges and technology limitations.
2) Identification of the latest open-source and available tools for augmenting city-scale spaces.
3) Schematic analysis of Tampere city's layout and optimal locations for introducing virtual content.
4) Informal interviews with local Finnish artists regarding the need for exhibiting their art in public spaces as virtual content.
5) Collection and design of context-specific virtual content to be placed in selected locations in the city.
6) Development and testing of the mixed reality application prototype using MAR and AR glasses.

This work aims to offer insight into the latest technologies used to augment large-scale urban areas, considerations for designing virtual urban space, as well as current limitations and future research avenues.

Case Study: the Tampere xRT Project

Tampere, Finland's third-largest city, is regarded as a hub for business, technology, and culture. The city is renowned for its cutting-edge technological research and advancements as well as its vibrant cultural scene, which features a wide range of museums, theaters, and festivals.

This project offers individuals access to alternative and novel viewpoints of the city that can enhance their daily lives by leveraging Tampere's diverse cultural experiences and the potential of XR.

By allowing users to shape their own virtual urban surroundings, the Tampere xRT project examines the idea of placemaking through XR and presents the city as an open exhibition. It offers a sustainable and accessible platform where local and international artists, cultural venues, and the public can share their visions of the city, by showcasing their art in virtual urban

space. The project explores how the public realm of Tampere can be co-created with XR through the collaboration of artists and the public.

Problem and proposed solution

For providing immersive and accurate AR experiences in outdoor urban settings, the project aimed to tackle the AR placement-accuracy challenges and offer an experience that can run on mobile devices as well as AR glasses. Different locations around the city were selected, those included a neighborhood park (Figure 1), a pedestrian bridge in the city center, and a landmark in Tampere's city center to explore the effectiveness of the AR solution in a 1) green setting, 2) an active pedestrian route, and 3) a distinguishable building and plaza. The design of virtual content in urban space not only provides a playful and interactive experience but can also enrich the public's perception of the city. This offers opportunities for visualizing future urban developments, historical information, and even fictional and fantastical scenarios as a form of speculative design that can widen users' imagination and allow them to rethink their surroundings.

Figure 1. Left: user viewing virtual content in a park using AR glasses, Right: the user's view through the AR glasses showing virtual 3D model in the park

Developing Urban XR Experiences: Tools and Technicalities

The project utilizes Visual Positioning Systems (VPS) to identify the users' location and accurately place the virtual content in physical space. The process begins with mapping specific locations in the city by using photographs, creating a spatial map and point clouds of the location, and extracting feature points that can be then detected, ensuring accurate localization (finding the position and orientation) and placement of the virtual content. For this process, the "Immersal" software development kit (SDK) was used, and the created maps of the scanned locations were then inserted into "Unity", a game development engine, for designing and determining the location of the virtual content that will augment the physical space (Figure 2).

The Immersal SDK facilitates the process of creating location-aware spatial environments using any mobile device, offering fast visual positioning with low system overhead. It enables devices to precisely locate and orient the users' view in the physical world, allowing accurate placement of persistent virtual content in their surroundings.

In addition to using the Immersal SDK, Google's Geospatial API recently released in 2022 was also used to add 3D virtual elements in locations that were not priorly scanned using Immersal's tools. Google's Geospatial API allows developers to use Google's pre-scanned data and feature points used in Google Street View AR to accurately place virtual content in any place in the world. However, the capabilities offered by Immersal's mapping tools by scanning specific building facades offer element-specific augmentation. This means that virtual content can be placed on certain windows, walls, ornamentation, roofs, etc.

Nevertheless, the localization of the devices faced some challenges after sunset, since the spatial maps were created from images captured during the daytime. This was resolved by mapping the environment at different times of the day to capture the context in different lighting conditions and ensure correct AR placement and environment detection in all settings.

The projects' results were shared with the public, as well as Tampere's municipality and multiple cultural venues including the Tampere theatre, Tampere Art Museum, and Tampere City Library, which all presented a positive attitude toward the introduction of XR in the city and the proposed platform.

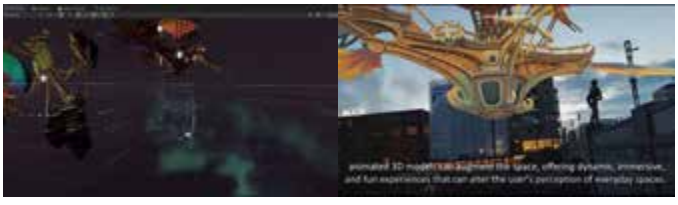

Figure 2. Left: Unity's work space showing the point clouds of the bridge and the placement of virtual content, Right: mobile screenshot of the bridge area through the AR app, showing the placed virtual content in its physical location.

Conclusion

XR technology is rapidly developing and the intersection between the real and the virtual is increasing at a quick pace. This study discussed the use of XR in urban contexts, the design of virtual urban space, and the tools available today to facilitate this process. Following an RtD approach, this work presented a case study that explores the latest software development kits for creating accurately placed AR content in large urban settings. Moreover, the study offered a possible solution for a challenge frequently faced while exploring the usability of AR in outdoor contexts.

XR offers great potential for the fields of architecture, urban planning, and design, and allows us to envision and experience future urban scenarios in real-time on-site and in full scale.

For architects, urban designers, planners, and other professionals involved in shaping the built environment, XR technology opens up new design options, promotes teamwork, streamlines decision-making, and boosts productivity as it can be connected with other technologies like Building Information Modeling (BIM), Geographic Information System (GIS), and Internet of Things (IoT). Additionally, by focusing on more immersive and interactive experiences rather than 2D drawings and models, XR has the potential to revolutionize the design discipline, resulting in new processes, tools, and techniques for design as well as new ways for practitioners and stakeholders to collaborate and communicate with one another.

However, the current state of XR technology, specifically MAR is limited by the utilized hardware and requires large processing power, which can result in low refresh rates, device overheating, and a lack of immersion for users with older devices. Moreover, further research is needed on designing good quality and context-specific virtual content for augmenting urban spaces without overpopulating them and creating visual noise for the users. Several social and regulatory challenges

are also presented when implementing XR technologies in the urban realm, those include but are not limited to accessibility, safety, privacy, impact on the built environment, as well as legal and regulatory issues, which could be explored in future research.

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The Metapolis – cities between a ripple and a blur

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Abstract

If the metaverse is the aggregated, embodied internet of experiences, applications, and products - a three-dimensional virtual world of decentralised interoperable networks, then, the Metapolis is the surrogate quasi-urban assemblage – a distributed scaffold and matrix of gateways and terminal experience architectures that coalesces in its wake. It contains the footprints, detritus, infrastructure and residue of our collective digital avatars and augmented experiences.

The Metapolis is without starting points or end points, an ambiguous and unstable category. The incumbent city and the Metapolis exist contemporaneously as contingent, unstable actions. The interaction between the post-industrial city, the metaverse and the Metapolis is not a logical Venn diagram but combustion. The city as particles and waves, that occur in superposition of each other, i.e., cities occupying the same coordinate infrastructures, organised by compatible data and metadata. Here, two seemingly distinct spatio-temporal phenomena converge upon the same reality, the conjuration and incursion of the 'built' environment into the internet.

The paper discuses s a conceptual framework and presents projects developed through a discrete combinatorial procedure - utilising data structures, spatialising APIs, point-clouds, and generative adversarial networks – an interface connecting the physical city, its digital twin and the open metaverse.

The Metapolis is manifested as a fluctuating spatio-temporal domain – a transient state between the incumbent city and the metaverse. Fundamentally, it is recognised as a 'realm' – operationally a physical territory and a formal category. It could be understood as a higher entity that provides a probability distribution and potential for the outcomes, mediating and inscribing the rules of play. It deploys a deep texture mapping – weaving together abstract and material signifiers. It appears as a seamless experience of consciousness – switching between, and burnishing over the folds amid real and symbolic, coupling the physical and virtual cities.

The Metapolis is an ordering of self-contained entities of functional significance. Complexity emerges from the consequential interactions of finitely bounded individual preferences. The city reacts more precisely to patterns and behaviours. Even objects are now subsets of the patters of utility. Emergent solution to emergent problems that, conserve historical layers. The Metapolis is the capacity to of urban infrastructures to abstract - a conceptual scheme to reconcile and map geography onto information, between the known and unknown. The metropolis and the Metapolis are a network of entangled infrastructures at a constituent level. They remain linked and share a common, unified state. Information and actions carry across the meta-physical breach. The Metapolis is an approximation and correlation to its physical counterpart.

Within this construct the paper also explores the potential for open-ended and user / operator / consumer generated architectures. As a spatial organised directory tree of information and unitary structure, the gravity of connections and intensity of uses delimit the temporal shape and form and restructure the potential of the city's network.

The research investigates the relationship between the embodied internet and its interaction with the incumbent city and the metaverse, and friction, challenges, and opportunities for machine intelligence in generative techno-social development.

Author keywords

Metaverse; AI; smart cities; digital twins; point-cloud; real-time analytics, urban narrative; cyber

Note: The style and language of the paper engages with the agency of critical, reflective, narrative, and descriptive text as well embracing socio-cultural and technological critique as a generative device for the qualitative design-research process.

Introduction

There's a world of goods and services, of extraction and making... and activities – Newtonian, Darwinian and perhaps Dickensian. Far beyond, there's an intangible sphere of hypothesis, conjecture and supposition – of accelerationism, dilation and escalation. Risk, liquidity, short sells, margin calls... volatility. Between, lies a proscenium where services are stages and goods are props. Sounds rather Machiavellian. Fungible commodities, tangible goods and intangible services synthesise a transactional event... i.e. the experience economy. The interaction between the two is not a logical Venn diagram but combustion. A breach that resists identity. This is the Metapolis.

Note, Clarification: The use of Metapolis, is the author - Ian Nazareth's own description of the term utilised in reference to the theoretical and design project, while Métapolis – references the use of the terminology by François Ascher

The economy emerges through intentional and arbitrary interactions and intersections of subjective factors, dispersed throughout a market and landscape of options. Usually, the city serves as the conduit and receptor for information encoding and extraction. Information is collected, categorised, and re-categorised at various scales and resolutions. The internet not only accomplishes this task but also feeds back into the city's physical substrate. This process produces an experiential reality that is both individual and collective. The challenges of abundance and scarcity reverberate back to the urban environment. There is no singular reality but an unavoidable technological singularity.

Data infrastructures, digital and physical artefacts - from low-poly forms to gradual high-resolution, high-fidelity architectures add a meta-layer, where forms become a representation of themselves, mirroring the technology that produces them. And vice-versa. The realm of the real and possible blur. The Metapolis occupies a conceptually flexible domain, to abstractly represent the city, in order to fully comprehend its potential. It is uncovering a future where variants can exist contemporaneously. It utilises spatio-temporal models of the existing as a comparative to manifold, heterogenous models for potential action and speculation. It creates a functional representation that stands in for the collection of objects and actions. It enables a city that senses far beyond normal limitations of the incumbent city.

The physical city in-turn provides a medium for strategic interactions with economic and other rational agents. The emergent choices are interdependent and produce outcomes corresponding to preferences - these outcomes are unintended or unknowable to the agents. (As discussed later, outcomes are contingent, and within certain parameters, possible only if they can be observed in the first place)

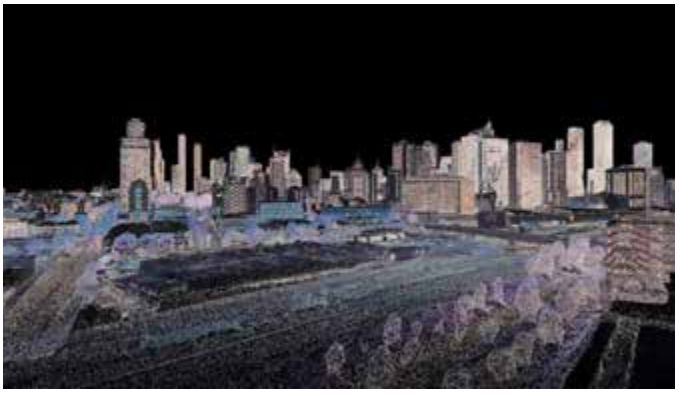

Figure 1. Visualising the temporal city through information modelling and data point clouds as a model of experiencing the mediated contemporary city. Image: Ian Nazareth and Lester Li. (Raw information extracted from the City of Melbourne LIDAR Point Cloud Data)

Deviation and slippage between the physical city and the virtual provide alternate modes of legibility. At present, it seems convenient that the two are not viewed or discussed in the same frame of reference. Its beneficial and indeed profitable to regard them as separate rather than coupled. The historic city *and* the benign metaverse. It is arguable naive, to assume the sensation to develop as separate categories, when in all likelihood, there is an embodied relationality, an eventual site of contestation rather than resolution. The relationship is likely exploitative.

Spaces in the Metapolis are hybrid and augmented world's spawned between a concept and experimental demonstration, between the real and unfathomable. It exhibits surrealism or the hyper-realist temperament subjected to a slow process of assimilation by a situationist impulse.

The Vector of Information

The balance of exchange is always weighed and measured, calculated, taking into account a relation without exchange, an abusive relation. The term abusive is a term of usage. Abuse doesn't prevent use. The abuse value, complete, irrevocable consummation, precedes use- and exchange-value. Quite simply, it is the arrow with only one direction. _ Michel Serres

With Web3, the incumbent city and the metaverse (internet) are now working on the same axis - to shape normative desire. 'Use value' and in ever increasing share – 'exchange value' are deployed as an immutable characteristic of late-capitalism. However, the dynamic is compounded by variables of 'sign value' (Jean Baudrillard's concept that takes into account the stature and status imparted, over the material, utility or functional value) - and Michel Serres' claim of 'abuse value' – goods and services of inadequate utility.

The divide between the physical and virtual realms - the fissure and the overrun - serves as a nexus of interaction and exchange, which is both necessary and perplexing. Traffic does not flow without friction or in a single direction; it may be asymmetrical. The urban environment, as well as the metaverse, could exhibit hyper-parasitism, where the host and the parasite are both parasitic entities. It is critical to acknowledge and comprehend the control, ownership, and directionality of information and material flow in both the digital and physical cities. There are finite physical resources directed to breed indeterminable exchange, sign, and abuse value. Once things are untethered from physical or material reality, the possibility of something emerging from nothing becomes viable. When the vector is reversed, inoperable and unserviceable elements become harmful and treacherous.

There is an unacknowledged friction between the city and the city. Between the physical, incumbent city and its digital twin, its internal representative model and the metaverse. Between physical artefacts and virtual avatars, between particles and pixels. Between clarity and allusion. Between matter and event. The opposite of network effects (any situation in which the value of a product, service, or platform depends on the number of buyers, sellers, or users who leverage it) is likely chaos theory and the butterfly effect (the idea that small things can have non-linear impacts on a complex system) Digital scarcity and exuberance meets real world serviceability and cultic hysteria.

What happens when trim of autonomous selfhood is peeled back? What if the physical city and the virtual metaverse compete for space, time, resources and your finite attention? What if they are adversarial by nature? What if the city is not synonymous with its digital self? What if the interde-

pendencies are burdening? What happens when the physical city loses its centrality?

Post Internet, Web3

Figure 2. User Interfaces and spatio-temporal architecture, of the post-internet and Web3, merge in The Crypto Miner's Share-house project. Image: Ian Nazareth and Jason Ho.

Post Internet Reality describes a period that corresponds to an extreme present where the internet in its every manifestation - its perception, influence, fragmentation, polarisation, disruption, accelerationism, and speculation - is the milieu. It is where and when the microgenres and subcultures of the internet influence the aesthetic, form, and relational hierarchies of the architecture of the city. The semantic web, blockchain, digital ownership etc., in their universality and omniscience, cannot be separated from political, cultural, and economic reality. It presents the multiplicative, ratcheting effect of combinatorial innovation. It is the emancipation and burdening of the infrastructures of the city. It is when the virtual is inapparent yet imperious.

Web3 is the ensuing restatement of the conceptual narrative of the internet. It is the internet as a topological entity, through processes of decentralisation and tokenisation, that anticipates the proliferation of transparency and ownership - an internet of value, and transactions at the speed of thought. It is the web that already fractionally exists, but also a medium that suggests an interoperability across platforms, systems, and protocols. New codes, technologies and platforms are each incompatible ecologies, with non-transferable assets, and it remain to be seen how these systems integrate. Nevertheless, they embody an ever-changing topography that might produce discrete ontologies, rather than a unification.

The paradigm of the Post Internet Reality implies that even seemingly radical technologies enter the common parlance. It represents a space that is physical, tangible space but also intangible paradoxical realm. The spaces are seemingly contained within the medium and format of their genesis, but escape the cliché of abstracted data, as they realise a philosophical, socio-cultural reality. Between non-space and a sensorial stimulation.

The following project elaborates on these ideas through the mode of design practice research.

The Metapolis and the Metablock

So, they used brick instead of stone, and tar instead of mortar. – Genesis 11:3

Early descriptions of the *'métapolis'* attempt to capture a multi-faceted city, generated by accelerated changes and hypermodernity in contemporary society, and consequent

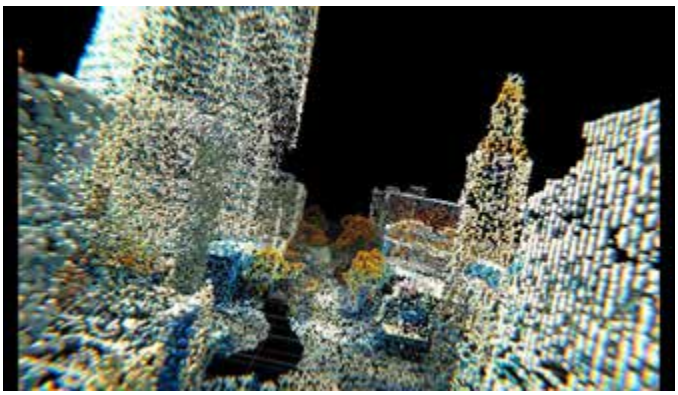

Figure 3. The Metapolis – visualized through modelling spatial architecture, meta-data and poin-cloud models where pixel refer to real-time usage statictics of programs within the built environment. Image: Ian Nazareth and Kevin Gao. (Raw data extracted from the City of Melbourne Open Data Portal, and City of Melbourne LIDAR Point Cloud Data)

transformation of the architecture of the city and urban arrangements. Urban sociologist François Ascher engaged the term *'métapolis'* to describe the phenomena of the urban experience that brings into view a discontinuous, heterogenous, networked model of the city. The spaces that make up a *métapolis* are highly mixed, though not necessarily contiguous. It extends beyond the conception of the metropolis. The Metapolis is extended and re-defined with the concept of the digital twins and the metaverse and utilised in reference to the theoretical and design project, while *Métapolis* is a reference to the use of the terminology by François Ascher.

The metaverse is not an escapism but an immersive interactive computer-generated reality where actions are performed. David Chalmers argues that virtual objects are real objects - that virtual reality is causal and real. It exists independently of us as individual or collectives and it's not an illusion. By extension, implying that interacting data structures are concrete, with evidence of cause and effect.

The conception of Metapolis subscribes to a scenario where entities have both spatial and temporal properties, substantive constraints and hence counterfactuals. To further interrogate and speculate about the concepualisation of the Metapolis, a block within the metaverse is utilised as an analogue to the city block in the physical incumbent city. As part of this project, data from the City of Melbourne (Australia)

Figure 4. The Metablock – speculative digital city block in the metaverse, where growth and behavior are products of a real-time patterns of occupation with its the analogous city block in the City of Melbourne. Image: Ian Nazareth and Kevin Gao. (Raw data extracted from the City of Melbourne Open Data Portal)

and the Digital Twin Victoria are utilised to build operative data models.

The city-block in meta coordinate space presents a quandary. Not only for a system to navigate a frontier of manifold potential, but a querying of the ontology of the urban block itself. While the architecture of the traditional city block in a city grid is a dogmatic hypothesis for action, of abstract appropriation and exploitative economic expression, it is firmly bound within extractive material logics and structural etiquette. Discrete econometric conditions, carefully contrived scarcity and decentralised property ensure that hyperbolic free market conditions prevail within meta-space as well. *But released from other bounded topologies and relational network impulsions, what forms the instructive conditions of spatio-temporal continuity in the meta block? What orthodoxies and archetypes will be revisited or generated?*

The dilemma for its spatial architecture begins with a challenge to orthodoxies of representations of formal characters that are in their new medium - immersive, experiential, spatial morphologies themselves. Unlike discrete representation, these are more immediate. The representation is the occupation. Space and time have a discursive relationship - as movement or mobility is perceptual and ambiguous, but also interactive.

Design is probabilistic or at the very least stochastic - generative conditions and communicative infrastructures that engender a likelihood of interaction, programmatic and social adjacency. Operationally and arguably, this is a qualitative, spatial agenda plotted on a probability matrix. Likelihood of encounters are increased by constraints of economics, scale, geometry, and materialism. Concentration is a human proclivity, recurrently mobilised through design. If the city is about the maximum things out can do in a day this poses further queries or variables - *Is the aggregate of (all) possibility conserved across meta and physical dimensions? And if possibilities are self-organised and limitless, what then defines a phenomenology? Or semiology? Are they closed loops or self-organised open-ended threads?*

The experience of the Metapolis is delivered across decentralised datascape through kinematic portals. These are frames that contain spatial references, the systems of motions and relative timescale. A realm where the city's geometrical description, is subjected to force and movement through its expanse.

Spaces and programs within the block are products of self-conditioned contingency - associative, proportionate qualities and relational responses to and within its locality. Contiguity and the capacity for concentrations, combinations, dilations and alterations are a response to adjacent stimuli. The Metablock is an ecology of immediacy and an architecture of spasmodic bursts, abrasion and contact where a series of local (near-field) changes organise within a spatialised data cloud of loosely organised simultaneous geo-local behaviours. Between clustering and void-ing, an emergent geometry of continuous transformations, foments.

Connected into the city's digital twin platform, real-time city infrastructure, and open metaverse the Metablock's growth, availability and structure is linked to real-time models of usage and occupation - some of these behaviours are amplified. The city and the Metablock are a network of entangled infrastructures at a constituent level. It offers a dynamic re-distributed of the infrastructures of the city - instinctive, instructive and reactive. It processes the circumstance, use and occupancy of the city, the overlaps, and breaks.

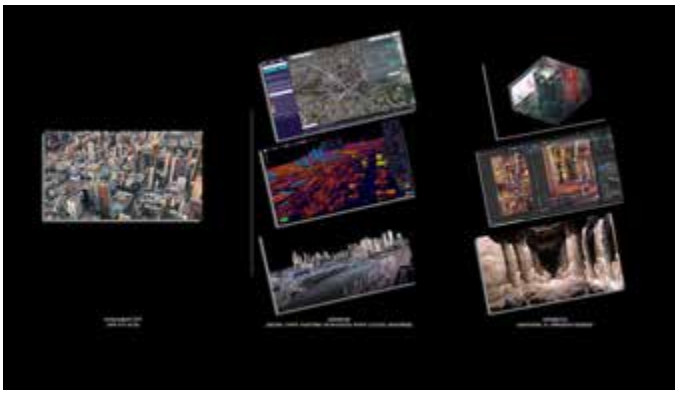

Figure 6. The Metapolis conceptual platform – (i) the incumbent city (the city as is), (ii) the Metapolis – that connects smart city platform technology, digital twins, real-time analytics, APIs and (iii) the Metablock that builds on the data models of the Metapolis to reconstitute a city block in the open metaverse, spatialized through AI diffusion model and search terms. Image: Ian Nazareth. (The diagram also includes images from HEAVY.AI, NVIDIA Omniverse and City of Melbourne LIDAR Point Cloud Data)

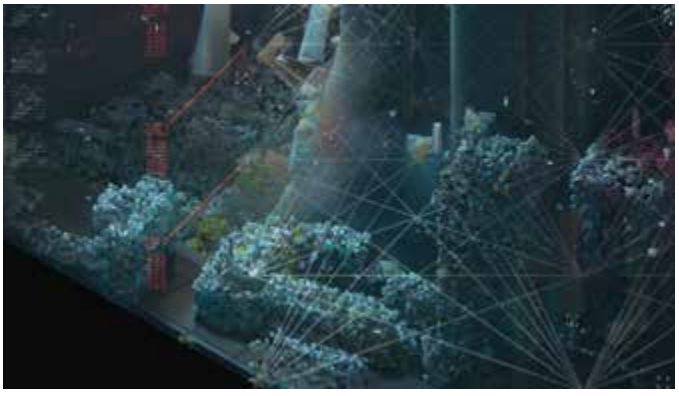

Figure 5. The Metablock – data architecture and spatial architecture are referenced, while a user interface overlays analytical models, data, usage statics, density and other parameters that offer an augmented reading of the city block in the physical city and metaverse. Image: Ian Nazareth and Kevin Gao.

This is conceptually and operatively a platform to connect or tether the physical city, its digital twin and the metaverse, - experimenting with data clouds, real-time information, application programming interfaces (APIs) and real-time analytic platforms HEAVY.AI built on Nvidia Omniverse for collaboration and simulation. The project can further connect to other analytical platforms at a city or neighbourhood level – and consider their value to AI diffusion models. Looking across this emerges as a scaffold connecting the incumbent the service and the metaverse.

The Metablock is a spatially organised directory tree of information, a unitary structure - gravity of connections and intensity of uses delimit the temporal shape and form and restructure the potential of the network. Fissures in data structure clear margins for emergent categories. The metropolis and

the Metapolis are a network of entangled infrastructures at a constituent level. They remain linked and share a common, unified state. Information and actions carry across the meta-physical breach. The Metapolis is an approximation and correlation to its physical counterpart.

The incumbent city and the Metapolis exist contemporaneously as a contingent, unstable action. The city as particles and waves, that occur in superposition of each other, i.e., cities occupying the same coordinate infrastructures, organised by compatible data and metadata. Here, two seemingly distinct spatio-temporal phenomena converge upon the same reality. The Metapolis is perhaps isomorphic. It is a what the city could be, not merely what the city is. Its physical reality delineated by bits and a virtual reality circumscribed by matter and stuff.

Black box, Search terms, Prompts

The architecture of architecture in the metaverse recenters one's gaze. The possibility tends toward the implausible recreation of all conceivable expressions.

Could a spatial system iterate infinitely? Conversely, what if everything that can be imagined has already been designed? Does the infinite deny certain opportunities? What lies beyond the reach of iterability?

Like Jorge Luis Borges' 'La biblioteca de Babel' (Library of Babel) where a library (of infinite chambers is a repository for every permutation of the alphabet) metaphorically describes the universe, the Metapolis confronts the paradox of the infinite, to understand, control and visualise its boundlessness. There's an inherent futility contained in the irrationality – that limitless possibility exponentially reduces the probability of any meaningful experiences. Yet this scarcely detracts from the pursuit.

The architecture of the block is experimentally open-ended, and user/operator/consumer generated. It is therefore confined by the parameters of present mechanical and procedural reproductions. Despite any claims for highly differentiated and enunciated outputs, the process combines generalities, averaging out idiosyncratic products. In the context of language, where expressions cascades as genres, sub-genres and micro-genres, machine learning image generators are form of search engine. Debatably, an utterly original, authentic conception might be beyond comprehension.

The conception of a user generation city proposes a city recreated through the mind's eye, through text, prompts and suggestions. Expression and intention condensed through a flattened visual apparatus sewn together with the benevolence of generative adversarial networks and machine intelligence. This deploys language and perhaps 'design' as an automated combinatorial process. Like machines, human to are visual sampling machines, and a lexicon of words are lateral to a vocabulary of pictures.

Letters, words, phrases, styles, references are all equivalent and unitised – i.e., Search Terms – the fundamental indivisible component of spatial, visual comprehension. The terms are a stenography for a sequence of code and machine instructions, alphabets prearranged into pixels. Outcomes in the city depend on rank-ordering of search terms – the benign act of searching and observing from a distance changes reality. Consequences are contingent on whether they have been observed. Infinitely divisible spatial labyrinths are suspended in the gravity of the meta cities paring to the city's digital twin – the real. It seeks some description of an indivisible quantity within the infinite.

The two concepts utilised to further explore the spatiality of 'rooms' within the Metablock are described below. As discussed earlier, these spaces are linked to the data structure of the city block. This presents the possibility to link the volume and availability of meta spaces as a contingent function related to the behaviour of the city block in real-time.

Allegorical Space

In Book VII of 'The Republic', Plato presents a parable that would come to be known as 'The Allegory of the Cave' – Plato describes a group of prisoners, whose lives are confined to a cave without any connection to the world. A fire (or candle) behind them illuminates movements. Their experiences, consequently, are only determined through the shadows cast before them, scenes that preoccupy their fascination and experience of reality – they classify these illusions and phantoms as actual entities.

In the story one prisoner ventures outside the cave, to discover a world that is illuminated by the sun. He sees 'true' forms not just shadows of form, and details, and reflections, and colour and shadows too. Enlightened, he returns to the cave to help his companions mired in confusion and error – but his vision can now scarcely adjust to the darkness in the cave, while the group, firmly believe his travels to the outside have made him irrational and untrustworthy.

Figure 7. Allegorical Space – a conceptual image of spaces within the Metablock for meeting, gathering, hosting events etc., generated through the use of open-source AI diffusion models and search prompts, then re-modelled into interactive immersive three-dimensional environments through modelling, simulation and rendering, also utilising physics of gaming engines. Image: Ian Nazareth and Kevin Gao.

Of the numerous interpretations, this allegory submits that the things that are seen are flawed reflections of ideal forms, it highlights the problem of representation and a querying of the nature of reality. Plato's Cave is also a techno-philosophy - the fire as a technology that casts shadows to inform perception and make claims about reality. The metaverse and virtual reality experiences are conclusively a form of technol-

ogy that irradiates a perception on reality – between known and unknowable between real and simulated. *What insights might be gained from moving out of the real, into the meta, (and back into a cavern of the real)?*

The Allegory of Plato's Cave is a departure point for the ideas contained within the design process – of how spaces are conceptualised within the project as well as the expansive notion of outside world i.e., beyond the known. The language and hierarchies of the space seek utility in the imageability of illumination and shadows, the form making process, representation in a resonant interior. Here the potential to conceptualise, formalise and accentuate a space though the design of its sciography manifests in the material and textural effects. Each space deals with its own conception of reality, and a totalising, highly differentiated boundary condition.

Backrooms

The Backrooms are not an actual place. One might informally refer to it as a 'non-place'. It exists outside the boundary of programmable floor, beyond all accounts of area and coordinates of architecture. An unfathomable poche. The Backrooms are an infinite abandoned, unfurnished labyrinth or a rupture in the fabric of reality.

Figure 8. Backrooms – a conceptual image of spill out, circulation and ancillary spaces within the Metablock for meeting, collectivity etc., generated through the use of open-source AI diffusion models and search prompts, then re-modelled into interactive immersive three-dimensional environments through modelling, simulation and rendering, also utilising physics of gaming engines. Image: Ian Nazareth and Kevin Gao.

In the paradigm of video games, Backrooms are a space you might encounter if you pass through solid walls – i.e., 'no-clipping', a scenario where you navigate through a game environment with collisions disabled, to glimpse the other side – levels, sub-levels, easter eggs. In the contemporary city this is recognized as 'Junkspace' as described by Rem Koolhaas – 'not Modernity itself, but a residue and coagulation of products while modernization is in progress.'

The Backrooms emerged as an internet meme, but conceptually represent a physical and virtual dimension – real so long as you are in it, a space of prolonged neglect, a buffer, a ballast. It is a space between spaces, a spatial and informational breach. Free-roaming in open-world information landscape, where repetition is sought an instant remedy for infinite.

Conclusion

Presented through the artifice of an architectural project, the Metapolis associates fundamental urban processes, strategic, comprehensive, and statutory urban planning, zoning etc. with elementary digital subdivisions like blockchain, data analytics, machine learning, operating between physical and simulated fields. The research and speculations seek to gather agency in the 'territory' across the more established planning instruments and generative, emergent paradigms manifested by decentralisation and distribution. It empowers an exploration between the city and its digital counterpart – a space to contend with, simulate and augment the metropolis. The platform can serve as an analytical device and a space for collectivity, events etc.

The Metapolis is a dialogue among its temporary inhabitants and users. Logistically and operationally, it is the infinite recreation of interminable rearrangements. Like the city, in its quest for popularity and totality it is in a perpetual state of incompletion. The imagery and experience presented through the project is architectural, industrial, technological and landscape. The Metapolis is a conjuration of biological, mechanical, electronic, linguistic social ideas, and incursion of the built environment into the internet.

The Metapolis captures an emergent, fluctuating domain of architectural exploration catalysed by an internet of things (IoT), distributed platform technology, real-time analytics, Web3, the metaverse and AI. These technologies can be viewed as discrete but are here explored as interleaved variables that could collectively engender an augmented and immersive urban and architectural experience. The terminology and language respond to a landscape of socio-cultural, technological, and gaming syntax, borrowed, and deployed to extract a spatial grammar and advance contemporary architectural practice.

As we continue to allocate our time between physical, simulated, and virtual realms, we are edging closer to a scenario where a significant portion of our lived experience will be simulated rather than non-simulated. Although this is a groundbreaking and dynamic frontier, the research establishes a feasible framework and platform for unifying distinct entities and datasets, as well as a theoretical basis for navigating the transition and translation.

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Towards data activation and engagement within a smart city

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Abstract

As part of a doctoral study this paper provides a data use reference model for Smart Cities, based on the various interaction points in a city. The SCIEP conceptual model is a way to understand the variances and interdependencies between data users aiding in a city's transformation with new service delivery that is citizen centric. It advocates a move from technologically focused Smart City planning to a more complementary approach to different and changing urban contexts and communities. The SCIEP conceptual model model presented in this paper imagines Smart City implementation as being citizen- centric in its approach, involving participation by all city stakeholders in the establishment of co-created and data driven ecosystem known as the Smart City. It does this by considering Smart City implementation as the establishment of urban intelligence through widespread ICT deployment and exchange combined with co- production and collaborative practices towards the uncovering and establishment of "data-driven innovation" and value (i.e creating new products and services) within a digitally driven ecosystem. The data model presented adds to current academic debate by gaining a better understanding of the role that data, its producers and consumers play in supporting various stakeholder engagement and governance practices when developing Smart City services. It offers a model foregrounding collaborative engagement practices to ensure that smart initiatives and their deployment are well aligned and appropriate in relation to various participatory networks and community engagement practices to establish a more inclusive, active citizenry. It also offers a way to interpret Smart City implementation by considering the context in which it operates in order to unlock its value and potential for providing new services to citizens, to improve their quality of life and enhance social and economic transformation.

Author keywords

Smart Cities; Citizen Participation; Engagement; Governance; City Futures; Internet of Things; Technology

Introduction

This paper puts forward the SCIEP conceptual model. The SCIEP model offers a multi-dimensional approach, imagining Smart City implementation as an overarching strategy that takes into account the contextual interstices, people, domains and associated resources needed to mobilise public and stakeholder value. The Smart City concept emerged as a viable model towards improving urban management and public life through the application of ICT and the optimisation and integration of smart technologies (Madakam and Ramachandran, 2015:34). As an instrument, the Smart City aims at improving cities by mobilising all city stakeholders in the creation of sustainable and equitable cities rooted in the use of technologies to establish a co-created, intelligent and connected city (Chamoso, Gonzalez-Briones, Rodriguez and Corchado, 2018:2). In essence, the Smart City concept is an attempt to render cities more efficacious for their citizenry, utilising its ability to optimise and integrate all city functionalities and infrastructure, such as resource optimisation and the advancement of public services.However, as each city is unique, the unlocking of its Smart City potential requires an exploration of its context and variables towards understanding and improving its operational efficiencies and functionalities, such as improving urban systems and accelerating digital transformation for a broader citizenry (Caird and Hallett, 2019:189). This research looked at Smart City implementation as an engagement practice. It offers a model and reports on the components that advance data driven Smart City implementation and engagement and how these components may be developed as a broader Smart City vision.

Methods: Constructing the SCIEP conceptual model

As part of a doctoral study exploring Smart City implementation as an engagement practice for the city of Cape Town, South Africa, this research started with a systematic literature review (SLR) and content analysis. The review was based on the assumption that Smart City implementation can play a significant role in addressing current urbanisation issues; however, the associated mechanism for unlocking its potential is unclear. The objective of the first-phase content and document analysis was to identify the central Smart City discourse and associated constructs and approaches in literature. Results from this content analysis process revealed 63 key elements which pertain to the Smart City discourse and enable a broadly defined overview of the components that lead towards Smart City implementation and engagement. These constructs were further refined regarding their purpose, process and objectives related to the conceptualisation of data through a process of constant comparison, analysis and labelling of raw data as a way of inferring meaning. The accumulation of such inferred meaning provided "potential indicators of a phenomenon" and, through constant compar-

ison and analysis, identified the unit of analysis that informs the theory (Pandit, 1996:1).This systematic approach and analytical process of constant comparison of the data served to identify abstract representations of a phenomenon. It involved the clustering of concepts into categories as they pertain to a phenomenon. The outcomes of this process of constant comparison disclosed 17 constructs, explicitly related to understanding Smart City implementation as a co-created ecosystem. Moreover, the outcomes uncovered the components that lead to Smart City implementation, engagement and the advancement of a local, more inclusive environment. The 17 constructs were further developed and interpreted using an inductive approach of constant comparison in order to understand and develop a Smart City vision that is geared towards engagement. Seven main concepts, specific to Smart City implementation as an engagement process, emerged from this process: 1) data, 2) co-production, 3) citizen participation, 4) knowledge management, 5) Smart City initiatives, 6) Smart City maturity, and 7) Smart City domains. These were further developed into the Smart City Implementation as an Engagement Practice model (SCIEP).

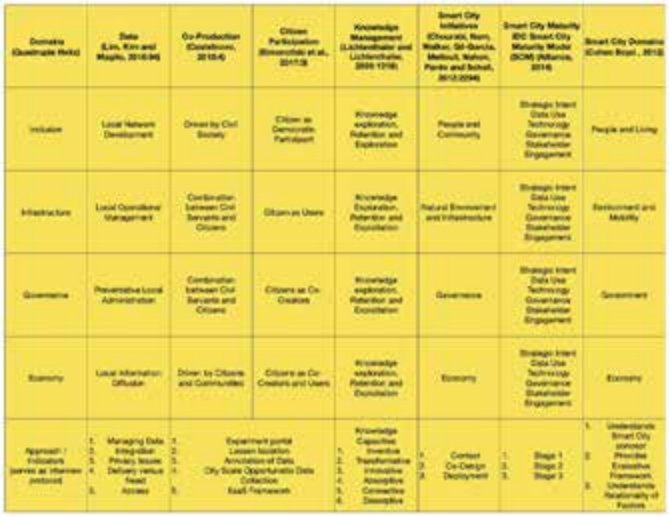

Figure 1. SCIEP conceptual model (Author's construct, 2020)

SCIEP Axis and its Meaning

The SCIEP conceptual model imagines Smart City implementation as being citizen-centric in its approach, involving participation by all city stakeholders in the establishment of co created and data-driven ecosystem known as the Smart City. It does this by considering Smart City implementation as the establishment of urban intelligence through widespread ICT deployment and exchange, combined with co-production and collaborative practices towards the uncovering and establishment of "data-driven innovation" and value (i.e creating new products and services) within a digitally driven ecosystem (Abella et.al., 2017:51). As such, the SCIEP model provides a set of variables by which to activate or establish Smart City implementation which enables social and economic evolution, taking into account the contextual nuances of a city and its wider developmental objectives, such as bridging the digital divide (Boyle and Staines, 2019:26). As such, the SCIEP model also advocates Smart City implementation that facilitates the creation of a more inclusive citizenry and in which citizens are perceived as prosumers (both producers and consumers of content) within the digital urban environment, therefore calling for a bottom-up approach and more participatory governance models to solve urban challenges and understand required city and stakeholder needs (Gutierrez et al., 2016:4). The SCIEP model and its axis, which I discuss below, offer a multi-dimensional approach by which to imagine Smart City implementation as either an overarching strategy from which to work or as a stage-based implemented model towards initiating and driving Smart City initiatives or measure projects, taking into account the needed considerations as they pertain to the contextual interstices, people, domains and associated resources towards mobilising public and stakeholder value.

The vertical axis of the SCIEP conceptual model

The vertical axis of the SCIEP conceptual model serves as a stage-based model for Smart City implementation. It can be thought of as a means of initiating scalable and practical citizen centric solutions, that form part of a city's innovation strategy and ecosystem. For example, in the domain of citizen participation, implementation could have as its focus seeking to permit engagement of collaborative digital practices and environments with citizens and the city, by leveraging citizens as city partners of an urban innovation platform (Madakam and Ramaswamy, 2015:3). As captured in the domain, this could be achieved either through perceiving citizens as (1) democratic participants, (2) citizens as users, or (3) citizens as creators of services. This is important as successful Smart Cities and their service delivery require new ways of public and participant engagement within an urban setting, that allow for more inclusionary platforms to serve as catalysts towards empowering citizens and to transform city management services (Burt, 2001:298; Paskaleva et al., 2015:131). Similarly, as captured in the "data" component, the model highlights the potential usage of data as they relate to (1) developing a local community and how citizen generated data can be reused to help users, (2) local operational management and how data from service providers can be used to improve government and company processes through improved data interoperability, (3) preventive local administration and how data from various companies, users or service providers are captured and leveraged in order to better understand the urban context and problem areas, as well as increase operational efficiencies, and (4) local information diffusion and how data from service providers and customers are leveraged for their usefulness to wider citizenry or stakeholders (Lim et al., 2018:93). These components can also work in tandem in the sense that the overall focus could be on data-use and the development of local network whilst being responsive to how it relates to aspects, such as knowledge management and how knowledge is leveraged for innovation or transformation.

The horizontal axis of the SCIEP model

The horizontal axis of the SCIEP model, therefore, highlights all key Smart City components as they relate to understanding Smart City implementation as a citizen-centric practice that operates within and contends with complex urban environments bearing diverse heterogenous contexts and urban challenges. Its components (horizontal axis), therefore, serve as essential recommendations in perceiving or modelling Smart City implementation as a co-created ecosystem

through an ongoing urban debate that utilises these components of data, co-production, citizen participation, knowledge management, Smart City initiatives, Smart City maturity and Smart City domains, in order to ensure that smart initiatives and their deployment are well aligned and appropriate in relation to various inclusive participatory networks and community engagement practices (Rodriguez-Bolivar, 2015). Furthermore, these key components and their activation as a framework for deployment ensure a better understanding and interpretation of what Smart City implementation should be in order to unlock its value with regard to providing new services to citizens, improving their quality of life and enhancing social and economic transformation and the advancement of a local more inclusive environment, while also focusing on adaptive, scalable and practical citizen-centric solutions as part of a city's innovation strategy and ecosystem (Gutierrez, Amaxilatis, Mylonas and Munoz, 2018:668). For example, the "Data" dimension calls for a data-driven Smart City approach where the activation of data is used as a tooling sport of Smart City initiatives. This dimension calls for consideration of issues, such as (1) associated challenges and required needs in dealing with a vast increase in generated data across distributed networks and data sources, (2) the structuring of data from several sources, such as sensors or city traffic cameras, etc., (3) the need for real-time data processing across city infrastructure and management, and user level, and (4) ensuring data reliability and value as gathered from several data sources (Santana et al., 2017:6). Furthermore, the "Data" domain considers the application of data analytics that support the application of IoT in matters, such as smart transportation, smart healthcare, the smart grid, etc. It also calls for a data-driven co-created city drawing on an array of distributed IoT technologies, data sources and data sets in order to resolve inner-city problems linked to better public services and an improvement in citizens' quality of life. This includes the leveraging of open data and the needed considerations with regard to making sure that (1) data are machine readable and facilitate use and reuse, (2) data are easily accessible on a publicly available online platform, (3) published data follow proper regulatory standards and formats in order to ensure interoperability between various data sets, (4) published data sets have an audit trail indicating the original, intended use which facilitates the interpretation of data sets and their use and reuse, (5) the need for a legal regulatory open data government framework that governs published data according to stakeholder concerns,(6) the need to define operational processes as a collective in order to regulate published data, as well as ensure data use, reuse and interoperability across data sets, (7) the need to generate and facilitate data interaction points between users in order to foster data supply and demand, as well as ensure data relevance and quality, (8) the need for a designated group of experts who manage a city's open data processes, and (9) the need to create and increase data demand in order to promote such issues as government transparency, efficiency improvement, and social and economic development (Nugroho et al., 2015:303).The components of co-production and citizen participation relate to garnering citizens participation in relation to planning and deployment of smart initiatives. As a set of recommendations, it centres around the need to establish collaborative citizen engagement and alternative forms of urban governance that allow citizenry and other stakeholders to collaboratively be part of the design and planning of urban spaces. This set of components supports a number of modalities of participation, as well as understanding the levels of participation within a Smart City, especially with regard to the context of the city and its people (Cardullo and Kitchin, 2019:5). Furthermore, citizen participation is seen as the means by which to enable public engagement, where digital communication tools are leveraged for their capacity to facilitate social conduct. As such, these tools often serve a mediating role towards activating aspects, such as co-production driven by citizens and communities, or citizen participation where citizens are co-creators and users of services (Niederer and Priester, 2016:137). Co-production and citizen participation, therefore, supports the application of digital tools to function as shared social objects towards identifying networks and their organisational conditions, as well as the "socio-material conditions" of communities or neighbourhoods (Niederer and Priester, 2016:137). Additionally, co-production and citizen participation reinforces sustainable forms of participation, and public and citizen engagement, centred around addressing public interests. Participation towards sustainability, therefore, includes the reconciliation of contextual nuances of place and space across the urban domains of economics, social factors and environment. It also supports participation, such as collaborative design, participatory decision-making, public discourse, participatory design challenges, policy integration and public resonance (Joss, 2014:49). The component "knowledge management" highlights the need to unlock latent urban value by supporting enhanced stakeholder interaction between industry, government, society and university. It, therefore, includes considerations around matters, such as open innovation and facilitating collaborative engagement amongst all participating city stakeholders towards a focused innovative action or goal (Paskaleva, et al., 2015:121). It includes a number of ways by which to leverage such engagement including inventive, absorptive and transformative capacities, etc. (Lichtenthaler and Lichtenthaler, 2009:1321). The "Smart City initiatives" component highlights key Smart City paradigms. These Smart City paradigms include (1) community and people, (2) natural environment and infrastructure, (3) governance, and (4) economy. It is within these paradigms, and with the establishment of these urban ecosystems in which social interaction occurs in diverse contexts, across different urban settings and with multiple associated social, infrastructural and technological characteristics, that smart services may be brought about through a blending of co-created social innovation practices based on actor or user needs (Aurigi and Odendaal, 2021:2). The "Smart City maturity" measures as part of the domain ways to determine a city's developmental stages in relation to its Smart City trajectory, as well as to ensure best practice and evaluation of Smart City projects. These measurements are (1) strategic intent, (2) data use, (3) technology, and (4) governance and stakeholder engagement. These variables can also be thought of as stage-based or sequential in nature, building on the preceding indictor or measurement in order to move towards full Smart City implementation. The component Smart City Domains highlights the key focus areas and factors towards establishing a Smart City that aims at resolving inner-city problems linked to public service availability, environmental sustainability, congestion, population density, inequality and liveabili-

ty, infrastructure and management, and smart services. These domains relate to (1) technological implementation, hardware and software frameworks; (2) the use of technological solutions to improve people and communities, emphasising creativity, heterogeneity and education; and (3) institutional governance and policy assistance (Lee et al., 2014:82; Anttiroiko et al., 2014:325). The bottom row titled "Indicators" provides a set of variables or guidelines by which to test or measure the extent or successful implementation of initiatives according to their corresponding SCIEP components. For example, under the "Data" component five variables are highlighted by which to test data-driven Smart City deployment. These variables are used to measure aspects, such as how data are managed in relation to local network development, and to what degree they are accessed, integrated and delivered.

Significance and contribution of SCIEP conceptual Model

The SCIEP conceptual model is a framework by which to imagine or characterise what a Smart City and its initiatives can be when focused as an engagement practice involving all participating city stakeholders and users. It contributes to understanding Smart City implementation as a data-driven approach. Additionally, the establishment of urban intelligence, through widespread ICT deployment and exchange, serves as agency, combined with co-production and collaborative practices, towards the uncovering and establishment of "data-driven innovation" and value (i.e. creating new products and services) within a digitally driven ecosystem known as the Smart City (Abella et.al., 2017:51). The SCIEP conceptual model also takes into account the complexity and heterogeneous nature of modern urbanisation and the challenges many cities face in establishing relevant Smart City solutions. The model also offers the mechanisms and processes to be included in the creation of services, specifically in understanding how data - and access to data - within the Smart City concept add societal value through the synergy created by the exchange of data paired with citizen participation, a co-creation process and knowledge management approaches (Abella et.al., 2017:51). The SCIEP model adds to current academic debate by gaining a better understanding of the role that data, and producers and consumers of data, play in supporting various stakeholder engagements and governance practices when developing Smart City services. It offers a model which foregrounds collaborative engagement practices to ensure that smart initiatives and their deployment are well aligned and appropriate in relation to various participatory networks and community engagement practices to establish a more inclusive and active citizenry (Anttiroiko, 2015:26). It also offers a way to interpret Smart City implementation by considering the context in which it operates in order to unlock its value and potential for providing new services to citizens, to improve their quality of life and enhance social and economic transformation.

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Teaching design of technologies for mediating collaborative interaction - An emerging pedagogical framework

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Abstract

Collaboration is one of the 21st century skills, and in our new digital and hybrid reality, the importance of designing technologies that support collaborative interaction in various ways has increased due to e.g., the recent Covid-19 pandemic and the need to decrease travel to keep down environmental impact and avoid unnecessary contributions to the climate emergency. Accordingly, designers of digital tools need to be educated regarding supporting collaborative interaction, online, on-site and hybrid. However, there is a lack of concrete teaching materials for how to design collaborative technologies. In this paper, we present an emerging pedagogical framework targeting technology design educations in higher education in teaching to develop students' knowledge and skills for how to design technology that mediates collaborative interaction. The pedagogical framework will be made available for everyone as an online open educational resource.

The framework is developed through a pedagogical design pattern method using a three-phased model for conducting educational design research and developing educational materials. The results are based on Laurillard's pedagogical pattern template (Laurillard, 2012), and further extended with the SOLO taxonomy for defining learning objectives (Biggs, 2003). Using one specific approach throughout simplifies consistency and coherence among the various parts. The pedagogical framework consists of 10 pedagogical patterns, which entail concrete teaching activities with accompanying learning goals. The teaching activities are divided into concepts, methods and practices:

Concepts explain the underlying conceptual and theoretical foundations that students need in order to take human collaborative interaction into account, both in their methods and in their design process, as well as in taking responsibility for their end product or service. An example of a teaching activity is a lecture on 'Collaborative interaction in Activity theory'.

Methods address methods for students to engage with groups, elicit requirements for design, and to practically design and evaluate collaborative technologies. An example of a teaching activity is a lecture and exercise on 'Requirements elicitation for collaborative technologies'.

Practices consists of case studies that illustrate best practices and case studies in designing collaborative technologies. An example is a lecture with an accompanying exercise on 'Designing for Collaborative co-located multi-display environments'. Together, these teaching resources, which are all freely available online, make up a framework that supports developing students' knowledge and skills for how to design technology that mediates collaborative interaction.

We believe that this work has two contributions. First of all, to propose what an emerging pedagogical framework for learning about designing collaborative technologies can be and open it up for critique and further development. Secondly, we also believe that a discussion on teaching practices is important in that it can contribute to developing the research field, as students display through their learning process, aspects that would perhaps have been hidden if we studied experienced designers, or only reflected on our own research practice.

Author keywords

Collaboration; design; CSCW; HCI

Introduction

Collaboration is a very complex skill which involves coordination, cooperation and at its most advanced level, reflective communication (Bardram, 1998), and is considered as one of the 21st century skills (OECD, 2018). In a time where remote collaboration has become increasingly more important due to e.g., environmental emergency and pandemics (e.g., Tudor, 2022), the need for designing and developing technologies that efficiently support and mediate collaborative interaction has become a high priority.

Historically, most user interface research has focused on single-user systems, although this has been challenged by multi-user or group interfaces (Ellis et al., 1991), which are sensitive to such factors as group dynamics and organizational structure. Collaborative technologies come with design challenges, such as that technology designed for use by different groups must be flexible and accommodate a variety of team behaviors and tasks (Ellis et al., 1991). E.g., two different teams performing the same task use collaborative technology in very different ways (Rein and Ellis 1989), and the same team doing two separate tasks uses the technology differently for each task.

However, teaching as an activity has been somewhat neglected within fields such as Computer Supported Collaborative Work (CSCW, Brown et al., 2007). This in some contrast to HCI, in which teaching has played a more prominent role, and where textbooks summarize what is to be learnt (i.e. Preece et al., 2019) and there is a lively discussion in the community (e.g. Churchill et al., 2013; Eriksson et al., 2022a; Frauenberger and Purgathofer, 2019), including in various sub-fields (e.g. Child-Computer interaction (Van Mechelen et al., 2020), animal-computer interaction (Zamansky et al., 2017). Teaching technology design for collaborative interaction involves imparting a distinctive attitude – in particular a sensitivity to co-ordination. In this paper we aim to initiate a pedagogical framework for teaching design of technologies for collaborative interaction in higher education. We do so by transforming concepts, methods, and practices from research into concrete teaching activities with accompanying learning goals.

Using the materials presented here for teaching a course on designing collaborative technologies will not make the students become experts, but hopefully they will gain a much deeper understanding of how to engage with understanding a group and a setting, before coming to think about design. This might perhaps be the most important student outcome and a core lesson – the connected nature of the technical and the social. We are aiming for students to 'come to see' collaboratively, and through that develop students' knowledge and skills for how to design technology that mediates collaborative interaction.

Background

In the light of the COVID19-pandemic, it is easy to think of collaborative technologies as primarily communication technologies such as applications to support video meetings (e.g., Grønbæk et al., 2021). However, in this work, we refer to a broader notion, including everything from social drones (e.g., Obaid et al., 2022), digital games (e.g., Eriksson et al., 2022b), to the collaborative society (e.g., Jemielniak and Przegalinska, 2020), just to mention a few.

There are several definitions of what collaboration and collaborative interaction mediated by technologies is (e.g., Bardram, 1998; Correia et al., 2017; Roschelle and Teasley, 1995; Sedano et al., 2013; Shah, 2010). However, terms related to collaboration, such as cooperation, coordination, teamwork, social interaction, etc. are often used as synonyms or interchangeably, and there is no systematization of the terms used (Baykal et al., 2020b; Sedano et al., 2013). For instance, social interaction is a vital but insufficient condition for collaboration because some social interactions do not involve shared goals, accommodation of different perspectives or organized attempts to achieve the goals (OECD, 2018).

However, recently, we have seen a tendency to adopt the levels of collaboration as defined in Activity Theory (AT), in order to define collaboration in an operational way (Bardram, 1998; Baykal et al., 2020a; Eriksson et al., 2021). AT provides a method of understanding and analyzing a phenomenon, finding patterns, and making inferences across interactions (Kaptelinin and Nardi, 2009). With AT as a theoretical foundation, Engeström et al. (1997) defined three levels of collaborative interaction, and building on this definition, Bardram (1998) introduced a framework for collaborative interactions between users and mediating technology. This framework consists of three different levels of collaboration, from the simplest to the most complex form: Coordination, Cooperation and Reflective Communication. Acknowledging that there are many other models for defining collaboration, we will in this work lean towards the three levels of collaboration as deriving from Activity theory (Bardram, 1998; Engeström, 1987).

What do we mean by collaborative technologies?

The goal of collaborative technologies, or collaboration systems or groupware, is to assist groups in communicating, in collaborating, and in coordinating their activities, and can be defined as: computer-based systems that support groups of people engaged in a common task (or goal) and that provide an interface to a shared environment (Ellis et al., 1991). In the classic CSCW matrix (Johansen, 1988), four main areas of collaborative technologies are presented:

Face to face interactions: Collocated social interaction focuses on scenarios of 'same time, same place', that is, a synchronous interaction between individuals in close proximity, e.g., single display groupware. In synchronous interactions, such as spoken conversations, people interact in real time (Ellis et al., 1991). In technology development, this area has attracted less interest than technologies for remote connectedness, and hence remains less explored and characterized (Olsson et al., 2019).

Remote interactions: Focus on same time, different place and a typical technology is video conferencing. This is an area that has received increased attention lately, not least due to the COVID-19 pandemic (Tudor, 2022).

Continuous task: Focus on different time, same place, and typical examples are team rooms and large public displays. Interactions are asynchronous, meaning those in which people interact over an extended period of time (Ellis et al., 1991).

Communication and coordination: Focus on different times, different places, where typical examples are email and group calendars.

However, there is one area missing in the matrix, namely that of technologies to support *hybrid interaction*. Neumayr (2021) presents a systematic literature review of the contexts and tools of hybrid collaboration and meetings in HCI and CSCW, with the goal to unpack how hybridity matters when it confers an asymmetry on the coordinated activity. In this review, hybrid collaboration refers to *"collaborative practices that involve simultaneous co-located and remote collaboration with phases of both synchronous and asynchronous work that spans multiple groupware applications and devices"* (Neumayr et al., 2018) and hybrid meetings refer to video- or audio-based communication sessions among co-located and remote participants (Roussel and Gueddana, 2007). Hybrid collaboration switches back and forth between

all four quadrants of the time-space matrix. There are constant transitions between co-located and remote as well as synchronous and asynchronous collaboration. Further, users typically do not rely on a single groupware application or hardware device but simultaneously use different tools and devices during collaboration. Also, the team size is greater than just two collaborators and multiple coupling styles can coexist simultaneously within a single team, effectively dividing the whole team in multiple temporary subgroups of various sizes and an individual coupling style (Neumayr et al., 2018).

Although many systems can be categorized according to their primary emphasis and intent (Ellis et al., 1991), it is important to note that there is no rigid dividing line between systems that are considered collaborative and those that are not, or belonging to one category of the matrix or not. Due to the varying degrees of support for common tasks and shared environments, it is more appropriate to think of a collaborative technology spectrum rather than well-defined boxes (Ellis et al., 1991). In the work presented in this paper, we apply this thinking of collaborative technologies as a spectrum with constant transitions in time, space, and level of collaboration.

Methodology

A three-phased model for conducting educational design research and developing educational materials (McKenney and Reeves, 2018) was used as an underlying and guiding research and development framework. Educational design research is aimed at providing concrete solutions to educational practitioners in relation to practical and complex educational problems such as how teachers can teach collaborative interaction in technology design. Solutions can take the form of educational products and materials that both support teachers in their educational practice and seek to discover new knowledge that can inform future research, development, and practice within that domain.

Phase 1) Exploration and analysis

Exploring the existing domain of teaching design of collaborative technologies by firstly making an inventory of existing teaching practices and research production at our own universities. Secondly, by conducting a literature review on (teaching) design of collaborative technologies and through this developing the research grounding. This included e.g., searching SCOPUS for (TITLE-ABS-KEY (cscw) AND TITLE-ABS-KEY (teach*)), in which we found 135 results, but only one (Brown et al., 2007) actually addressing teaching collaborative technologies. In this phase we also invited two experts and interviewed them on their teaching practices in regard to designing collaborative technologies. We further snowballed on further research resources to include.

Phase 2) Design and construction

Based on phase one, two/three core competencies were identified, and a number of overarching learning objectives were extrapolated and described. Then the SOLO taxonomy (Biggs, 1982) was applied to the competencies and learning objectives to describe how we as teachers can develop students' competencies from a beginner to an advanced level. This led to the construction of an overarching model for how teachers can plan, carry out and evaluate teaching and learning on designing collaborative technologies. Based the results from the first phase, and on the core competencies and learning objectives, we developed a number of concrete learning activities consisting of lectures and exercises.

Phase 3) Evaluation and reflection

Alongside the design of the stand-alone teaching activities, an iterative peer-review of all activities was carried out using the pedagogical pattern evaluation method called shepherding (Harrison, 1999). This method ensured multiple cycles of evaluation, reflection, and revision of the activities throughout the project. Additionally, the teaching activities were put into practice and evaluated through 30 pilots involving around 40 teachers and 523 students coming from various disciplines, programs, institutions, and educational contexts in five universities in four different countries. After each pilot, the teacher was asked to fill out a questionnaire. The students involved in the pilots have been enrolled in bachelor (n=14 pilots), master (n=5 pilots) and mixed PhD \& master programs (n=11 pilots). The programs range from communication design (Faculty of architecture and design) to interaction design (Department of computer science), digital design (Faculty of Arts), Design, Technology and Society Program (Institute of Social Sciences), Design, Technology and Society Program (Institute of Media and Visual Arts), and experience economy (Faculty of Arts).

Pedagogical design pattern approach

The main outcome of the project – the collection of teaching activities – was developed using a modification of the pedagogical design pattern method (Goodyear, 2005; Köppe et al., 2017; Laurillard, 2012; Nørgård et al., 2019). The method is aimed at capturing "best practices" from research and practice, which are then developed into concrete activities for teaching and learning within a specific domain.

The pedagogical pattern method has been applied in order to elicit existing best practice from teachers and from related work found through snowballing. The method has been modified in that we have iteratively developed our own pattern template highly inspired by the pattern template suggested by Laurillard (2012) with the main difference that the students' learning objectives are formulated based on the SOLO taxonomy for defining intended learning outcomes and objectives (Biggs, 1982), for consistency and shared language. The template is complemented with teaching materials, such as suggested literature, worksheets, assignments, and presentation slides. Additionally, all visuals and figures in the developed teaching material are either private images with consent to be published from the owner or generated using artificial intelligence (DALL-E).

The pattern template consists of the following items (Italicized items are modifications from the original template prosed by Laurillard (2012):

- *Title* (Title of the pattern).
- Origin (the original source and later contributors).
- Summary (brief description of what is being taught and how).
- Topics (keywords that will help other teachers decide the relevance).
- Learning outcome (what the learner will know or be able to do by the end *defined using SOLO taxonomy*).

TITLE	Requirements elicitation for collaborative technologies			
ORIGIN	TEDCO			
SUMMARY	Requirements elicitation is about exploring the problem space and defining what will be developed. Requirements range from functional to contextual such as e.g. social environment and user goals. Methods for gathering and analyzing data to elicit requirements will be presented and practiced.			
TOPICS	Methods for requirements elicitation, qualitative data analysis and evaluation			
LEARNING OUTCOME	• Students should be able to name methods for requirements elicitation and qualitative data analysis for collaborative technology. • Students should be able to formulate requirements for collaborative technology. • Students should be able to apply requirement elicitation in design of collaborative technology. • Students should be able to evaluate requirements in the design of collaborative technology.			
RATIONALE	Experiential learning; learning through practice.			
DURATION	3h			
LEARNERS	Design and engineering in higher education			
SETTING	Online, face-to-face, hybrid			
RESOURCES AND TOOLS	Slides in .ppt with lecture and assignment			
LEARNING CYCLES	Sequence of teaching–learning activities	Group Size	Time Mins	Code
	The teacher introduces students to relevant factors for eliciting requirements from qualitative data when designing collaborative technologies. Explains how they will be advised and evaluated	All	40	TCC1
	Students in groups practice analysis of qualitative data and/or requirements elicitation.	4	60	TPC1
	The teacher checks what the students are doing, and advises on aspects to consider.	4	3	TPC2
	The students share their practice outputs with peers, and gain access to peers' outputs as a model for their practice.	8	20	PMC1, 2
	The teacher chairs a class discussion, asking for reflections on experiences, and consolidating the lessons learned.	All	30	PCC1, 2, 3

Figure 1. Example of a completed pattern template - here for Requirements elicitation.

- Rationale (the learning approach or pedagogical design principle).
- Duration (total learning hours, not necessarily continuous).
- Learner characteristics (educational pre-requisites, experience, interests)
- Setting (face-to-face, blended, or online).
- *Resources and tools (the teaching materials e.g., lecture slides).*
- Group size (the range of minimum to any maximum).
- Learning cycles (Sequence of teaching–learning activities)

For the learning cycles, the following codes are used:

- Formative assessment FA
- Summative assessment SA
- Design elements for activities in the Conversational Framework Cycles Access to the teacher's concepts TCC1
- The means to articulate their concepts and reflections on practice TCC2
- Extrinsic feedback on questions or articulations of their concepts TCC3
- A practice environment that facilitates their actions TPC1
- Extrinsic feedback on their articulations of their actions TPC2
- A modeling environment that elicits their actions TMC1
- Intrinsic feedback on their actions from the model TMC2

Figure 2. The pedagogical framework for teaching design of technologies that mediate collaborative interaction. The framework is centred around the overarching learning objective, and consists of three parts: teaching activities, learning objectives, and concepts, methods and practices.

- Access to peers' concepts PCC1
- The means to articulate their concepts and reflections on practice PCC2
- Extrinsic feedback from peers on articulations of their concepts PCC3
- Sharing practice outputs with peers PMC1
- Access to peers' outputs as a model for their practice PMC2

For an example of a complete teaching pattern, see Figure 1.

Results

The overarching learning objective of the entire pedagogical framework is: *To develop student's knowledge and skills for how to design technology that mediates collaborative interaction*, see Figure 2. In order to strive for this learning objective, the teaching activities that the framework consists of are divided into concepts (Table 1), methods (Table 2), and practices (Table 3), each with its own learning objectives and pedagogical pattern. The teaching materials are available for download at https://www.tedco.se.

Considerations for applying the pedagogical patterns

The collection of teaching activities presented in the framework above is meant as an inspirational educational resource, where it is possible to pick and choose what is needed, and what fits into the existing curriculum. They are not designed for a specific curriculum or meant to be taught together as a course. However, there are many considerations to take when planning to teach about design of collaborative technologies including: Who are the intended students, and what curriculum are they following (computer science, engineering, social science)? Length of learning activity (workshop, full course)? Level of knowledge of the students in relation to designing collaborative technologies (beginner or more advanced)? The dimensions of knowledge, skills and attitude that need to be taught (awareness of aspects of collaborative technol-

Table 1. Overview of Concepts in teaching design of collaborative technologies.

Concepts in Design of Collaborative Technologies
The core concepts of collaborative technologies which are relevant for design research and practice, and what are the strategies to link these theory and concepts to design practice. Explains the underlying conceptual and theoretical foundations that students need in order to take collaborative interaction into count, both in their methods and in their design process, as well as in taking responsibility for their end product or service.
Learning Objectives
• Recognize and describe different aspects of collaborative interaction. • Analyze and critically reflect on how collaborative interaction is mediated by technology design
Pedagogical Patterns
• **Introduction to designing collaborative technologies.** Summary: The students are introduced to designing technologies that mediate collaborative interaction. This includes examples of technologies that mediate collaborative interaction, the elements that make up collaborative interaction, and various levels of collaborative interaction. • **Collaborative Interaction in Activity Theory.** Summary: The students are introduced with theoretical approaches and paradigms related to collaborative interaction mediated by technology. Students describe different aspects and levels of human collaboration mediated by technology. Topics for the final discussions is on how students would want to modify the systems to increase or enhance the current collaborative interaction.

Table 2. Overview of Methods in teaching design of collaborative technologies.

Methods in Design of Collaborative Technologies
The methods and approaches for understanding, investigating, and designing technologies for collaborative interaction. Addresses methods for students to engage with groups and their collaborative interaction mediated by technology design, and also to practically design and evaluate collaborative technologies.
Learning Objectives
• Identify and describe direct and indirect stakeholders of a collaborative technology design. • Elicit stakeholder requirements for collaborative technologies. • Integrate considerations for collaborative interaction into the design process. • Analyze, evaluate and critically reflect on the impact of a technology in collaborative interaction in context
Pedagogical Patterns
• **User research in designing collaborative technologies.** Summary: The students are introduced to relevant factors for performing field research when designing collaborative technology (distinctions from dyads to communities), three types of methods to achieve it (ethnography, artifact ecology, and network analysis). • **Requirements elicitation in designing collaborative technologies.** Summary: Requirements elicitation is about exploring the problem space and defining what collaborative technology will be developed. Requirements range from functional to contextual such as e.g., social, environment and user goals. Methods for gathering and analyzing data to elicit requirements for collaborative technologies will be presented. • **Evaluation of collaborative technologies.** Summary: The students learn how to evaluate the user experiences with the system. Students list the methods of evaluating user experience, and propose which method works best for their own system. Students also reflect on why studying user experiences is important, and in which phases of the design process this can play a meaningful role.

ogies, methods for practicing design of collaborative technologies)? When aiming for the overarching learning objective, the framework can be used in several different ways, see Figure 2. For instance, teachers can *explore the learning objectives* for each activity and select those that are the most relevant to their discipline, curriculum, or course. The learning objectives are described in broad terms, while the teaching

Table 3. Overview of Practices in teaching design of collaborative technologies.

Practices in Design of Collaborative Technologies
The practices and pedagogies highlighting how design problems related to collaborative interaction mediated by technology are more uncertain, more nuanced, or more complex than originally assumed. This complexity will be unfolded through a number of case studies. Consist of case studies that illustrate practices in designing collaborative technologies.
Learning Objectives
• Recognize, design, and analyze relevant factors for the design and collaborative aspects of multi-display environments. • Recognize, describe, and analyze relevant factors for the design of technologies for co-located interactions. • Recognize, describe, analyze and integrate hybrid collaboration aspects in the design of collaborative technologies. • Recognize and describe relevant taxonomy for extended reality and analyze aspects in synchronous extended reality remote collaboration systems. • Recognize and describe different aspects of collaborative society
Pedagogical Patterns
• **Designing for Collaborative co-located multi-display environments.** Summary: The students are introduced to the concept of multi-display environments (MDE), i.e., the coupling of several displays together to form a shared interactive environment. The concept is described through a framework and illustrative cases. • **Designing for Mobile and co-located collaborative interaction.** Summary: The students are introduced to designing for co-located collaborative interaction mediated by technology. A framework for designing co-located mobile interactions is presented that can be a useful tool for work in this area. • **Designing for collaborative interaction in hybrid settings.** Summary: The students are introduced to relevant factors for recognizing, analyzing and designing technology to support hybrid collaborative interaction, while reflecting on the consequences of the technologies. This includes understanding how hybridity matters to the tools and processes of collaboration and unpack how hybridity matters when it confers an asymmetry on the coordination that occurs within the interrelated concepts of collaboration. • **Designing for collaborative interaction in extended reality environments.** Summary: The students are introduced to the taxonomy for synchronous collaborative interaction in social augmented, mixed or virtual reality platforms. This includes understanding the main components for designing extended reality platforms that mediate collaboration. Opportunities and challenges of future virtual systems for collaboration are presented for future design considerations. • **Collaborative society.** Summary: Introduces to collaborative society, an emerging trend that changes the social, cultural, and economic fabric of human organization through technology-fostered cooperative behaviors and interactions. This includes different modes of cooperation, illustrated by examples such as sharing economy, peer production, social activism, internet of things, big data etc.

activities connected to each of the learning objectives execute them in concrete ways. Further, teachers can *combine concrete teaching activities* that move students from a simple (unistructural) to a complex (extended abstract) level of understanding of designing collaborative technologies in accordance with the SOLO taxonomy Biggs (2003). Teachers can also *combine concepts, methods and practices* that create a broad foundation for students to become designers of collaborative technologies. Whatever way is chosen, it is important for teachers to adapt and appropriate the teaching activities to fit their specific educational context (Hendry, 2020; Nilsson et al., 2020).

Experiences with using the teaching materials

The teaching materials were iteratively developed based on the peer-review process but were also evaluated based on a questionnaire by the teacher after pilots. Some of the teach-

ers gave concrete input to further development and design iterations of the teaching materials, such as a pilot using the Evaluation pattern, where the teacher states that 'the pattern on Evaluation should be split up into multiple parts'. Also, when the teaching material on stakeholder mapping was tested in a bachelor project course, the teacher comment that 'the workshop gave insights into the topic that could be taken into account in the further developments of the material, and that in general students tend to be well able to grasp 2x2 matrices in various contexts (not only placement of collaborative technologies, but also types of stakeholders could be classified in a 2x2 matrix)'. The teachers state that the added value of the piloted teaching material was: 1.) professional development within technology design for collaborative interaction, 2.) a qualitative update of the design curriculum of collaborative technologies, 3.) increased capacity to teach technology design for collaborative interaction in relevant and innovative ways.

Discussion

The pedagogical framework presented in this paper is the result of an inductive approach to the pedagogical pattern method, meaning that we started with our own and our colleagues research and teaching practices, and snowballed from there. This means that we are not trying to claim that this framework covers everything a student needs to know in order to develop knowledge and skills for how to design technology that mediates collaborative interaction. Rather, this is an initial approach to an emerging pedagogical framework. We are not claiming that an inductive approach is the best or only approach possible, a more deductive approach could have led to a different outcome. Also, the evaluation of the developed teaching material is so far restricted to iterative peer-review and questionnaire feedback from teachers after pilots. In future work, we would encourage further evaluation based on feedback from students, and not only rely on the teacher's conception based on the students observable learning.

Challenges and considerations

In this work, we have met a number of challenges and considerations that we need to pay attention to when designing teaching materials for the design of technologies that mediate collaborative interaction. The first issue is the lack of a common definition for collaboration. The term "collaboration" used interchangeably with similar but not synonymous words such as "social", "cooperative", "coordination" in the literature especially in technology design studies (Baykal et al., 2020b). Thus, in our teaching materials we adopted the following formulation for the term collaboration in order to identify the elements of collaborative interaction Collaboration is a technologically mediated social interaction between multiple people who share a common goal. Based on this formulation of the term, the core elements of the collaborative interaction include; Social (synchronous or asynchronous), Multiple people (human), Those people have a shared goal, Technology plays a mediating role between multiple people, Intention of designers and/vs. users' appropriation.

The second issue is also linked to the first one in that collaboration is a very complex phenomena which is not only difficult to define but also to analyze. To this extent, we found the levels of collaborative interaction defined in Activity Theory as the most comprehensive one. Derived from Activity Theory, Engeström defined three levels of collaborative interaction: 1. coordination, 2. cooperation, 3. reflective communication (Engeström, 1987; Engeström et al., 1997). This definition inspired some work particularly in CSCW (Kuutti and Arvonen, 1992) as well as in HCI in general by being used as a lens to analyze the collaborative interaction mediated by technology (Kaptelinin and Nardi, 2009; Kuutti et al., 1996; Bardram, 1998; Baykal et al., 2020a), albeit having its own limitations (Bødker et al., 1988). The future work may use the definition to analyze the collaborative activities in different scales (e.g., business models such as Uber, Airbnb which were built on shared economy as explained from a critical theoretical perspective in Collaborative Society by Jemielniak and Przegalinska), spaces (e.g. hybrid meetings, see Neumayr et al. 2021; Grønbæk et al. 2021), or realities and temporalities (e.g. envisioning and designing various interaction modalities and sensory inputs which require further investigation in social AR/VR/MR platforms (Schäfer et al., 2021).

The third issue is sort of an outcome of the former two in that the lack of a common definition and level of complexity of the phenomena for analysis yields a diverse but scattered knowledge of how to design for and evaluate the collaborative interaction (Baykal et al., 2020b), let alone the challenges in mediating a higher level of collaboration between the collaborating actors.

Intention and adoption in the design of collaborative technologies

In this framework, collaborative technologies are considered as a spectrum with constant transitions in time, space and level of collaboration. This is due to the fact that there is no rigid dividing line between systems that mediate collaborative interaction and those that do not. Many systems can be categorized according to their primary emphasis and intent (Ellis et al., 1991), but still most often have varying degrees of support for common tasks and shared environments and is also highly dependent on the specific adoption by the users in specific situations. So, this is why we in this work find it more appropriate to think of a collaborative technology spectrum rather than well-defined boxes, as in e.g., the CSCW matrix (Ellis et al., 1991). This, however, led to difficulties when designing the teaching materials, as the literature more often has a focus on the intention rather than actual use.

Another related challenge we experienced when developing the teaching material, especially when focused on practices, was that most literature has an emphasis on a specific technology or application, and not on the collaborative aspects as such. This led to many discussions on what is specific to designing technologies for mediating collaborative interaction, with the consequence of that much material has been excluded for being classified as too general. Examples of this are general theory on HCI for the pattern "Collaborative Interaction in Activity Theory", and even a whole pattern on "Prototyping collaborative technologies" was excluded.

Methods used

Applying the pedagogical pattern method worked well for the development of the teaching materials presented in this framework. Especially the use of the SOLO taxonomy as a shared language for defining learning objectives was experienced as very fruitful. The SOLO taxonomy became a shared language not only for the design team, but also in correspond-

ence with the teachers involved in the pilots, as they are used to SOLO in their practice. In regard to the pattern template inspired by Laurillard (2012), especially the learning cycles were highly useful in developing the teaching materials. The sequence of teaching-learning activities helped to provide at the same time a holistic and detailed take on the various materials, so that the lecture and exercises became better aligned.

Conclusion

In this paper, we have introduced an initial pedagogical framework for teaching design of technologies that mediate collaborative interaction. The framework is based on an inductive approach to the pedagogical pattern method in combination with the SOLO taxonomy. The framework is a first try to transfer concepts, methods and practices from research into concrete and inspirational teaching activities aimed for teaching in higher education. In the framework, collaborative technologies range across many different application areas, and without a well-framed definition. Still, the core elements include social interaction (synchronous or asynchronous), Multiple people (human), Shared goal, Technology as mediator between multiple people, Intention of designers, and User appropriation. In the framework, collaborative technologies are considered as a spectrum with constant transitions in time, space and level of collaboration. Hopefully this framework can inspire teachers in higher education to dive into the complex world of teaching in designing technologies for mediating collaborative interaction.

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A mixed-method approach: virtual reality to co-create future higher education workspaces in a post COVID-19 academic environment

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Abstract

The turmoil caused by COVID-19 saw academics and students in Higher Education (HE) institutions across the UK, and worldwide, facing the sudden and unplanned move to online or blended delivery. It left pre-pandemic operational models in need of evolving, leading to an opportunity to develop and test innovative architectural and spatial programming design strategies for 'knowledge work' spaces as academic staff and students returned to campus. The aim of this inter-disciplinary longitudinal study was to evaluate and validate a unique mixed-method approach, which combines extended reality, user experience (UX) and psychological research methodologies with architectural design strategies, to understand how people feel at work; how the environment influences their performance, health and wellbeing; and how to maximise spatial usage. Results were obtained by triangulating data collected from co-creation workshops, an ecological momentary assessment (EMA) survey, and a final usability virtual reality (VR) evaluation. Results imply that there is no ideal layout that would fulfil every user's needs, instead new strategies need to be developed for workspaces to be redesigned creatively following longer-term usability and healthy architecture standards. This includes the mixed-method approach in this study that successfully creates a link between disciplines and user groups: UX and psychological researchers, architects, estates managers and end-users.

Author keywords

Extended Reality; VR; User Experience; Co-creation Methodologies; Architectural Design.

Introduction

The COVID-19 pandemic has enforced a dramatic change to the working practices of millions of people across the UK and beyond, having a significant impact on many existing working practices, quality of life, and wellbeing. The impact of the unprecedented lockdowns on the nation's mental health is already being witnessed. Evidence from similar situations such as the SARS-CoV outbreak in 2003 predicts that there will be a global future impact on health and wellbeing with increased levels of stress, anxiety and depression amongst the population (Torales, et al., 2020). For those in employment during the pandemic, the significant changes to working practices and work-life balance associated with working from home led to increasing concerns about the ongoing impact of the pandemic on the wellbeing of the nation's workforce and the need to identify effective future working practices (Boland et al., 2020). Despite these challenges, many effective working practices emerged during this time driven by innovative service provision, which has been significantly felt amongst academics in Higher Education (HE) institutions across the UK; with the sudden and unplanned move to online delivery (either wholly or blended) and the rapid adaption of traditional academic roles and working practices. The concept of 'office fit' (the characteristics of the working environment and their interaction with the individual psychological and physiological characteristics and needs) has long been acknowledged as needing to be addressed by any organisation, for them to ensure their long-term survival (Shalley, et al., 2004). Traditionally, in HE, academic staff have been primarily seen to carry out what is termed 'knowledge work' (Drucker, 1959; Davenport, 2005); applying their mental faculties to understand ding and use of information, decision making, and with high levels of creativity (Oyetunji, 2014). Researchers have explored similarities between academic and commercial knowledge work and the influence of work-group space (Leaman and Bordass, 2006; Ashkanasy et al., 2014; Khoshbakht, et al., 2021), layout (Haynes, 2008) and activity-based prac-

tices (Engelen et al., 2019) on mental health, wellbeing and productivity (To et al., 2012). However, it is clear that pre-pandemic operational models need to evolve. Alternative approaches, that consider environment factors such as lighting, heating, and ventilation (Al Horr, et al., 2016; Lan, et al., 2012), or connection to natural elements (Jamrozik and Clements, 2019; Berman et al., 2008; Palacios et al., 2020), noise prevention (Jamrozik, et al. 2018), and privacy (Keeling et al., 2015), are required. These integrate existing and new working practices for future knowledge working, which maximise people's physical and cognitive functions (Jamrozik, et al., 2019), and prevent loss of interest (Whitley et al., 1996). The Well Spaces and Academic Environments (WellSPACE) Project is a collaboration study between the University of Wales Trinity Saint David's (UWTSD) Assistive Technologies Innovation Centre (ATiC) and the Psychological Evaluation and Research Consultancy Hub (PERCH) with renowned architectural practice Stride Treglown. This study tested a mixed-method approach of three phases (Figure 1) that introduce user experience (UX) and psychological research methodologies; implement extended reality; and investigate data correlation between environment control, health and wellbeing measures to assess the usability of various hypotheses of a HE space as staff returned to the campus in Swansea (Wales, UK) for the start of the academic year 2021/2022.

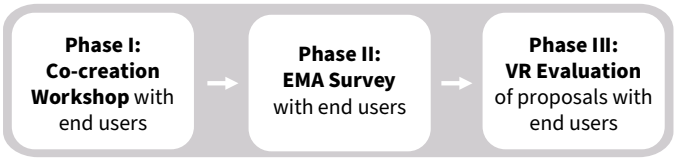

Figure 1. Phases of the mixed-method approach tested in this study.

Ultimately, we present this as a feasibility study of the application of this mixed-method approach as a novel architectural and spatial programming inter-disciplinary design strategy, which gives voice to end users throughout all stages of the study.

Mixed-method Approach

At the core of this study are end-users, academic staff who provided us with an insight into their own professional experiences in the engagement with workspaces, daily tasks, and students, to help us define how to redesign effective environments based on the conditions that affect people's physical and cognitive functions, as people tend to perform better when physically comfortable. Participants were encouraged to give feedback on how they feel at work, the spaces, furniture, layout, and footprint of these, and were challenged to suggest how to improve their experiences from a problem-solving approach. Shortly before the COVID-19 pandemic, the participant group had relocated to a new building which was purpose-built to accommodate an activity-based working typology – the 'IQ building' (UWTSD). This building comprises non-assigned workspaces, bookable meeting rooms and small pods for quiet working from an open-plan space that we call 'Room 303'. Post-pandemic, and during the study, participants had incorporated a hybrid workspace model, alternating working from home (WFH) with working on-site. The aim of this project was to identify the factors that affect mental health, wellbeing and performance of academic staff who have been assigned Room 303 as their workspace. For this, our team investigated the relationship between academic staff, their workplace, and the post-pandemic reconstruction that their practice was experiencing to support architectural design as an agent of change alongside end users. Our final outcome was the validation of data triangulation between the three phases of the study, explained below.

Phases of the study

During phase I, researchers implemented design thinking and UX methods. The workshop was divided into three activities that implemented methods such as mind mapping, place-centred user journey mapping, and participatory co-creation design (Figure 2A).

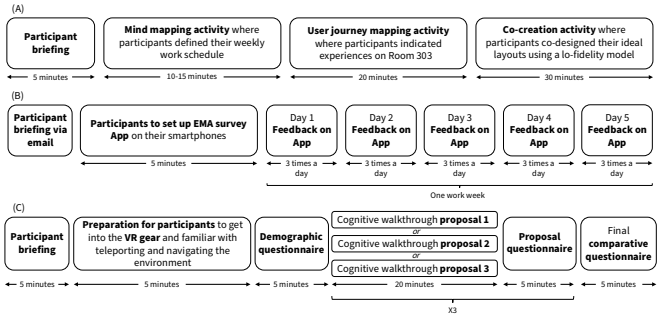

Figure 2. Protocols for (A) Phase I, (B) Phase II and (C) Phase III.

The ecological momentary assessment (EMA) survey, phase II, allowed us to collect data on end-user behaviour while working from their normal environments as explained in Figure 2B. Methods for data collection during this phase included experience sampling over a period, and exploratory analysis. The protocol for the final evaluation, phase III, (Figure 2C) included the use of VR and usability testing methods for qualitative and quantitative data collection – subjective VR walkthroughs, live observation and feedback questionnaires. The first two phases of the study informed the generation of three architectural proposals for the chosen test space Room 303 (Figure 3).

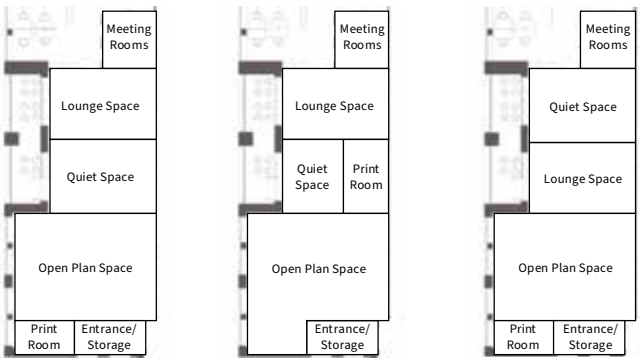

Figure 3. Architectural plan proposals for Room 3.
From left to right: proposals 1, 2 and 3.

Results

Data collected during the three phases was triangulated to identify the main findings of the study.

Phase I. UX metrics

Journeys mapped (Figure 4) helped us identify predominant use of Room 303 for 12 end-users over a two-day period and allowed us to investigate the correlation between the main activities and factors that influence their choices when working from this open plan space (Table 1).

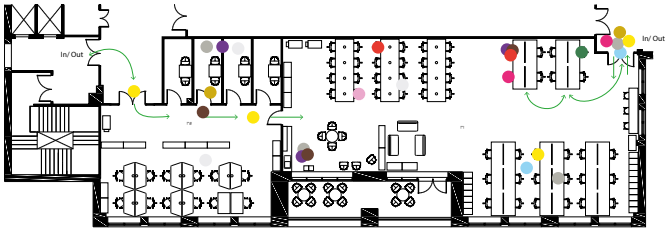

Figure 4. Participants' journeys were mapped on their use of Room 303 during co-creation workshops.

Table 1. End-user interaction with Room 303.

Activities mapped	Common influencing factors associated with low use of Room 303
Supervision/Emailing	No privacy; background/visual noise; and limited surface/power capacity.
Socialising/Having lunch	Fear of disturbing others; and limited kitchen storage.
Storing things/Printing	Insufficient storage units; and unclear allocation of these.

In general, there was discomfort in relation to some rooms. This was due to lack of ventilation, daylight, and connection to natural elements, which contribute negatively to performance. Through data collection on negative and positive variables (Figure 5A), we could recognise key objections in relation to spatial needs, which revolve around: privacy (e.g., pastoral care or data protection issues); accommodating unplanned use of Room 303 (and adjacent rooms); or managing ground rules (e.g., unsure of what is available for their use in the kitchen). Participants of the co-creation workshop demonstrated interest in getting involved on design decisions to improve the space by providing us with suggestions (Figure 5B), using a low fidelity model the groups generated five ideal layouts.

To inform subsequent work on behavioural assessment, the analysis of all the qualitative data collated during the co-creation workshops allowed us to group end users' needs into several salient themes (Table 2).

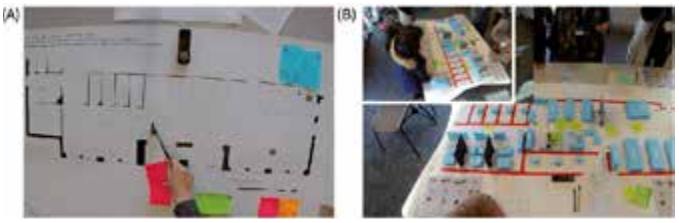

Figure 5. (A) Co-creation workshop feedback on negative and positive variables on Room 303, (B) example of layout co-designed by participants of the study using a low fidelity model.

Table 2. Salient themes captured from co-creation workshops.

Themes	Examples
Space	Quiet and private; community-building; and hybrid/hyflex teaching spaces.
Noise	Background and visual noise prevention.
Environment	Control over lighting, heating, ventilation and power; as well as more plants and daylight.
Storage	Personal/work belongings and food.
Management	Establish ground rules; identifiable furnishings; or hygiene and health & safety measures.

The lovely views of this workspace seemed to play a big role in ease of use of this workspace with those participants of the study sympathetic of open plan layouts enjoying working from Room 303; who found helpful building a sense of community and promotes teamwork. However, disparity in the feedback received implied that lighting and heating control and noise prevention remained prone to contentious issues between users.

Phase II. Behavioural assessment

For the phase II, EMA study, 55 responses were recorded from eight participants over a five-day period. Each respondent received 15 alerts across this period, with response rates ranging from 27% to 73% and an overall response rate of 46%. Table 3 shows primafrily on-campus activities, with comparative WFH data only presented to illustrate potential future design considerations. In our study, it is important to note that participants reported mainly WFH (65.5% of the time). The data presented in this section primarily focuses on data reported from on-campus activities, with comparative working from home data presented to illustrate potential future design considerations. Of those reporting working on campus (34.5%) the majority reported working in teaching rooms (14.5%) and non-shared spaces (14.5%) with a small number working at the on-campus library (3.6%). No participants reported using the shared workspace during the study period. Comparatively, Table 3 shows that whilst working from home, participants were most regularly engaged with preparation of teaching materials (22.2%), and least often engaged in online teaching (5.6%). The data indicates that the main reason for participants being on campus was for face-to-face teaching (50%), with associated teaching preparation being carried out on campus 16.7% of the time compared to 22.2% of the time at home. Of particular interest is the finding that no participants reported engaging in administrative or research-related tasks on campus.

Table 3. Activities undertaken during the working week.

Activity	WFH	On-campus
Teaching - Online	5.6%	5.6%
Teaching – Face to face	0%	50%
Student supervision - Online	8.3%	0%
Student supervision – Face to face	0%	5.6%
Meeting - Online	13.9%	5.6%
Taking a break	5.6%	5.6%
Marking	8.3%	5.6%
Preparing teaching materials	22.2%	16.7%
Admin tasks	16.7%	0%
Research related activity	11.1%	0%
Other	8.3%	5.3%
Total	100%	100%

Environmental disturbances, suitability, and control

Over the course of the study, participants indicated that they were being disturbed by one or more environmental factors 41% of the time. Of the overall on-campus disturbances, the most common were insufficient surface space and factors such as physical discomfort, feeling cold, and lack of access to resources, with the latter being reported significantly more often than WFH ($t(52) = -2.91$, $p = 0.005$). Table 4 indicates

that respondents reported generally similar levels of perceived environmental suitability across both on-campus locations and while WFH without significant differences across these locations. Participants also reported a generally high perceived level of control over their working environment WFH and in non-shared on-campus rooms. The lower level of control reported within the teaching rooms is indicative of the nature of teaching activity within the room but warrants further exploration.

Table 4. Mean scores of perceived environmental suitability and control across all responses.

Location	Suitability (0-5)	Control (0-10)
Working from home	3.7	7.7
On-campus teaching room	3.4	3.4
On-campus non-shared room	4.1	6.3
On-campus library	4	5

Wellbeing

Of the eight wellbeing factors captured during this phase of the study, the most endorsed overall while working on-campus were happiness and engagement (both M = 6.8). The lowest-reported factor was anxiety (M = 2.9), which was also significantly lower on campus than when WFH (M = 4.2, t (52) = 2.36, p = 0.02). Whilst the trends in the data suggest that engagement was often higher towards the end of the week than at the start with anxiety lowering over the course of the week. The individual variation in these wellbeing factors is an important reminder of the challenges of accounting for individual differences in the psychological facets of workplace design preferences.

Phase III. VR evaluation

Five academic staff from UWTSD participated in this phase of the study, whose main roles were lecturers or senior lecturers, between the ages of 35 and 58 years old. They had limited previous experience of using VR systems.

Participants

Demographic data gave us an indication of population-based factors representative of the academic community, that we could correlate with subsequent datasets collected more specific to spatial factors. We found that predominant work model was hybrid (80%), as opposed to working on-site (20%) or fully WFH (0%) (Figure 6A). Academic staff have rapidly adapted to hybrid working (Figure 6B), implying that depending on their main roles and time of the year, individuals need a flexible space that adapts to their changing needs.

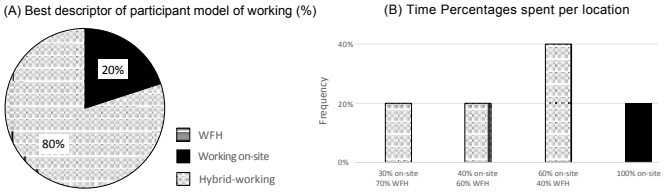

Figure 6. Participant working preference per (A) model of working and (B) location.

Data indicates that the main activities that academic staff undertake daily were teaching face-to-face; taking virtual meetings; marking; preparing teaching material; and administrative work (Figure 7). If we look reflectively upon previous findings from phases I and II, this data suggests a reiteration of certain factors. This includes the need for spaces to run one-to-one sessions on-site, teach within hyFlex facilities or catch up with colleagues.

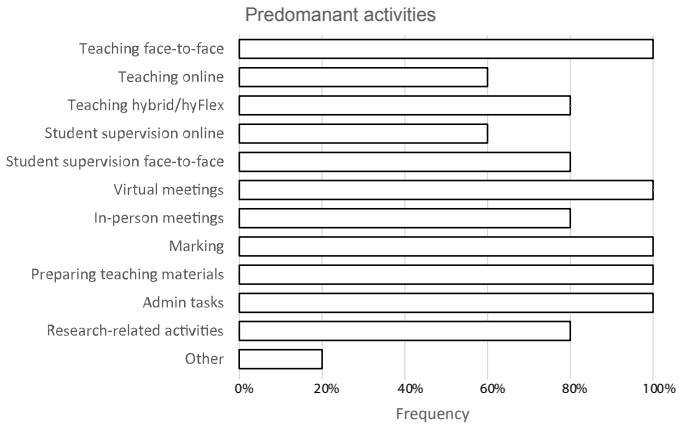

Figure 7. Predominant activities registered as undertaken by end-users daily.

VR walkthroughs

Using computer-generated environments of the original layout of Room 303 (Figure 8A) and of the three redesigned proposals (Figure 8B), participants were asked to navigate through each of the proposals in random order to evaluate their usability based upon factors defined from previous findings. Mixed reality (MR) played a big part in the protocol designed for the VR evaluation. Researchers generated computerised realistic representation of the architectural proposals using Unity development platform with high-end VR system HTC Vive Pro. To match VR simulation characteristics with that of the real world, this technology was combined with the use of physical furniture, embedding of audio recordings from the existing space, and photographic maps of the external views (Figure 8C). Participants' experience of the VR simulation was documented using internal VR recordings of their perspectives and external multi-camera recordings (Figure 8D) for post-processing.

Figure 8. (A) VR representation of original layout of Room 303, (B) VR representation of proposal 1, (C) VR simulation with participant interacting with furniture, and (D) lab set up for VR simulation.

Data suggests that meeting spatial needs linked to privacy (e.g., one-to-one sessions with students or being able to provide hyFlex teaching) is still challenging for the three alterna-

tive proposals. However, there is a general agreement about the effectiveness of the proposals when it comes to meeting social needs. Personalisation and individual desking areas are very important for academic staff, where we have identified that it contributes towards a lack of sense of belonging. User footprint suggests that those whose practice is in proximity to Room 303 use this staff room more frequently, as opposed to those whose practice is disconnected to Room 303. Data shows that storage is a recurring challenge. In general, there is a tendency to prefer a variety of furniture within the same open-plan office space as opposed to having separate and crowded quiet areas.

Comparative between proposals

Following the physical and cognitive VR walkthroughs of the three proposals, previously designed by Stride Treglown, participants registered their preference in feedback questionnaires following a five-point Likert psychometric scale (Figure 9), which indicates that most participants tend towards the layout configured in proposal 1; very closely contested by proposal 3. Although the layout presented in proposal 2 did not satisfy participants as consistently as those in proposals 1 and 3, participants suggested that the variety of furniture choice available in this second configuration would pose an advantage for those who want to work more privately or within teams all in the same hybrid workspace.

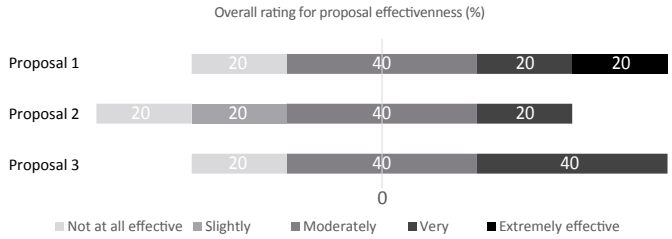

Figure 9. Overall participant rating of the effectiveness of the three alternative proposals presented.

Discussion

The triangulation between methods used in the three phases of the project direct us towards identifying the factors that impact academic staff behaviour, wellbeing, and performance, looking closely at the features of our test space, to inform future design strategies and decisions. However, there are other factors around user expectation (e.g., not feeling heard by management team) that may generate loss of interest in building community and could prevent the use of dedicated workspaces. Even though academic staff participating in this study were inclined towards one of the alternative architectural proposals designed for Room 303 during this study, data shows that this workspace would still present challenges when it comes to: accommodating one-to-one meetings, tutorials, or external guests; privacy for marking or dealing with student issues; and creating the right spaces for quiet working and online teaching on-site parallel to their pre-pandemic responsibilities. However, our intention with this study is to set out the pathway for future research approaches on investigating the features needed to overcome these challenges in pursuit of a workspace configuration that minimises the impact on the mental health, wellbeing, and performance of its users in relation to their practice.

When considering the future design of academic workspaces, therefore, in addition to continuing to support teaching and related activity, there is a need to better understand the barriers and requirements to supporting research and administrative activity in modern academic shared workspaces. Collectively, our results potentially suggest that hybrid working practices may help academic staff to fit their environmental location to the requirements of the specific task. Possibly, allowing academic staff to personalise part of the workspace assigned to their teams will help tackle issues around storage, as well as to allow Room 303 to turn into a hub for all academic staff from across disciplines. The challenge for the future design of academic workplaces is how to create the flexibility of workspaces to enable academics to engage with all aspects of their job roles in on-campus shared locations and consider individual preferences and motivations. Therefore, standardising design strategies that support this and allows for the implementation of research methods, such as those tested in this study, are needed at both early design stages and post-occupancy, to explore the longer-term effect of new spatial designs.

Going forward, the team intends to investigate further methods to quantify human response to changes in architectural features, where extended reality is fused with non-invasive techniques to measure and quantify psychophysiological responses longitudinally in conjunction with attitudinal and behavioural techniques validated in this study; and to continue exploring how a mixed-method approach can be further validated by testing it within alternative settings and user cohorts.

Conclusion

This inter-disciplinary study outlines an opportunity to systematically explore what the future of working spaces and practices should look like by testing these within a HE context to develop new and innovative architectural and spatial programming design strategies that can be translated to working environments in other creative, knowledge and professional service sectors. Due to COVID-19 restrictions we faced limitations on participant recruitment and managing their expectations where some may feel their voices have not been heard. Researchers have been aware of conflict of interests where possible to ensure transparency during research in the prevention of potential bias. With the c o-creation workshops (phase I), we identified users' needs – categorised by space types, storage, environment control, noise and management – and co-designed ideal layouts with end-users. The ecological momentary assessment (phase II) gave us an insight into how participants feel and behave when working from different environments over a work week. Finally, we evaluated the effectiveness of three alternative proposals for Room 303 where participants took part in a VR simulation (phase III). Results from the three phases, predominantly through formative evaluation, consistently show that end-user participation is hugely beneficial in developing design strategies essential for inclusive architecture. Overall, the data suggests that management plays a big role in ensuring that workspaces respond to the needs and footprint of different users throughout academic periods. This document focuses on such findings of this study that demonstrate the feasibility of the mixed-method approach implemented for the WellSPACE project. We conclude with a research agenda that advocates building on the positive results of this mixed-method approach by (a) introducing psychophysiological measures;

(b) maximising the implementation of mixed-reality; (c) and investigating data correlation between environment control, health and wellbeing in future research works.

Acknowledgments

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An attempt to integrate AI-based techniques into first year design representation course

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Abstract

This research aims to explore the potential application of AI-based techniques in the introduction of design representation during first-year education. Specifically, the study examines the integration of traditional representation techniques used in design education with AI algorithms through an assignment implemented in a course namely Visual Communication 1. This course is part of the Integrated Foundation Studio (IFC) model, which has been implemented at Istanbul Technical University, Faculty of Architecture for the past 8 years. The assignment was completed by 64 students from three different departments (architecture, interior architecture, industrial design) who were all freshmen with little prior knowledge and experience in design representation and digital tools. The assignment has three steps as: (i) creating a composition with basic solids and producing an isometric projection of the composition by hand drawing, (ii) generating a series of images by using an AI-based tool Midjourney by defining keywords, and (iii) combining the previous two productions using various techniques. As a result of this assignment, 50 out of 64 students produced and submitted their personalized and unique design representations. The outcomes of the assignment are qualitatively evaluated under two main categories as Combining Techniques and Atmospheric Elements. While the first main category Combining Techniques refers to types of used modification and visualization techniques, Atmospheric Elements deals with texture, color, and forms derived from AI-generated images. Initial findings indicate that text-to-image techniques of AI contribute to enhancing the interpretation and composition skills of freshmen while producing new visual representations by making use of source images and technical drawings.

Author keywords

Design Education; Design Representation; Visual Communication; Artificial Intelligence; Freshmen; Midjourney

Introduction

Advances in digital technologies continue to transform design processes with an increasing acceleration in the last two decades. Processes from a conceptual design to an end product have required a new mindset, toolset, and skillset with the rise of the computational design paradigm. In his paper, Schmitt (1997) conceptualizes the evolving impact of digital technologies on design under three phases: computers as tool, medium, and partner. In this consideration, the first encounter with designers and computers served to digitize traditional representations. The second wave mediated the utilization of computational approaches in design and production, while digital technologies provided more contribution than being a tool or a method. Partner refers to the active contribution of digital technologies to the design process as an actor.

Considering the constant pressure on the evolution of design processes, it has become crucial to reconsider integration of the emerging tools, techniques, and approaches into design education. On one hand integration of emerging technologies into existing design curricula is not a new topic (Duarte et al., 2012, Mark et al., 2001), the technologies that support design and representation continue to evolve on the other hand. Although the insertion of computation into design education has been approached by many scholars (Güzelci et al., 2021; Varinlioğlu et al., 2016), implementations and experiments on the integration of AI-based technologies into design education are limited (Akçay et al., 2022; Sciannamè, 2022; Sorguç et al., 2022).

The goal of this study is to explore the potential use of AI-based techniques in first-year design education, with a specific focus on the fusion of traditional representation methods with artificial intelligence (AI) algorithms. This examination is conducted through an assignment implemented in a design representation course, namely Visual Communication 1 (VC-1). VC-1 is a module of the Integrated Foundation Studio (IFS) model, which has been implemented at the Faculty of Architecture of Istanbul Technical University.

This teaching experiment seeks to answer the following questions:

- Does combining the current teaching methodology of the VC-1 with the possibilities of AI contribute to the students' skills such as establishing a part-whole relationship, thinking in three dimensions, expressing their design ideas, making collages, and forming compositions?
- How can students' creative thinking be supported while teaching operational knowledge and skills such as technical drawing and orthographic projection?

The assignment is carried out as part of the VC-1 course in which 64 students from 3 different departments (architecture, interior architecture, industrial design) are involved. The students enrolled in the course are all freshmen and have very limited knowledge and skills on design and representation. The assignment has three steps as: producing an isometric projection by hand drawing, generating a series of images by using an AI-based tool Midjourney, and fusing these two productions with various analog techniques. Following these steps, all students produced and submitted their personalized and unique design representations. The outcomes of the assignment are evaluated by the tutors according to 5 criteria (grouped under 2 main categories) extracted following an initial qualitative evaluation (Table 1).

Methodology

The education model and the course

The Integrated Foundation Studio (IFS) is an integrated education model that has been implemented at Istanbul Technical University, Faculty of Architecture for over eight years. The IFS model provides integrated and systematic course modules to students from five different departments, including architecture, urban planning, industrial design, interior architecture, and landscape architecture, to avoid repetition and convey that concepts and principles are part of the whole. The IFS program is composed of a total of five-course modules, distributed over two semesters. The first semester includes courses such as "Project 1", "Visual Communication 1: Visualization and Technical Drawing", and "Basic Design and Visual Arts". The second semester includes "Project 2" and "Visual Communication 2: Visualization and Perspective". The IFS model is supported by theoretical lectures and assignments, with a focus on creative thinking, the design process, and the final product. The syllabuses of the modules are prepared and presented concurrently to reflect the coordination between them. The emphasis on creativity, process, and final product, in addition to the cohesive nature of the program, allows students to develop a holistic understanding of design principles and practice.

The "Visual Communication 1: Visualization and Technical Drawing" (VC-1) is a 4 hours course that aims to enhance students' ability to externalize and develop design ideas through a variety of mediums, tools, techniques, and approaches. By taking this course, students will gain insight and knowledge on the basic design elements such as line, shape, form, and color, as well as graphical elements and techniques such as shade, shadow, texture, collage, and rendering. They will also learn about the representation and manipulation of complex geometries and the principles of projection, as well as how to sketch the orthographic views of structural and contextual elements (TES Foundation Studio, 2022).

In addition to traditional representation techniques such as freehand drawing, sketching, orthographic drawings, and axonometric drawings, the course also encourages students to explore experimental representation techniques that they develop themselves to express their design ideas and products. The course exposes students to digital tools and software for visual representation, providing them with the skills necessary to effectively utilize technology in the design process. Overall, the VC-1 course is an essential component of the Integrated Foundation Studio (IFS) program and aims to provide students with a comprehensive understanding of visual communication and technical drawing in the context of design education.

For the 2022-2023 fall semester, the weekly schedule of VC-1 is organized as given in Figure 1 and 64 students from 3 departments are enrolled in the course. The numbers of architecture, interior architecture, and industrial design students are 24, 22, and 18, respectively.

Figure 1. Weekly schedule of VC-1 (2022-2023 fall semester).

The assignment

As a module of IFC, the VC-1 course is selected to experiment the fusion of traditional representation techniques with AI-based algorithms. The assignment for this experimentation is designed to last for one week (Week 8) and is divided into three steps: in-class technical hand drawing by the students (2.5 hours), in-person tutorial by the tutors (1.5 hours), and work at home by the students to complete and submit their final productions.

In the first step of the assignment, each student created an isometric projection drawing relying on their previously generated composition of basic geometric forms, and traditional drawing equipment. The second step of the assignment involved a tutorial on the use of the Midjourney interface, which uses AI-based algorithms to generate images from text inputs. Tutors first prepared a tutorial video that described how to use the Midjourney interface through example image generations for text inputs. The content of the video tutorial was introduced to the students in the class and their questions (both contextual and technical) were answered.

DALL-E is another AI-algorithm that can be used for assignment and generates images from text. The DALL-E interface allows users to change the dimensions of the generated images, delete selected parts of the images, and replace them with new visual materials. Due to its limitations to interfere with the generated image, Midjourney was chosen to provide a common format that can be evaluated/compared in the works. In the Discord channel where Midjourney generations were made, students also saw text inputs defined by other users as well as visual outputs corresponding to these inputs.

Following the in-person tutorial, tutors shared the assignment brief, a public link to the tutorial video, and a flowchart describing the steps for image generation. To ensure that the generated images are relevant to the assignment, "isometric projection", "detailed", "shade and shadow", and "8K rendering" were defined as compulsory keywords and phrases for the image

generation. Apart from these compulsory keywords, students are asked to select their keywords or phrases considering the predefined categories. The predefined categories are as follows; "style" (like cinematic, cartoon, realistic, futuristic, "color" (such as soft, dark, neon, pastel, black and white), "story" (one or more sentences from a movie, series, book, poem or imagination of the participants), "material" (like metal, concrete, steel, timber), and "people" (such as woman, man, elder, teenage, robot, alien, groups of people). Last, students were requested to upload their isometric projection drawing, AI-generated image, and fusion of drawing and image to separate cloud-based folders created by the tutors.

In the final step of the assignment, students were asked to complete their work at home by utilizing the AI-based algorithms they learned about in the tutorial. Following logging into the Discord application where they can interact with Midjourney interface, students decided on the keywords or phrases as input and ran the algorithm to generate 4 AI-generated images. The Midjourney allows the students to run the algorithm multiple times (up to 25 for the free version) and produce alternative images. The final step required students to augment their previous isometric drawings by incorporating information captured from the AI-generated images. This reflection from AI-generated images into new productions by using previously obtained isometric drawings covers the decomposition and interpretation of the source domain, as well as the use of free techniques such as collage, watercolor, and redrawing.

Table 1. Evaluation of students' work based on defined categories and criteria.

	COMBINING TECHNIQUES					ATMOSPHERIC ELEMENTS				
	MODIFICATION		VISUALIZATION TECHNIQUE			TEXTURE OF AI		COLOR OF AI		FORM OF ISO
	DIRECT USE OF ISO	DIRECT USE OF AI	DRAWING	PAINTING	CUT & PASTE	BACKGROUND	FACES	BACKGROUND	FACES	ADAPTED
1	●	●		●	●	▲	▲	▲	▲	▲
2			●	●		▲	▲	▲	▲	▲
3				●		▲		▲	▲	
4		●		●	●	▲		▲	▲	▲
5			●		●	▲	▲	▲	▲	▲
6	●				●	▲	▲	▲	▲	
7	●			●			▲	▲	▲	
8			●	●		▲	▲	▲	▲	▲
9			●	●		▲	▲	▲	▲	▲
10	●		●	●	●	▲	▲	▲	▲	▲
11	●	●	●	●	●	▲	▲	▲	▲	▲
12			●	●	●	▲	▲	▲	▲	▲
13	●			●	●	▲	▲	▲	▲	
14	●	●		●	●	▲		▲		
15	●			●			▲	▲	▲	▲
16	●		●	●	●	▲		▲	▲	
17	●	●			●	▲		▲	▲	
18	●	●			●	▲		▲		
19	●		●	●	●	▲	▲	▲	▲	
20					●	▲	▲	▲	▲	
21	●	●			●	▲	▲	▲	▲	
22	●				●		▲	▲	▲	▲
23			●	●		▲	▲		▲	
24	●	●	●	●	●	▲		▲	▲	▲
25			●	●		▲	▲	▲		▲
26			●	●			▲	▲	▲	▲
27	●				●	▲	▲	▲	▲	
28	●			●	●	▲		▲	▲	
29			●	●			▲	▲	▲	▲
30	●	●			●		▲		▲	
31			●	●		▲	▲	▲	▲	▲
32	●		●	●	●	▲		▲	▲	
33	●			●		▲			▲	
34			●	●		▲	▲	▲	▲	▲
35						▲	▲			▲
36	●				●		▲	▲	▲	
37			●	●	●	▲	▲	▲	▲	▲
38			●	●	●	▲	▲	▲	▲	▲
39	●			●	●	▲	▲	▲	▲	
40			●		●	▲	▲	▲		▲
41	●			●			▲		▲	
42	●		●	●		▲		▲	▲	
43			●			▲	▲	▲		▲
44	●	●		●	●	▲	▲	▲	▲	
45			●	●	●	▲	▲		▲	
46	●		●	●		▲		▲	▲	
47	●	●			●	▲	▲	▲	▲	▲
48			●	●		▲	▲	▲	▲	
49			●	●		▲				▲
50	●		●	●		▲		▲	▲	

Results

The productions obtained by blending the AI-generated image and the isometric projection drawings are grouped into two basic categories according to their characteristics. The first category, "combining techniques", involves the evaluation of the modification type and visualization techniques used while creating the final product. The second category, "atmospheric elements", comprises the usage of texture, color, and form derived from AI-generated images. All final productions were evaluated under these two main categories and their subcategories, which are summarized in Table 1.

To emphasize, the presented assignment was completed by a group of students from architecture, interior design, and industrial design. However, since the students had only been at the faculty for seven weeks and had not enrolled in any field-specific courses, the assignment results were not discussed according to the departments in which the students were enrolled.

Combining techniques

Modification

The analysis of the final results showed that different combining techniques were preferred by the students while creating the final images by blending the isometric drawing and the AI-generated image. 44% of the students revised their isometric drawings, while 56% kept their drawings as they were. On the other hand, 78% of the students modified their AI-generated images and transferred them to their final work. Only 20% of the participants adapted both the isometric drawing and the AI data. It is observed that 32% of the participants did not modify either the AI image or the isometric drawing. This could indicate that the students had difficulties in adapting the AI image and isometric drawing, which could be due to the fact that they have not completed even half of the first semester of the first year of design education. This highlights the need for further education and training in the use of AI-based algorithms in design education, to improve students' ability to effectively incorporate these techniques into their design process.

Visualization technique

Although the participants were not limited to any particular method, the visualization techniques used by students while creating the final product can be grouped under three basic categories: drawing, painting, and cut-and-paste methods. It should be noted that, as the students were in the early stages of their design education, no digital compositing and editing programs were taught before this assignment. Students were

mainly expected to create a poster using traditional methods, but the use of digital methods was also accepted.

The most common method used by students was painting, with 37 participants using this technique. The second most common method was the cut-and-paste, used by 28 participants, followed by drawing, used by 27 participants. Some students preferred to use more than one of these visualization techniques. 20% of the participants used all three visualization techniques together. There was one participant who did not use any of these techniques. The most preferred combination was the use of both drawing and painting techniques, which made up 28% of the participants. Additionally, 14% of the participants used painting and cut-and-paste techniques together.

Atmospheric elements

Texture of AI

In the scope of the given assignment, it was examined whether the image produced with the Midjourney interface was used while creating a texture in the final data. 42 students used the texture of the image that emerged in Midjourney as the background of the newly created data. A total of 36 students used the AI-generated texture on the surfaces of their isometric drawings. The work of student 30 (STU.30), shown in Figure 2, is a clear example of this. This result suggests that students were able to effectively incorporate the textures generated by the Midjourney into their final work, highlighting the potential of AI-based algorithms in enhancing the visual qualities of traditional representation techniques.

All of the participants used the AI-generated texture in their final work, either in the background or on the surfaces of their isometric drawing. A total of 56% of the participants utilized the texture in both the background and the isometric drawing, indicating the flexibility and versatility of the AI-generated textures in changing the visual qualities of their work.

Color of AI

The usage of the colors of the image created with AI in new production is frequently preferred by the students. In this context, 86% of the students used these colors in the background of their new work and 86% used them on the surfaces of the geometries represented in the isometric drawing. Since most of the students completed the work by hand, the exact match of the color codes in the digital data and the colors in the final work was not expected. The use of colors from available materials was also accepted as long as they represented the digital color code. Only 4% of the participants did not transfer the AI-generated color to their new production, and 76% of them used both for the background and the isometric drawing surface.

This result highlights the importance of color in enhancing the visual qualities of the final work and the ability of students to effectively incorporate AI-generated colors into their traditional representation techniques. It also suggests that providing students with a wide range of colors and color palettes generated by AI-based algorithms can support their design work.

Form in AI

48% of the students used the form, which they created as an isometric drawing, by reshaping and adapting it according to the AI image. In this interpretation, minimal changes were generally preferred, and the main block of the isometric drawing was not far away. The form in the isometric drawing of student number 34 (STU.34) is a typical example of reshaping according to AI data. In the isometric form, several openings were created to strengthen its spatial characteristics, and the similarities to the mass offered by AI were revealed (Figure 2). This result suggests that students were able to effectively incorporate the forms generated by AI-based algorithms into their traditional representation techniques.

Conclusion

This study aimed to explore the potential use of AI-based techniques in first-year design education, with a specific focus on the fusion of traditional representation techniques used in design education with AI algorithms. Through an assignment implemented in a design representation course, the study sought to investigate whether combining the current teaching methodology with the possibilities of artificial intelligence technology would contribute to the students'

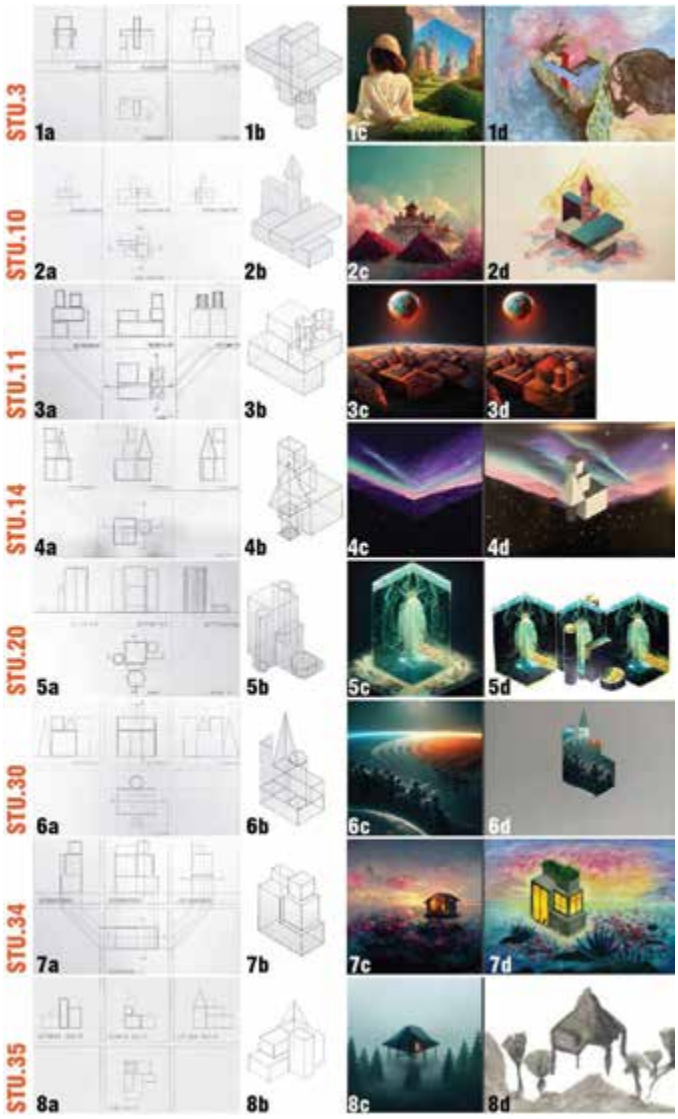

Figure 2. Examples from students' work: plans, sections, and views (column a); isometric projections (column b); AI-generated images (column c); fuse of isometric projections with AI-generated images (column d).

skills such as establishing a part-whole relationship, thinking in three dimensions, expressing what they think, making collages and forming compositions. This study allows for a clear comparison and analysis of the different techniques and elements used by students in the final products and provides insight into the potential of combining traditional representation techniques with AI-based algorithms in design education.

In previous years it was observed that technical orthographic drawings mostly remain as a separate skill and it cannot meet design thinking processes. Students tend to generate technical drawings and other conventional representations after their design ideas become concrete, instead of integrating these drawings into visual and spatial reasoning. In this context, the findings of the study showed that the integration of AI-based techniques in the design representation course improved the students' skills and supported their creative thinking, highlighting the potential of AI-based techniques in design education. The AI-generated images provided contextual qualities such as composition, temporality, sense of scene with environmental elements, scale, etc. The decomposition of these elements and making collages supported the reflective thinking process, while augmenting the previously generated technical drawings. The assignment, in particular, encouraged students to use traditional representation methods combined with AI-based algorithms to create an innovative and unique representation of their design ideas.

It should be noted that the results of this study should be interpreted within the context of the study's limitations. The number of students enrolled, the complexity of the design task, and the specific encounter between AI and students could all affect the results. To draw more concrete conclusions, further research with larger sample size, more complex design tasks, and different AI-student interactions would be necessary.

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The Emperor is naked: deconstructed materiality in fashion NFTs

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Abstract

Guy Debord defined his modern world as the society of the spectacle. Today, the increasingly influential Metaverse that includes the NFT images indicates a new postmodern spectacle. Like so many other spectacle spaces and activities, fashion could not remain innocent and started to develop its NFT world. Fashion is thus entering a Metaverse as yet unforeseen but probably inevitable. Matthew Ball claims that: "As more of human culture shifts into virtual worlds, individuals will seek out new ways to express their identities and show off." Examples of this new kind of human expression are *the Antwerp Cyber-Six(C6-Designers)* projects or the collaboration between the luxury brand Balmain Paris and the toy brand Mattel. However, the Balmain NFT Barbie is raising fundamental questions of aesthetics and the psychology of image. Fashion and the Barbie universe have been mutually inspired by each other since the 1970s. NFT Barbie is a new step in imagining the child's existence through the Barbie dolls and the doll phenomenon in general. In the background of this story, we may find Freud's and E.T.A Hoffmann's *unheimlich* Olympia doll, and the surrealist phantasy of Hans Bellmer's 1934 photo book *The Doll*. This paper explores how our relationship with fashion is changing with the emergence of fashion NFTs. The paper investigates this new phenomenon through three case studies.

Author keywords

digital fashion, NFT, fashion studies, deconstruction, Antwerp Cyber-Six

Metaverse and NFT

The pandemic has brought about a powerful change, primarily economic but social and cultural, transforming the arts into a newly emerging digital space, the Metaverse. If we had to name the most exciting phenomenon in the art scene in 2021, it would definitely be the NFT. There is hardly an artist who has not heard of the 'non-fungible token' system and the heated debates surrounding it, "which are expected to bring about a revolution in the digital art market through blockchain- technology." (Sárai, 2022, p. 4) "The success of NFT has exploded relatively recently thanks mainly to the record $69.3 million sale of the digital artwork by artist Beeple" ("Crypto Art," 2022) According to the book *Crypto Art: How to Become A Crypto Artist Step by Step*. Of course, the world of fashion is also affected by the emerging and popular NFT. This paper focuses on this phenomenon, giving three examples and a possible theoretical framework.

Metaverse refers to a three-dimensional world that is simultaneously considered real yet not real, created at the boundary between virtual and augmented reality. "It is a persistent virtual world that reached, interacted with, and affected nearly every part of human existence." (Ball, 2022, p. 4) Their users interact with each other through virtual avatars built with different fetish characters. The terminology "Metaverse" comes from the 1992 science fiction novel *Snow Crash* by American author Neal Stephenson. One of the settings of the book's plot is a virtual space called Metaverse. Video games (World of Warcraft, Fortnite, Second Life) account for the most significant percentage of platforms currently operating as Metaverse. However, they still need to be properly interconnected. "One of the main promises of the future is that a Metaverse network can be created in which these atomized virtual worlds are interconnected so that their users can roam between them with a single sub-agent." (Sárai, 2022, p. 4) As home office became more widespread thanks to the quarantine of the Coronavirus, developers of digital spaces continued to work on NFTs, originally linked to video games, as their popularity grew. Matthew Ball claims that: "As more of human culture shifts into virtual worlds, individuals will seek out new ways to express their identities and show off." (Ball, 2022, p. 270) Ball also warns us that with the rise of Metaverse we are entering a kind of 'dystopia': after all, the concept of Metaverse is that it will envelop all our lives, labor, leisure. (Ball, 2022, p. 22)

In addition to demand, a solid base for the construction of the digital space is to be found in the spread of the digital economy and the burgeoning cryptocurrency trade[2]. NFTs can be created on a blockchain network (e.g., Ethereum, Polygon, Solana, etc.) and then purchased using cryptocurrency on online marketplaces such as Nifty Gateway, SuperRare, or Decentraland. These are intermediate spaces through which real people in the real world can buy and own digital products, take ownership. The items that can be bought, range from digital artwork to collectible cards to clothes for your virtual avatar. Their unique authenticity is what gives them their verifiable digital authenticity. Items created on the blockchain are unforgeable because their sale is traceable precisely through the blockchain's mechanism, so their origin can be controlled and recorded. The cryptocurrency operating principle automatically associates a certificate of authenticity with the purchased artwork, and the transaction trail remains on the blockchain, indelible, indicating who bought the original digital work, when and for how much. Because a blockchain-based archive of the ownership of artworks is maintained, original copies can not only be owned but also passed on. Owners of original copies can buy and sell artworks on NFT marketplaces. However, they

can also create online galleries and museums in the digital space so that anyone can browse the digital art they own. "The buyer can do two things with his NFT: he can show it off, or he can trade it."(Sárai, 2022) In other words, he can include it in his desires, enjoy the exclusivity of possession in the manner of Lacanian jouissance (Leader, 2021), or, through the operation of a commodity relationship, sell this perverse pleasure.

The blockchain network significantly impacts the art trade scene and the luxury fashion industry precisely because of its "customization". At the same time, fashion shows are becoming increasingly digital: the first ever *Crypto Fashion Week* appeared between 10-17 September 2021 ("Crypto Art," 2022). Commercial galleries, auction houses, and major fashion houses are also affected by NFT and cryptocurrency trading. A good example is *Sotheby's*, which has eighty locations in the real physical world but has its own digital auction space. The company opened a virtual counterpart of its London gallery in the Voltaire Art District of the Decentraland virtual platform in 2021. There are also examples of digital exhibitions. Among art institutions, the German *König Galerie* was the first to organize an exhibition on the Decentraland platform, *The Artist is Online*[3]. It has also set up a linked NFT auction on its OpenSea platform. The exhibition was shown live in the gallery's real space in Berlin. From this perspective, it seems that even investors and the profession at large have doubts about the success of an exclusively online exhibition.

Digital fashion examples

My first digital fashion example is the collaborative 3D fashion film work of the AES+F (artist) group with the design brand *Gentle Monster*, which, alongside its stunning visual world, blurs the boundary between art, advertising culture, and fashion while "blurring the real body in favor of the spectacular body." (Sibrik, 2022, p. 11). Their *The Circle of Life* project is also linked to the world of fashion films (see more: Reese-Roberts, 2019). Hieronymus Bosch's *Garden of the Earthly Delights* is brought to life with this spectacular project as NFT. "First formed as AES Group in 1987 by Arzamasova, Evzovich, and Svyatsky, the collective became AES+F when Vladimir Fridkes joined in 1995. AES+F work at the intersection of traditional media, photography, video, and digital technologies. They define their practice as a kind of 'social psychoanalysis' through which they reveal and explore contemporary global culture's values, vices, and conflicts."(Malevolent, 2021)

The second example is *The Antwerp Cyber-Six (C6 Designers)*. The group is named as an homage to the six graduates (1980) of the Antwerp Royal Academy, who became an influential avant-garde collective in fashion history. In order to re-ignite this legacy, MUTANI invited six Antwerp-based creative zealots to blaze new virtual trails: Brandon Wen, Flora Miranda, Max Rittler, Nadav Perlman, Shayli Harrison, and Stefan Kartchev. *The C6-Designer* is a project by Antwerp- based digital fashion network MUTANI, supported by the City of Antwerp. MUTANI is a Web3 digital fashion company stepping up "against the oppressive and exploitative nature of the fashion industry, alongside the capitalocene that has broken our imaginations and blocked the formation of a creative spirit." ("Introducing: The Antwerp Cyber-Six," 2022). To subvert this system they are staging a creative coup; inviting and onboarding a digital fashion, unitive to drive actions between the most radical fashion designers and digital creators. MUTANI collaborated with ior50 Studio to translate six digital silhouettes on six avatars. ("Introducing: The Antwerp Cyber-Six," 2022). The first stop of this futuristic digital fashion project was in Miami. The digital collection was exhibited at the Scope Art Show from 29 November to 3 December. There was also a live exhibition and online auction in partnership with MetaMundo ("Miami Art Week + Art Basel Miami Beach 2022," 2022). *The C6-Designers* put avant-garde aesthetics into the digital realm.

The third example is the Mattel x Balmain collaboration. The Barbie collection that could be bought as NFT: the auction was held on Mint NFT.com. This has also affected the physical sales of the luxury brand Balmain, as in addition to the NFTs, the brand has launched a ready-to-wear collection with the Balmain x Barbie logo.

Deconstructed ideologies: The Antwerp Cyber-Six

C6-Designers are carrying on the cultural heritage of the "Antwerp Six" (Walter Van Beirendonck, Dries Van Noten, etc.) in the digital space. A good example is the "Halo" character designed by Flora Miranda: the designer deals with the disintegration of physical borders, with the immaterial body and being. *C6-Designers* not only deconstruct the materiality of the garment, but the function of the garment is also no longer connected to the physical world. In doing so, they also perform a critique of the fashion industry through their deconstructive design (as did their great predecessors such as Martin Margiela). Their distinctive technique is irony [4] and gender performativity (Butler, 2006). These designs deconstruct not only the human body but also gender. The MVFW23 collection by the designer "Brandylaa" clearly questions gender. Still, a very similar aim is also pursued by the designer Stefan Kartchev, whose clothing design/character "Cooee!" is linked to the concept of "ecosexuality" (seeing nature as your significant other, a relationship that comes with all the nuances of human relationships). These *C6-Designers* are not only deconstructing the materiality of clothing, but also ideologies.

On their own Instagram page, the aforementioned *C6-Designers* have posted images of these NFTs drawn with their own hands on a page and also photographed the garments realized/created in the physical world on real flesh and blood models. Although the same glamour cannot shine through in the clothes created in the physical world, it is still exciting to see these designs on the page and as part of a real photographic material. This also implies that the physical world and the Metaverse still mutually support each other, so it cannot be said that these artists only created these works of art as NFTs in the digital space. It seems that the Metaverse will always draw its strength from the real world. In the case of *C6-Designers*, NFT is a deconstructive gesture, a critique of the fashion industry (which, as we know, is unsustainable...)

Deconstructed materiality: Balmain x Barbie in the digital world

From 11 January 2022, the digital outfits Balmain x Barbie NFT1, Balmain x Barbie NFT2, and Balmain x Barbie NFT3 - three different NFT Barbie styles - were up for bidding on the MintNFT.com auction site.

The heads of both companies (Mattel and Balmain Paris) said the launch of NFTs was a historic moment for both the new web3 technology and the fashion and toy industries. According to a representative of the Balmain brand, the future of NFTs will be a vital tool for fashion brands to drive strong customer engagement: "I believe it is going to change the fashion industry

completely, and it will have the same impact as when social media first started or when the internet first launched." (Klich, 2022)- notes Txampi Diz. Metaverse researcher Matthew Ball says Metaverse is "more about driving new narratives, product launches, and marketing than anything life-changing." (Ball, 2022, p. 10).

We should also remember that digitally owned NFTs have received much criticism since their launch. Some argue that it is unnecessary to pay for an artwork or fashion product that is already freely available by anyone at any time. Others argue that it is an excellent new opportunity, as creators have never before been able to receive financial remuneration for their works of art circulating in the online world. The NFT is, therefore, a kind of modern digital "patronage" system for the arts. In this sense, NFTs are also commonly thought of as giving control back to creators. Unlike other artworks, however, fashion is at greater risk of losing its materiality. In the case of clothing, we are already talking about objects whose materiality is by its very nature indispensable since clothing serves to cover the body and protect it from the forces of nature. The wearer of a digital garment cannot wear it at real social events, nor can he enjoy the simple protection of the material (he cannot put it on). Despite owning something, its owner remains naked in the real world. Thus, eliminating the materiality of cloth has severe consequences in real social life. However, when one chooses to buy the Balmain x Barbie NFT dress, one is also supporting the fashion house and voting for a technological evolution of the fashion industry that is taking on a whole new design practice and a new form of appearance. As I mentioned above, visuality and 3D reality in the digital space have different potentials. This is exactly what the designers are taking advantage of when they create their own MVFW event in Decentraland, the Metaverse Fashion Week (held this year from 28-31 March with over 60 artists).

Barbie in the Metaverse wearing luxury fashion. The NFT1-style avatar is wearing a striped sweater dress with a shoulder cut-out and is holding a pink maxi bag with the Balmain monogram and the Balmain x Barbie logo. The NFT2 avatar shows a puffy dress with maxi bow detail in pink silk satin. While NFT3, also up for bid, is now a Ken avatar in a white cotton T-shirt with pink trim and a vest blazer, a long-collar jacket paired with loose pleated trousers(all in pink satin crepe), and a logo baseball cap to complete the digital set. There is no doubt that NFT partnerships are redefining the meaning of brand ownership for customers, as it "symbolizes buying into the ethos of the company." (Klich, 2022)

A curious encounter of the toy universe and luxury fashion

Mattel's first Barbie doll was unveiled to the public on 9 March 1959 at the *American International Toy Fair* in New York. It was created by Ruth Handler, who named the dress-up doll Barbie after her daughter. Barbie's first dress was designed by Charlotte Johanson, then a fashion designer for Mattel. (Peers, 2004, p. 172) Barbie's original, classical function was a children's toy. It is, however, a very complex object in its simplicity because it involves its owner in a heterogeneous, performative mental process: it has to be played with. For the child owner, a doll is a transitional object, "it is an intermediate area of experiencing, to which inner reality and external life both contribute" it happens "between the subjective and that which is objectively perceived" (Winnicott, 1971, pp. 2-3). On the other hand, the child playing projects onto the doll his or her own inner experiences, conscious (thought), and unconscious (bodily-instinctual) desires. This contradictory nature of the play doll has long been explored in art and philosophy. Although the Barbie doll would suggest this, she is not just beauty and kindness. She is essentially heterogeneous: she has clothes and a parallel (but repressed) "body". Freud once cited the doll Olympia, from E.T.A. Hoffmann's short story *The Sandman*, as an example of the uncanny, disturbing experience of being a real Barbie doll when she was 'intact', life-like, before her creators sadistically tore her apart. And it was in the wake of this duality that Nathaniel, the protagonist of the short story, fell into pathological love. The rewriting of the doll in this way can be traced back to the photographs and texts of a surrealist author, Hans Bellmer, who in 1934 published ten sadistically dismembered dolls in his photo book *Die Puppe*. According to Hal Foster's summary, these dolls are "uncanny confusions of animate and inanimate figures, ambivalent conjunctions of castrative and fetishistic forms, compulsive repetitions of erotic and traumatic scenes, difficult intricacies of sadism and masochism, of desire, defusion, and death."(Foster, 1995, p. 101) The Barbie dolls, of course, conceal this heterogeneous basis, for the dolls (unlike Bellmer's dolls) are dressed, and the dressing itself (the concealing fetish) is their essence. And this is reinforced by the Balmain- Mattel dolls, which, unlike the normal Barbie, are undressable, existing only in their original clothes.

In her comprehensive essay, Beauregard Houston-Montgomery notes that the development of the so-called "designer Barbies" was a surprisingly belated move by Mattel, despite the company's generally quick reaction to various trends and real fashion trends (Houston-Montgomery, 1999, p. 86). According to fashion history writings, Oscar de la Renta was one of the first designers to dress the legendary Barbie figure in luxury fashion. The designer Barbie phenomenon began to blossom after 1994 when the New York department store *Bloomingdales* ordered a Barbie doll. (Peers, 2004, p. 175) In 1995 and 1996, the Dior fashion house was already producing haute couture dresses for the iconic Barbie. In 1999, to celebrate the fortieth anniversary of Barbie's 'birth,' designer Barbies were presented at two exhibitions at the *Bon Marché* and *Galeries Lafayette* department stores. (Peers, 2004, p. 175) The Barbie collections presented there included dresses from the houses of Missoni, Moschino, and Christian Lacroix.

Later, brands such as Givenchy, Marc Jacob, Calvin Klein, Hérmes, Prada, and Claude Montana followed suit [5]. Since then, of course, not only have the styles of Barbie's miniature toy clothes been inspired by contemporary fashion, but contemporary fashion has also thematized the idealized world surrounding Barbie. The Barbie figure, as an iconic object, becomes a collectible object of value itself. In addition to being a muse and decorative object for countless fashion brands, the famous Barbie doll has also attracted sharp criticism from some designers. In 1999 Tim Walker, in his installation for Italian Vogue titled *Couture Delivery*, based his show on an explicit critique of the capitalist logic embodied by Barbie. In the installation, a real flesh-and-blood model embodies a life-size Barbie doll wearing a burgundy evening gown (in Gautier, Versace, and Valentino dresses) in a giant box. Moreover, Tim Walker's model was photographed in a warehouse so that she appears to be an object transported to the warehouse as if she were an industrial product (Evans, 2003, p. 183). Also in the nineties, a similar problem is thematized in several collections and performances by Maison Martin Margiela. In 1994, Margiela, as deconstruc-

tor, presented a 'collection of clothes reproduced from a doll's wardrobe', which retains elements of toy clothing in its appearance: by using oversized details such as zips and buckles, Margiela questions the functional purpose of real clothing through incongruities and pushes fashion towards conceptuality. This critical gesture by Margiela draws attention to the fact that the human body cannot be standardized.

The digital version of Barbie, created in collaboration with the Balmain house, becomes an NFT, a collectible artifact in the digital space, through which the primary function does not play but rather the 3D graphics made possible by the modern technology of the time and the possession of the object. It would not be possible in the real physical space. In real life, the toy Barbie has always been a collectible object (in the case of a limited number of special editions, an "artifact"). Linked to the world of NFTs, whose very essence is the experience of 'collecting' and possession, Barbie is a collectible artifact that represents and embodies other collectible (art) objects worn on its person. In Metaverse, it is no longer the real human body but Barbie's digital body that becomes collectible through the digital fashion of luxury. Her digital body exists only in a simulated space, yet it has a mighty power of identification, she is what women want to be. Like the plastic doll itself, the avatar holds the promise of a malleable body and a body image shaped by technology. It is a new digital ghost of capitalism that no longer attributes materiality or tangibility to the amount of money spent on a commodity. The nature of the commodity fetish in the Marxian sense (Marx, 1977) persists but is radically transformed; the exchange value remains. However, the use value and the materiality of the thing sold disappears and becomes ghostly: the digital clothes bought cannot yet be worn. The question is, of course, how this will change as technology develops and the possibilities of the digital universe expand. However, the advantage of the digital Balmain Barbie is that 3D works of art can be created that would be impractical and unwearable in real life. Thus, Mattel and the Balmain brand's opening to the NFT market is likely to be a landmark in the same way that Oscar de La Renta was asked to design the first designer dress for Barbie.

In January 2022, the fashion press responded positively to the new digital collection (Spellings, 2022). Bids for the Balmain x Barbie auction were around $2,000. This gesture transforms the famous children's toy into a collectible art treasure. Fashion is no longer a 'thing-like' object worn on the physical body. In addition, the importance of *Crypto Fashion Week* and *Metaverse Fashion Week(MVFW)* is expected to grow spectacularly in the future.

To summarize, the analyzed examples show that at the moment, the Metaverse is very much fed by the physical world, and that fashion NFTs are very much defined by it. Clothes and accessories sold as NFTs are still in some way linked to physical pieces (see Balmain's ready-to-wear or *C6-Designer's* clothes). In essence, an exciting combination of goods is created, where the NFT and a physical version somehow linked to it coexist.

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[2] By their nature, cryptocurrencies consist of interchangeable and fungible units. If two people have two bitcoins, they are worth the same amount each, so they can be exchanged without loss of value. What money and cryptocurrency have in common is that they can be broken down into smaller units (e.g. 4x50 cents). NFT, by comparison, is indivisible and irreplaceable, absolutely unique.

[3] This exhibition, which was staged in both virtual and real space, has since been followed by several others, both on the gallery's digital platform and in its physical reality. Jonas Lund, Addie Wagenknecht, Andy Kassier. See: https://aesf.art/

[4] The Metaverse itself also has this irony, as they create their own METAGALA named after the MET Gala)

[5] In most cases, the designers were also approached by Mattel. (For more information on the Barbie collections designed by these designers see Beigbeder, *Barbie,* 1998; Peers, 2004, pp. 169- 194; McDonough, 1999).

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Dematerializing fashion. Improving design-led sustainable and hybrid retail experiences via digital twins

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Abstract

Digitization has changed the way individuals build relationships, work, and consume. Such changes have affected the fashion industry in significant ways, revealing a whole series of new practices, not only regarding the design and manufacturing processes but also modifying how products are displayed, distributed, and consumed.

In the age of connectivity and technological innovation, a dematerialized economy is being shaped based on rethought consumption patterns and solutions to reduce energy demand. New concepts come together aiming at the possibility of economic development supported by sustainable social and environmental practices. Regarding this, the fashion industry has relatively recently embraced the dematerialization of fashion products, exploring different paths and opportunities that multiply the possibilities of relationships with the consumer and on the other promotes more sustainable and valuable processes.

Since the outbreak of the covid-19 pandemic, luxury brands and large retailers invested in the incorporation of new technologies, especially regarding the digitization of clothing, where multi-million partnerships between fashion brands and the games industry in the development of skins for electronic games proved to be a promising investment. In addition, for many companies, the adoption of 3D design and computer graphics software for the creation, modelling and prototyping processes represents an optimization in the workflow, increasing productivity, efficiency and reducing the environmental impact. The boundaries between the physical and the digital seem to be progressively being blurred, offering new experiences to users. In these circumstances, the Digital Twins technology, already adopted by other industries, is now starting to find its place in the fashion system, showing a potentially disruptive impact on traditional retail and communication channels that pass from omnichannel to phygital up to a new hybrid reality.

Considering the range of applications and usability opened by the digitalization of fashion, the emergence of new technologies (AI, VR, MX, Digital Twins) and the complexity of new challenges and impositions faced by the design field, the present paper aims to define innovative trajectories within the fashion retail sector, impacting both business models (in order to make it more sustainable and valuable) and consumer experiences. In addition, this paper intends to discuss how design could contribute to creating new sustainable experiences, supporting the transition between physical and digital spaces, as well as adapting operational practices to make the phygital process positive and viable.

Author keywords

Fashion Dematerialization; Retail; Digital Twins; User Experience; Design for Sustainability.

Introduction

The entrance of new players - mostly from Information and Communications Technology areas - into the fashion competitive landscapes, the pandemic crisis that has further required a quick digital transformation (Bertola, 2021), and the emergence of contemporary technologies, such as metaverse, 3D printing, the Internet of Things, VR, AR, AI and Digital Twins, made the fashion industry recognize the importance of integrating digital fashion into its operation portfolio (Baek et al., 2022). Such digitalization process relates to the concept of dematerialization of fashion, which allows the unfolding of new trends into the contemporary design scene, aimed at the development of digital products using advanced technologies (Azambuja et al., 2021). Even if recent, the process of digitalization of fashion may expand the field of action of fashion design by bringing new ways of relating to fashion processes itself, beyond the challenge of bringing together the physical and digital worlds (Giuriatti & Pinheiro, 2022). Furthermore, one of the opportunities created by the digitalization of fashion regards the dematerialization of the supply chain, capable of "improve resource efficiency and compressing, eliminating, and shortening various business activities, as well as reorganizing the operating model toward a more collaborative approach in different stages of the process" (Casciani et al., p.790, 2022).

Within this context, this paper presents a conceptual framework (regarding t7he impact of advanced technologies on fashion consumer experience and how Digital Twins are reshaping the fashion value chain), followed by an interpretative framework, composed by three different operation models (Digital Twin-empowered hyper-real visual campaigns; Digital

Twin-empowered tailored and sustainable buying and retail dynamics and Digital Twin-empowered phygital and immersive retail experiences), intending to investigate the impacts of Digital Twins technology within the fashion value chain, focusing on distribution and communication processes.

Conceptual framework

The impact of advanced technologies on fashion consumer experience

Since the Covid-19 pandemic outbreak, the global fashion industry faces exceptionally challenging conditions, and due to the various restrictions imposed - mainly during 2020 and 2021 - digitalization processes have been accelerated. However, to date, few brands or retailers have embraced technology with a truly competitive mindset to fuel positive and valuable innovations (Bertola, 2021). Now, fashion and technology work together to enable companies to expand into new markets, win deeper levels of customer loyalty, and establish data driven strategies and decision making (Bof & McKinsey, 2022).

Emerging technologies such as blockchain and non-fungible tokens (NFTs) along with impactful technologies such as Digital Twins (DT), artificial intelligence (AI), machine learning (ML), and virtual reality (VR) (Joy et al., 2022), are placing the fashion industry under a historic transformation, entering the new global competition market by augmenting those phases in which design, creativity, sustainability, and technological transformation are the principal axes while simultaneously reinventing its business models (Iannilli & Linfante, 2022).

Besides the high investments from fashion brands into the Metaverse (Burberry - B Bounce Game, 2019; Gucci - Tennis Clash game, 2020; Balenciaga -Fortnite game, 2021; Ralph Lauren - Zapeto, 2021; Zara - Lime Glam Meta collection, 2022; Adidas - Digital Ozworld Experience, 2022), the use of other technologies are also arising, such as IoT (Burberry, 2012; LDN Adidas, 2019); Mixed Reality (Hipanda, 2019; Lego & Snapchat, 2019; Gucci, 2022); AI (Chanel+Farfetch, 2019; Burberry, 2018) and Digital Twins (Yooxmirror, 2018; Bacon's version, 2021). Apart from increasing process efficiency and quality in the production process, reduce costs and improve logistics, these technologies can strategically create a unique relationship with consumers, especially those belonging to generation Z. In fact, such technological commitment coming from fashion companies is somehow directly linked to the demands of this new generation of consumers, which will define the future of consumption with $4.4 trillion in estimated discretionary spending power (Snap Inc., 2022). In addition to being considered digital natives, along with Millennials, Gen-z generation base their relationships with companies by evaluation how they treat the environment, protect personal data, and position themselves on social and political issues (Deloitte, 2022).

How Digital Twins are reshaping the fashion value chain

Digital Twins are expected to become a business imperative, covering the entire life cycle of an asset or process, and forming the foundation for connected products and services (Hartmann & Auweraer, 2020). Coined in 2010 by John Vickers of NASA (Hazrathosseini & Afrapoli, 2023) the term "Digital Twin" stands for an encapsulated software object or model that mirrors a unique physical object, process, organization, person, or other abstraction (Gartner Glossary, 2023), and according to Kamble et al (2022. p.1) "it is a method of developing sustainable, intelligent manufacturing systems for attaining robust quality, reducing time, and customized products using real-time information throughout the product life cycle.".

Listed as one of the top 10 strategic technology trends in 2018 and expected to cross the chasm in 2026 to reach $183 billion in revenue by 2031 (Gartner, 2018/2022), Digital Twins are being explored in multiple fields (Guo & Lv, 2021), where the most successful ones, according to IBM, are those of engineering (systems), automobile manufacturing, aircraft production, railcar design and building construction manufacturing. The fashion field, however, found itself forced to accelerate its digital processes due to the pandemic (BoF & Mckinsey, 2020/2021), and now recognizes Digital Twin technology as a possible valuable and sustainable addition into the field.

A first and rather extensive literature review (Nobile et al., 2021; Noris et al., 2021) has shown a growing interest of the scientific community in the topic, which the proliferation of experiences and explorations of leading fashion brands and emerging digital companies has accompanied. In particular, the authors investigated the field of Digital Fashion (within which Digital Twins represent a particular typology with peculiar features and potentialities) according to three categories: Communication & Marketing - also related to the transformation of the Customer Experience in the retail environment; Design & Production; and Culture & Society. Not surprisingly, the area of Communication & Marketing includes the most studies and applications.

Fashion brands have been experimenting the application of Digital Twins from buying campaigns (SUNNEI) and visual campaigns (Puma Flash Retail Film; Chase the light – Timberland; Kendall for the TB Summer Monogram campaign by Burberry) to animated fashion shows (Bacon's Version by Bacon; GCDS Out of this world SS 2021) and retail distribution (I.T Hong Kong x The Fabricant). Within the gaming industry, widely explored by fashion companies over the last few years, the specific use of Digital Twins is still diffident (Ralph Lauren redesign of polo logo for first time in new digital collection with Fortnite; Moncler limited-run of physical apparel inspired by the fashion house's far-reaching archives with Fortnite; Balenciaga and Fortnite on a series of in-game outfits and a limited-run physical apparel collection). From the creative and production processes to the retail and communication operations, Digital Twins, according to Riedelsheimer et al (2020, p.664) "could be used as an information basis on environmental, social and economic aspects along the whole lifecycle and provide assistance by optimizing the product's environmental and social impact."

Interpretative framework

Reframed fashion retail & communication operating models through Digital Twins implementation

Within a context of progressive and pervasive dematerialization of fashion, large and small fashion companies have recognized the great potential of digitization both to make their omnichannel distribution system smoother and more efficient (Jocevski, 2020; Palmié et al., 2022) and to improve and enhance the consumer experience (Alexander & Kent, 2020; Bonetti et al., 2019). According to this critical scenario, this paper proposes an interpretative framework to understand

and analyze the impacts of the adoption of Digital Twins within the fashion value chain, with a specific focus on those distribution and communication processes that typically result downstream of the design and product development phases. Starting from the analysis of exemplary case studies, this research proposes three different operating models that, in one hand, shows the most recent strategies and operational paradigms in the fashion field and on the other hand, identify potential and significant trajectories of development and innovation in the sector.

The three different operating models reflects the many transformations of the "traditional" supply chain (Figure 1) with impacts acting at the level of: business models, user experience, and sustainable processes.

The first operating model refers to the adoption of Digital Twins in a complementary approach to the traditional design and prototyping process of the physical garment, with significant impacts on the collections' display and communication formats and, consequently, on the experiential models proposed to the consumer. The second operating model regards the adoption of Digital Twins by transforming the traditional supply chain from the early stages of fashion product design, opening the possibility of experimenting and redefining key and particularly "unsustainable" processes such as sales campaigns and online distribution channels' management. Finally, the third operating model proposes a still partially unexplored and highly alternative model to the traditional supply chain translating into a properly phygital solution the relationship with the consumer and integrating in a valuable way the digital and physical dimensions of the purchasing experience.

Figure 1. Illustrative diagram of the traditional Fashion Supply-Chain (simplified elaboration from the Miroglio Group Supply-Chain diagram presented at the company visit, July 2022).

Digital Twin-empowered hyper-real visual campaigns

The rise of digital transformation, and its acceleration due to the COVID-19 pandemic, has significantly impacted the fashion industry. One of the most visible and impressive consequences was how visual content and fashion shows are produced. Many fashion events and fashion weeks have been postponed or cancelled due to the pandemic, and those that have taken place have often been held virtually or with strict safety measures. One of the significant impacts of the pandemic on fashion shows has been the shift towards virtual events (de Carvalho Godim & Cunha, 2023; Linfante & Pompa, 2021). Many fashion brands and designers have turned to digital platforms to showcase their collections through live streams, pre-recorded videos, or interactive digital experiences. These strategies have allowed them to continue to present their works while reaching a global audience, thus experimenting with new visual formats and narrative codes and simultaneously introducing changes and new operational settings to the traditional fashion design process (Figure 2). In fact, creative and technical back-end design processes - trend and color choice; fabric and raw material research and choice; sketching; colors approval and technical files development - were directly impacted, as shown in the following cases.

A couple of examples can particularly illustrate the potential and impact of the dematerialization of fashion in communication, from fashion shows to visual and marketing campaigns. "Out of This World SS2021" was the first virtual and appropriately "multi-format" fashion show proposed by the young brand GCDS, realized in collaboration with the international AR, VR and MR production studio Emblematic Group. It represents one of the first cases that used digital avatars not only for the presentation of the collection, but also for the realization of an immersive and narratively complete experience offered to an active and involved community. The virtualization of the garments took place starting from the sketches of the creative director Giuliano Calza, thus disrupting the conventional process of prototyping and product development (GCDS Had the Most Surreal Front Row, 2020). In this way, the creation of the digital fashion show and the entire collection production process followed parallel, non-sequential processes, allowing the former to be released well in advance of the latter and expanding the opportunities for interaction between the brand and its community (Moore, 2020). The fashion show was part of a more comprehensive communication and exhibition format that, based on an interactive digital platform, enabled augmented reality community socialization through playable video games, interaction with avatar-like front-row guests, and behind-the-scenes content.

Another example of a digital pipeline being used to produce a fashion show, and more generally, to promote a new and more sustainable model of visual content production and marketing, is 'Bacon's Version Show', presented at Milan Fashion Week 2021 by Bacon Clothing and developed in collaboration with TwinOne (Essere sostenibili nella moda usando la realtà virtuale, 2022). TwinOne recreated the 3D digital collection, starting with sketches and paper patterns and then, using the 3D game tool Unreal Engine technology, developing a potentially unlimited number of fabric-colour-pattern variations. This new digital pipeline impacted both the traditionally long prototyping phase and the equally costly production phase of visual communication content (Goodine, 2021) by promoting a new sustainable framework that reduces waste, accelerates timelines, and eliminates redundant investments.

Digital Twin-empowered tailored and sustainable buying and retail dynamics

As discussed previously, Digital Twins have been introduced and implemented within distribution processes for various purposes, ranging from supply-chain optimization to improving the user experience, to promoting new and more sustainable operating procedures. From the point of view of sustainable supply-chain optimization, for example, they can help retailers to manage inventory more efficiently, reduce waste, and improve responsiveness to changing demand (dos Santos et al., 2021). Similarly, from the point of view of improving the user experience, Digital Twins allow customers to make more informed purchasing decisions by creating virtual try-on experiences (Riedelsheimer et al., 2020), with a positive impact, particularly for online retailers or by offering garments' ID cards thus improving transparency and traceability. In the following described cases, the back-end processes affected concerns mainly campaigns and online distribution

channels' management, such as market analysis, merchandising strategy and assortment planning.

In this context, SUNNEI Canvas - a project developed from 2020 onwards by the streetwear brand SUNNEI with the support of the 3D production agency Pezzo di Studio - represents an interesting example of connecting and hybridizing the digital dimension of fashion with its physical connection to the retail channel, implementing new services and forms of interaction between the brand and its audience, from buyers to end customers (Iannilli & Linfante, 2022) (Figure 3).

SUNNEI Canvas is an ongoing project launched with the SS21 collection of the brand's signature pieces delivered in all white and designed to be customized and developed with selected stores worldwide: the clothing and accessories could be modified to meet the specific preferences and needs of each store. To facilitate this customization process, SUNNEI created an online platform – only accessible with a password – that utilizes 3D engineering and customization technology to allow buyers to modify shapes, fits, and fabrics digitally. In order to enhance the virtual experience, SUNNEI developed male and female avatars with human-like features and a 100% SUNNEI aesthetic. These avatars can be used to showcase the clothing and accessories in the SUNNEI Canvas collection and allow buyers to see how they would look on a virtual model. The customization process, therefore, will result in different collections resulting in "Made for..." tags for different retailers (Leitch, 2020). The SUNNEI Canvas collection was launched as part of Milan Digital Fashion Week, with the buyers' platform also going online on that day. A second part of the collection was released in September, focusing on end customers' experience. The second part of the project focuses on community involvement by proposing an "endless video game" without objectives or levels to overcome. The avatars in the game are dressed in outfits and look chosen by game players, who are part of the SUNNEI community. The whole project is a reflection on the potential of the venture between fashion and the game industry to generate and test new ways of consumer engagement and involvement (Salibian, 2021).

Digital Twin-empowered phygital and immersive retail experiences

The third operating model refers to a complete integration of a digital pipeline assuming, different from the previous cases, a complete consumer and retail-oriented perspective. In the exemplary case considered, the adoption of Digital Twin has the main objective of experimenting and taking opportunities with new emotional and highly interactive models in the final client relationship. The opportunity for collaboration between the retailer I.T Honk Kong and The Fabricant, a pioneering agency in the fashion dematerialization field, arises on the retailer's 30th anniversary. For the occasion, a travelling pop-up exhibition is planned to showcase a unique collection of global exclusives created in collaboration with leading fashion designers (The Fabricant, 2022). The adoption of Digital Twins, together with other technologies that "activate" and "augment" the physical space of the exhibition/retail space, represents one of the first and most interesting experiments of phygital reality (Iannilli & Spagnoli, 2021). This approach connects the tangibility of the physical experience with the interactivity and smoothness so typical of the digital dimension (Figure 4).

The travelling pop-up exhibition was held at various locations, including Hong Kong, Shanghai, and Beijing, in the winter of 2018 and in Europe at the beginning of 2019. Designed to showcase a unique mix of physical and digital garments featuring interactive displays, the exhibition was intended to provide a unique and immersive shopping experience that showcased the capabilities of digital fashion and the potential for omnichannel retail. The exhibition included a digital collection of garments from brands such as Marques Almeida, Helmut Lang, and Alexander McQueen, only available for pre-purchase viewing in digital form at the pop-up locations. Customers could purchase these garments by scanning QR codes using a specially developed app. The retailer's goal was to attract various consumers with this unusual presentation and shift the perception of what a fashion retailer could deliver (Morris, 2019). Moreover, the interactive digital displays included a surreal maze of humanoid figures rendered in real-time 3D and buyable garments. The humanoids were programmed to respond to shoppers' movements, which were tracked using object detection cameras mounted above the screens. The 3D models were rendered using the three.js library and were synchronized with videos of the digital garments, which were displayed across 16 LED displays ('I.T Hong Kong', 2019).

This third operating model focuses on the experimentation of new codes and forms of emotional, immersive, and interactive connection traditionally about the exhibition sphere, which is reframed and performed in a hybrid space between the pop-up store and the travelling exhibition. This implicates the back-end processes from the design phase to distribution, logistics and retailing, until delivering the experience to the consumer. In addition, the perspective shift reflected the potential of the dematerialization of fashion from a communication and retail point of view and made it possible to renew and revolutionize the traditional supply chain and, therefore, the connected business model, starting from the innovation of the consumer experience, with promising and positive future implications.

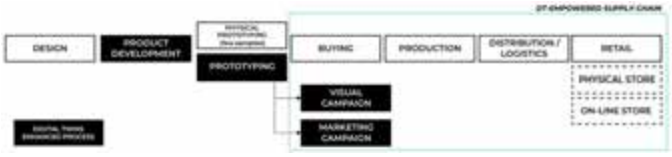

Figure 2. Digital Twin-Empowered fashion supply-chain with impacts on visual and marketing campaigns' phases.

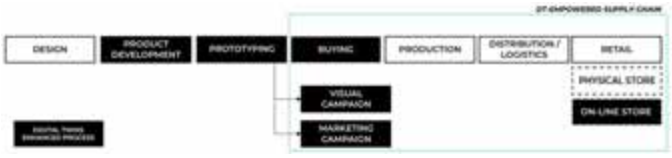

Figure 3. Digital Twin-Empowered fashion supply-chain with impacts on B2B and B2C buying and selling phases.

Figure 4. Digital Twin-Empowered fashion supply-chain with impacts on phygital products and services offerings.

Improve Design-led Sustainable Innovation in Fashion Retail

Increasing sustainable actions in creation, production and consumption processes has become an urgent issue and challenge involving the fashion industry along with the whole stakeholder ecosystem. Awareness about sustainable fashion is growing, even though most operating models and applied experiences are exclusively focused on the fashion product development phase (Kozlowski et al., 2018), going from waste reduction design strategies to raw material control to product lifecycle management. More recently, new agendas are emerging, acting on different levels and contributing to bridging a gap both in terms of operational practices and strategic conceptualization in the field of sustainable fashion: on one hand, the growing interest in the retail sector (Ruiz-Real et al., 2019) that, together with the communication domain, represents the interface between fashion product and consumer and which, by adopting sustainable approaches, has the potential to affect both the consumer experience and business models (Dodds et al., 2022); and on the other hand, the need to integrate the concept of sustainability into the fashion design processes (Kozlowski et al., 2018) with a systemic approach to generating long-term and viable sustainable innovation in the fashion system.

Concerning specifically the fashion retail design field, technological and digital acceleration very quickly increased the implementation of advanced technologies (among others AI, VR/AR, MX and, not least, Digital Twins) in all back end and front-end distributive processes (Bulović & Čović, 2020; Casciani et al., 2022). In addition, as big data is increasingly being used in trend forecasting research/consumer behavior analysis and data centers and data transmission networks are responsible for nearly 1% of energy related GHG emissions (Iea, 2022), the use of data also integrates debate regarding sustainability. These technological applications have often been used to improve specific retail chain knots. However, a systemic reflection on the potential of technology to sustainably rethinks the fashion value chain, shaping a virtuous integration of retail design, marketing, management, and ICT disciplines is still in its infancy (Dodds et al., 2022; Iannilli & Spagnoli, 2021).

Similarly, a reflection on the peculiarities, practices, and tools of "Design for Sustainability" has been pursued. Taxonomic definitions (Arnette et al., 2014) and analytical frameworks (Rocha et al., 2019) are flanked by evolutionary readings of the Design for Sustainability domain. Design for Sustainability has seen a progressive broadening from a predominantly technical and product-centric level of innovation to a broad socio-technical and systemic innovation scale (Ceschin & Gaziulusoy, 2016). In a context in which "the current understanding suggests that sustainability is a system property and not a property of individual elements of systems (...) achieving sustainability requires a process-based, multi-scale and systemic approach to planning for sustainability guided by a target/vision instead of traditional goal-based optimization approaches" (Ceschin & Gaziulusoy, 2016, p.119).

Starting therefore from the previously investigated operating models - which highlighted both the potential of the Digital Twins in the distribution, promotion and valorization processes of the fashion product and the consequent transformation of the value chain - a first and tentative critical interpretation of design-led innovation for fashion retail is proposed (Figure 5).

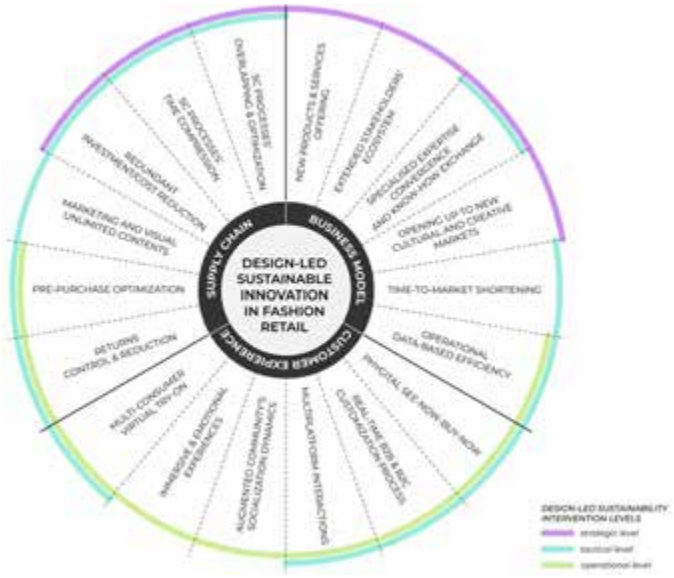

Figure 5. Design-led Sustainable Innovation in Fashion Retail enhanced by adopting advanced technologies (with a focus on Digital Twins implementation).

Design-led innovation oriented to promote sustainable solutions through the exploitation of advanced technologies operates on several interdependent levels: on business models' innovation, the supply chain and, finally, the customer experience innovation. The valuable impacts that adopting Digital Twins can bring in these three domains range from the improvement of customer service (e.g. Real Time B2B and B2C customization as in the case of SUNNEI Canvas) to performance efficiency (e.g. time reduction in marketing and visual contents' production as in the case of Bacon's Version), to the creation of new hybrid and phygital consumption formats (e.g. offering new products and/or services as in the case of the I.T Honk Kong exhibition/pop-up). Within this framework, it is also important to highlight how design-led innovation for sustainability can act at different levels: strategic, tactical, and operational. These levels, systematized by Rocha, Antunes and Partidário (Rocha et al., 2019) and used as an analytical framework to explore different Design for Sustainability models, here similarly return the different dimensions that a systemic approach to sustainability for fashion retail should take charge of. In particular, the strategic level refers to the highest layer of corporate policies and macro-strategies; this level acts mainly at the business model scale and systemic supply-chain transformations. The tactical level refers to the operating processes and the system of relationships that regulate specific business units; for this reason, the tactical level has impacts that predominantly involve the supply chain and the customer experience when its transformation entails changes in processes, services, and distribution channels. Finally, the operational level acts within the micro-level of project management approaching primarily incremental sustainable innovation and focusing on streamlining traditional processes or flanking them.

Concurrently, addressing these different levels becomes mandatory to drive and implement sustainable innovations in the areas of fashion retail and communication. Within this context, design is required to encompass the system's complexity once again and embrace technological innovation (together with other contemporary drivers) by embedding it within positive and long-term signifying frameworks.

Conclusion

In the light of the dematerialized economy that is being shaped in the attempt to fulfill new sustainable demands through advanced technologies (AI, VR, MX, Digital Twins), fashion embraced digitization as a facilitator in the process of rethinking smart solutions for its value chain. In this context and aiming to study the impact of Digital Twins technology within the fashion system and how it can be used throughout the supply chain as a mean of feasible practices, this paper analyzed three different operational models. The first model "Digital Twin-empowered hyper-real visual campaigns", mostly regarding visual and marketing campaigns; the second model "Digital Twin-empowered tailored and sustainable buying and retail dynamics", inclined to the traditional supply chain transformation from the early stages of product design; and the third model "Digital Twin-empowered phygital and immersive retail experiences", drawing up phygital solutions. The research then, based on the analyses of the three operational models, presents a critical interpretation of design-led innovation for fashion retail, showing that the application of advanced technologies (in particular Digital Twins) can, from a sustainable point of view, improve customer service, increase efficiency and create new phygital consumption formats.

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FASHION ARCHIVE AS METAMEDIUM unfolding design knowledge through digital technologies

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Abstract

Currently, the issue of archival fashion is mainly to explore emergent methods and digital technologies' application to foster innovation in terms of activation, knowledge-sharing and knowledge-generation related to archival artefacts. The complex archival collections consist of a plurality of artefacts, meanings, and practices interconnected through technologies that make the archive a knowledge-generating process.

Narrowing the study on fashion archives, these are characterised by a significant heterogeneity of materials preserved by companies, private collectors and cultural institutions as evidence of heritage values, design activities, manufacturing culture, and creative processes embedded in artefacts and intangible know-how.

This inner knowledge inherently linked to archival fashion stays permanently implicit in the artefact and usually cannot be accessed by public audiences. Even though Cultural Institutions currently deploy technologies to democratise three-dimensional garment explorations, there are still rare attempts that operate with digital technologies to allow an in-depth study of the creative process and technical know-how lying behind fashion heritage.

In light of this, the paper explores the Reverse Engineering (RE) methods applied to fashion archives to access and unlock the implicit features and techniques embedded in archival fashion to facilitate knowledge-sharing and knowledge-generation processes in exploring culture-intensive artefacts through digital technology application.

Through the explorations of case studies in the fashion archival context, the paper will focus on augmented fruition practices to derive knowledge from the reading of the archive itself, starting with RE and reflecting on virtual and augmented integration to represent and disseminate fashion culture with the final aim of activating the vast inner fashion knowledge patrimony.

Specific considerations will regard the potentialities of digital integration in fashion archives in terms of (1) the different nature of the knowledge unfolded through RE depending on peculiar aspects of archival artefacts; (2) technologies used to encode/decode inner knowledge; (3) the future digital directions related to archival practices and experiences derived from them, also in light of the changes in design languages when technological approaches hybridise those of humans.

Author keywords

Reverse Engineering; Fashion Archive; Digital Technology; Augmented Heritage

Introduction

Immersed in the knowledge economy paradigm, where the intangible assets related to fashion and cultural-intensive contexts have a predominant value (Bertola et al., 2016), the heritage capital preserved in cultural institutions, historical archives and foundations became a competitive tool contributing to the definition of a stratified and transdisciplinary fashion cultural identity that embraces different components: creative, design, material, manufacturing, historical, cultural, social, etc. In the fashion industry, this archival heritage has always been jealously preserved and has contributed, season after season, as an active resource in the design profession because it allows cultural capital and intangible values to be translated into symbolic codes and languages (Martin & Vacca, 2018). In curatorial and museum practices, archival heritage has traditionally been activated by strategies of conservation, enhancement, and promotion of its tangible components through processes that appear more conservative and traditional in the ways of exhibiting. At the same time, the intangible dimension preserved within archives and collections often remains *ephemeral* because it is challenging to display and disseminate. However, as pointed out by recent academic studies (Clark & de la Haye, 2014; Pecorari, 2017; Rocamora, 2012), the potential offered by digital technologies provide cultural institutions and archives with new opportunities to explore their collections beyond the constraints of their physical form and to contribute to disseminating culture linked to fashion heritage to a broader audience.

In particular, the digitisation of collections and the necessary redefinition of archives into digital repositories to preserve digital-born material (such as podcasts, audio, video, photographs and documents) has led (1) to a reorganisation of archival methods and practices by integrating technological solutions, (2) to a redesign of museum spaces that stage artefacts of a heterogeneous and ephemeral nature through the

introduction of apparatus and devices aimed at creating an immersive experience for the visitor and (3) to a rethinking of fashion curatorial practices with new modes that extend and hybridise the physical and digital dimensions of fashion cultural reservoir (Pecorari, 2019).

To date, the most explored experiments in Fashion Curation are linked to AR, which –by integrating the use of QR codes and digital devices in the exhibition– can create a continuous connection with the archive contents allowing the visitor to deepen meanings, themes and relationships. However, the possibilities offered by the new digital technologies can considerably increase the immersion experience and the continuous fruition of artefacts in more sophisticated manners.

For instance, the tangible and motion dimension in fashion is a primary form of knowledge that is difficult to replace by simply observing a garment on display. Therefore, the implementation of VR can unravel innovation scenarios by providing users with an out-of-the-ordinary experience in perceiving materiality, motion, interaction, and manufacturing insights, often invisible in fashion exhibitions. Moreover, multiple transmedia narratives can reach vast and diverse fashion communities by exploiting media integration and hybridisation in terms of diffusion through new social platforms and media legacy and user engagement through empowered interaction with cultural fashion meanings, techniques, processes and relationships.

Coherently with what has been stated so far, the paper explores some of the possibilities offered by digital technologies to identify common research directions related to fashion cultural artefacts that can support the implementation of an augmented archive and constitute a transferable reference standard in the context of fashion cultural heritage. Specifically, the paper aims to codify Reverse Engineering (RE) practices applied to fashion repertoires to enhance the research methodology of archival fashion and develop a technology-enhanced approach favouring knowledge-sharing and knowledge-generation processes in Fashion Archives.

Reverse Engineering for fashion heritage

Fashion, over time, has undergone profound transformations in terms of creative, productive and distribution processes, being a highly multidisciplinary system made of humanistic and scientific disciplines, a cultural-historical dimension and one always in search of change and innovation (Bertola, Teunissen, 2018). Transdisciplinary and hybridisation of knowledge and approaches belonging to different industries and domains (Bertola et al., 2007) have always been at the core of the Fashion System that has always looked towards other industries to learn and combine different methods and methodology through the interaction and connectivity among multiple actors (Gonzalez-Piñero et al., 2021). In particular, this article aims to explore how the practice of Reverse Engineering has been appropriated by fashion in the context of fashion cultural heritage through the discussion of some case studies that have translated this practice into the field of studies on archival fashion.

For the first time, RE was mentioned in the automotive sector and, in particular, to describe the very first design method of eastern car manufacturers such as Toyota, which consisted of simply taking American cars apart piece by piece, learning how they were designed rather than manufactured and replicating them cheaply. More generally, RE techniques can be broadly defined as "the process of analysing a subject system to identify the system's components and their interrelationships and create representations of the system in another form or at a higher level of abstraction" (Chikofsky and Cross 1990, 15).

The introduction of the RE into practices related to fashion archives codifies an approach oriented towards the study, understanding and re-elaboration/restitution of an archival fashion which has always been implicitly carried forward in archival practices. Even if fashion archives have always been reluctant to disclose information related to their collection (Vacca, 2014), they have always documented archiving practices of historical garments and accessories, which mainly consist of an in-depth description of all the material components, techniques, and features of that very artefact. Each aspect is then put in relation with the other archival documentation that – in the form of drawings, technical sheets, and fabric samples – allows deepening every aspect of that given object. This coding process seldom exits the walls of the archive for dissemination or collaboration purposes, with the sole objective of conserving, preserving, and valorising the object, keeping knowledge transferral actions as implicit learning processes, not evident and shared but tacit and concealed. What RE can add to this meticulous archival study is the ability to activate the archive contents to produce new knowledge or share it with different actors. For example, knowing how an item was historically crafted allows an understanding of materials, techniques and technologies employed, the problems related to conservation and restoration, and the shortcomings in the documentation (Fondevilla, 2019).

Moreover, RE methodologies applied to a historical fashion garment have the potential to involve multidisciplinary teams of experts in the "inductive" coding process of "visualising the thinking through things" typical of the fashion design process (O'Neill, 2020, Riello, 2011). The patternmaker and the archivist have the capabilities to acquire the archival garment understanding and reconstruct the technical parameters and material knowledge behind it, while historians and experts in the arts and humanities outline the object's history and context (O'Neill, 2020). Digital specialists and engineers, together with curators, collaborate using transmedia technologies to overcome the pitfalls of materiality when dealing with visualising and explicating the processes behind an exhibited garment, using transmedia technologies such as 3D scanning and virtual prototyping to describe and narrate the knowledge gathered from the analysed object. In this context, the transdisciplinary competencies belonging to fashion designers are conceived as strategic and inventive to transfer, connect, and communicate fashion cultural heritage through novel solutions (Banerjee & Ceri, 2015), having the historical object presented and showcased as a trigger for boosting creativity and fostering cultural literacy within the fashion system.

Following and implementing these approaches facilitates the transfer of culture-intensive knowledge to new generations. It also fosters sharing processes and promotes activities for the implementation of new technologies in fashion design and high manufacturing processes, favouring attention to detail, error corrections, and quality improvement. (Cianfanelli et al. 2019)

Advanced technologies to unfold knowledge inside a fashion artefact

RE's methodologies applied to fashion artefacts mean trac-

ing fashion archival design history and cultural influences (Riello, 2011). Moreover, through new digital technologies, RE accesses more knowledge than one would acquire by looking at a garment on display at an exhibition promoting an augmented and immersive dimension (Martin, Vacca 2018). Therefore, digital technologies intervene in processes of RE in what can be clusterised as *acquisition*, *simulation* and *restitution* phases of the object, encompassing a variety of approaches aimed at reproducing and analysing a physical thing taking advantage of the opportunities derived from digital technologies.

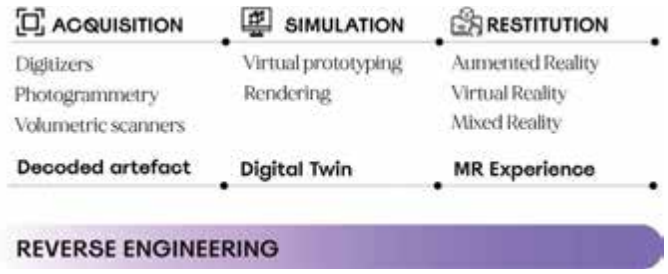

Figure 1. RE and digital technologies implementation in Fashion Cultural Heritage. Source: Authors

The acquisition phase starts with the artefact and its related documentation and implies the access and deepening of the technical documentation available within the archive to start digital explorations to trigger the complete understanding of the artefact's creative processes. Patternmaking and archivist/historical competencies, as well as fashion design and curatorial ones, are involved in the RE acquisition phase, providing culture-intensive insight and appropriating the intrinsic value and techniques inherent in the object. The study of sketches, technical drawings and related paper patterns are verified and validated by directly acquiring dimensions and specifications from the object itself. The digitisation process is crucial at this stage to inform the next steps. Paper patterns are designed from scratch, acquired manually or through automatic digitisers in order to be translated from physical to digital shapes. Shapes of the artefact are captured involving photogrammetry and 360° product photography, which leads to the creation of a wireframe, providing a complete view and greater insight into the garment. Volumes are then scanned – albeit still with limitations in reading textures and fabric processing – to recreate a point cloud from which a 3D model is derived.

A virtuous case in the field is the *Virtual Fashion Archive* (VFA) (https://virtualfashionarchive.com/), an online platform designed by the creative studio Superficial in collaboration with The Museum at FIT aimed at exploring how to combine 3D computer graphics and simulation to examine, measure and study the garments to make users see them in motion through interactive touchpoints (Figure 2).

The *simulation* phase allows the product to transition from 2D to 3D through processes of virtual prototyping (Santos et al. 2020) aided by 3D modelling software, like CLO3D (https://www.clo3d.com), initially programmed following cognitive models dedicated to industrial product innovation, aimed at digitally design a three-dimensional, fashion garment from scratch. Following transdisciplinarity and hybridisation of knowledge during the simulation phase, the RE process appropriates the industrial software to transform archival materials acquired digitally in the design of a digital twin (DT) that closely mirrors the original form, inside and out (Wagner & Kalbaska, 2022). DT simulation allows for in-depth analysis of the fundamentals of pattern making and construction geometries related to a fashion artefact and in-depth visualisation of materials regarding fabrics and textiles, embellishments and embroidery techniques. In this phase, rendering software, such as TwinOne SEE (https://twinone.eu/), allows the creation of photorealistic visual content through textures customisation and material libraries. During simulation, the competencies involved in the capturing phase merge with virtual prototyping, digital visualisation and rendering to digitally represent "the complex of knowledge about such heritage assets, organised to describe the details of which that object is composed" (Niccolucci et al., 2022).

A best practice in this field was the exhibition *From Pattern to Polygon* (https://www.centraalmuseum.nl/en/exhibitions/utrecht-lokaal-from-form-to-polygon) at Utrecht Centraal Museum – coordinated by Studio PMS and several young Belgian designers – that uses RE to stage the kinetic dimension of digital archival fashion through virtual catwalks while study and reinterpreting the object itself (Figure 3).

Figure 2. The Virtual Fashion Archive acquisition and simulation phase. Source: Virtual Fashion Archive https://virtualfashionarchive.com

Figure 3. Digital Twins simulated for the "From Pattern to Polygon" exhibition. Source: Studio PMS, Centraal Museum https://www.centraalmuseum.nl/en/exhibitions/utrecht-lokaal-from-form-to-polygon; EFHA https://fashionheritage.eu/from-pattern-to-polygon-at-centraal-museum-utrecht/

The *restitution* phase of the RE process is used to transmit, communicate and disseminate the fashion artefact's tacit, intangible, embodied knowledge (Casciani, Vandi, 2023). VR technologies are able to provide an in-depth study of the kinetic dimension of the DT garment, digitally reanimating museum objects as moving images. Even though the research area of Cultural Heritage demonstrates great interest and willingness to deploy Virtual Reality (VR), Augmented Reality (AR), or 3D scanning to visualise, animate and disseminate culture-intensive objects, architectures and sites (Cameron e Kenderdine, 2007, p. 51), there are still only rare attempts applied to fashion heritage both in terms of exhibition making and in digital archival platforms that apply these technologies to unfold the related design process and make the knowledge within the object accessible to the wider public. Moreover, technologies acting along the "virtuality continuum" (Milgram, Kishino, 1994) intervene to connect real environments to completely virtual ones resulting in Mixed Reality (MR) tools that potentially transmit inputs synesthetically through audio, visual, haptic and olfactory interfaces (Raisamo et al., 2019; Giannachi, 2020). In this context, competencies related to interaction design are fundamental to structuring relationships between the physical and digital object, generating a cyber-physical continuum where implicit and explicit characteristics are acknowledged and experienced by experts in the RE process and broader audiences. Indeed, users interact with and immerse in the object's unfolded knowledge while staying aware of the physical archival context.

A remarkable, multidisciplinary study and exhibition on archival fashion using RE is 'Exploding Fashion', conducted by Oneill et al. (2021) (https://www.momu.be/en/exhibitions/exploding-fashion) at Central Saint Martin. Here, RE practices are aimed to 'explode' the fashion design process, quickly understanding the interconnection between 2D and 3D clothing, the final garment design and related patternmaking process, highlighting movement and animation dimensions through digital capture. The project clarifies that there is a need for greater articulation of the forms of fashion knowledge produced during design processes and that blended experiences combining the physical and the digital increasingly inform established showcase formats such as the fashion exhibition and the fashion show (Figure 4).

Conclusions and discussion

Following what Muzzarelli et al. (2010, p.10) state: "A dress is not just a dress but the intersection of a series of trajectories, just like a historical event, small or big. [...] It is a matter of reconstructing as much as possible using different methodologies of sources and under the grazing fire of numerous questions. It is a matter of overcoming descriptivism and giving the idea of perspective and context. It is a matter of inserting fashion into history, of using fashion to capture changes, to use it as a mirror reflecting social, economic and political conditions."

In light of the changes in design languages facilitated by the digital turn (Runner et al., 2013) and the ever-increasing integration and pervasiveness of digital tools into curatorial and museum practices discussed in the contribution, major cultural institutions are moving from a traditional curatorship format towards "conversational learning" (Baker, 2002) and "continuous dialogical engagement" (Tchen, 1992) of different publics. Therefore, fashion archives become what Giannachi (2016) defines as Archive 4.0: an augmented repository that transforms from "situated cultural production" into "immersive and augmented environments" in which each component of the physical/tangible collection is equipped with virtual insights guiding the involvement of users in a participatory, interactive and inclusive experience.

Future directions are outlined here regarding the application of digital technologies to archival practices based on the many realities that are currently moving to codify new systems of dissemination of cultural heritage. On the one hand, there is a need to explore new ways of using archival artefacts through digital technology, allowing users to dig into the design knowledge of an object through an immersive analytical approach. This is the case of VFA, which designs DT to show close-ups of specific construction details, seams, textures, and particularly relevant embroideries, as in Thierry Mugler's designs or the animations of the pleated volumes of Issey Miyake's dresses (Figure 2) kept at the Museum at FIT. Alternatively, as expressed by the exhibition at the Centraal Museum in Utrecht (Figure 3), digital practices start from the selection of archival pieces in order to create and animate DT fashion shows to restore those characteristics of dynamism and movement a garment displayed in an exhibition would not be able to transfer. Finally, disseminating knowledge not only on archival fashion but also on the practices and study approaches related to it opens up new opportunities for hybridisation with new professionals to generate new narratives, as in the case of Exploding Fashion.

All these approaches, focused on the preservation and enhancement of cultural heritage in the fashion field, start from RE practices in order to access and unlock the implicit features and techniques embedded in archival fashion. Because archives nowadays are complex assemblages consisting of a plurality of meanings interconnected through technologies, practices, and media (Giannachi, 2020), these approaches could overlay depending on the nature of the contextual archive and the technological apparatus deployed. In conclusion, the RE methodology with digital technologies' applications is essential to multiply the narrative levels of the cultural experience hybridising the boundaries between the implicit and explicit meanings, tangible and intangible dimensions, physical and digital space, and durable and ephemeral components. In fact, RE practices applied to fashion culture are definitely a valuable resource for students, designers, researchers and fashion professionals to discover the beauty and innovation of these designs, enabling curators to show a fashion artefact from different angles and get a sense of the dynamics and know-how behind that creation (Vandi, 2022).

Figure 4. Highlights from physical and digital restitution formats of the "Exploding Fashion" exhibition. Source: MoMu Antwerp, https://www.momu.be/en/exhibitions/exploding-fashion

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Fashion and the metaverse: from omni-channel to direct-to-avatar

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Abstract

The goal of this contribution is to identify and share guidelines that luxury and fast fashion companies can follow to understand the principles and limits of the metaverse-economy, the potential of NFTs, the value of the relationship with the physical self and the many avatars users can choose to represent themselves in the Metaverse.

The paper will emphasize the necessity to rethink consumer spaces and experiences, going beyond the simple imperative to be customer-centric. Indeed, new immersive and experiential consumer hubs will have to be based on the direct relationship with the individual avatar, overcoming the traditional Omni-Channel approach in favour of a *Direct-to-Avatar* approach.

While the Metaverse is at the centre of increasingly broad and articulate debates, for some industries, such as luxury and fast fashion, it already represents a fertile ground for experimentation and competition. And the more the experimentation grows, the more it becomes clear how the opportunities offered by the Metaverse to take on different identities, that transcend traditional categorisations of gender, ethnicity, identity and even physical disabilities makes it an extremely inclusive, ethical, sustainable scenario primarily for the customers. The possibilities for brands to create a deep connection with the potential target audience are just as interesting: through a positioning built around deep values, whose impact on the definition of one self as a 'social being' is decisive, the bond between a brand and its existing or potential customers will increase exponentially.

In complex and uncertain times like the ones we are living in, the advanced use of immersive technologies should be understood as serving a new way of defining one's self and identity. And even if the definition of ethical and moral guidelines of the Metaverse is still an ongoing process, we are offered the opportunity to overcome the limits imposed by the physical dimension, in order to face the challenges of everyday life resiliently but proactively. The assumptions on which the Metaverse is founded are those of equality and democracy: its strength lies in the virtual and physical community of people that animates and populates it, well aware that only from the mutual exchange of skills, information, resources, it is possible to identify the guidelines of an inclusive and sustainable tomorrow.

In this regard, the system of interoperable, hybrid and immersive universes that we now call the Metaverse could be extremely interesting, in particular, for fashion companies and content creators. First and foremost, fashion is inextricably linked to the concept of redefining one's identity through personal style choices and it can find an expressive sphere of unprecedented power in the Metaverse. This great potential is, however, also accompanied by an inevitable rethinking of the rules of communication, content creation and marketing, with a consistent impact on brand equity, dialogue with the public and sales.

Author keywords

Fashion; Metaverse; Avatar; Identity; Inclusivity; Self-expression; Direct-to-Avatar.

Introduction

Inherent in human nature there's always been a reflection on identity and the possibility of being someone else.

In the last two years, though, the introduction to the general public of refined forms of immersive technologies and detailed alternative digital worlds as the Metaverse, has given this process a decisive acceleration, with still unpredictable outcomes (Barile, 2022).

In the Metaverse, a system of interoperable, hybrid and immersive universes, the idea of redefining one's private and social self and role through personal style choices, costumes, outfits, uniforms , opens up to endless possibilities and challenges (Chevalier, Mazzalovo, 2021).

Thanks to a playful, gamification-based approach to the fashion experience in the Metaverse, conceptual entry barriers into the world of luxury collapse. For younger consumers, that sense of awkwardness and inadequacy in going to brick-and-mortar luxury shops disappears as well. And for luxury brands, there is no fear of selling off or debasing a heritage built up over, sometimes, more than a century of market presence. In a playful, virtual world, anything is possible, acceptable, coherent and consistent with the existing positioning.

However, the Metaverse could be an extremely inclusive, ethical, sustainable scenario only if its adoption is accompanied by a substantial rethinking of the rules of communication, content creation and marketing, which will result in a consistent impact on brand equity, dialogue with the public and sales.

On one hand, fashion customers may have an expressive field of unprecedented power to take on different identities, transcending traditional categorisations and even physical disabilities (Ball, 2022).

On the other hand, brands will have to be willing to revert the strategies of value construction and dialogue with the tar-

get adopted so far, to implement new strategic approaches. The very idea of "target" will need to be redefined in depth (Volponi, 2022), as it will be defining an original positioning in the luxury and in the fast fashion world. One based not only on the aesthetics of the product, but on deep values, whose impact on the definition of one self as a 'social being' is decisive.

Redefining customers' identities

Fashion is a code of communication and a set of expressions that each of us, more or less consciously, use to represent itself in private and social contexts. "An audience it's not essential to start this process. We can play with identities and even build a 'super-ego' with clothes and objects" (Volli, 1988). The reasons for choosing one style or another may vary: "We use fashion as a costume in a never ending staged scene and, although we play mostly with ourselves, we use it as a key to seduce others, appease, gain group approval and so on" (Volli, ibidem).

From the customers' point of view, could there be a more interesting scenario than a virtual world, each time re-inventible, in which the infinite mirrors we use to reflect ourselves tell a story with unpredictable and therefore stimulating premises and outcomes?

In the Metaverse, each individual will be able to explore places and communities with its own avatar, the image or graphic representation chosen to experience the virtual world, in an infinite number of variants (Sanchez, Garcia-Badell, 2023). The degree of adherence of the avatar to the physical reality of the person it represents is changeable, conditioned by the customisation possibilities offered by the platform on which it is generated and thus linked to them (Yogesh et al., 2022). And it can also vary as a result of the desire to experiment more or less with one's own identity (Volponi, 2022).

The impact, on the concept of identity and representation, is huge, even more so for the world of fashion: one-fifth of Roblox users – one of the leading metaverse hosting platforms - change their avatar on a daily basis. They see it as a way to achieve a greater collective involvement in the experience and an emphasis on personal expression. Nearly 60 per cent believe there is a lack of inclusivity in virtual worlds and more than 40 per cent describe their online clothing style as deliberately 'unreal', detached from personal identities, highlighting the importance of personalisation when creating avatars in 92 per cent of cases (Institute of Digital Fashion, 2021).

The range of desired clothing types reflects that of styles users would like to find in the Metaverse: unreal (24 per cent), casual (20 per cent) and couture (15 per cent), a combination of clothes that one would probably not wear in the real world, but which are perfectly acceptable in the virtual one. A perfect mix to allow anyone to align themselves, through the right set of clothes and accessories, with the virtual community - hence the preciousness and appeal of the collections inspired by the best-loved video games - or to opt for a more mainstream version to be 'sparkled' with precious and exclusive garments from time to time (Lee et al., 2021).

Today's fluid and assertive public expects to be understood from the companies to which it grants the privilege of its scarce attention, and to be supported in any of the many expressions and facets in which it recognises itself (Volponi, 2022). "It is the revolution of the concept of identity. Everyone feels they have the right to create their own self-expression, distinct and separate from the conditions of their birth" (Hayek, 2021).

Figure 1. Roblox's Avatars Line up. Source: courtesy of Roblox.

Endless possibilities for luxury and fast fashion brands

Adopting luxury and fast fashion brands' perspective, the opportunities laying ahead to enter the Metaverse are just as interesting: the more pertinent and original the offer, the more the public will be willing to pay to possess, even if only virtually, a unique set of products capable of enhancing their 'physical' appearance and more (Barile, 2022).

In terms of inclusivity and body positivity, the dominant themes of the present fashion narrative, a brand can also benefit greatly from the broadening of the possibilities of representation offered by the Metaverse. The limits of physical reality are over, as are discriminations (Fernandez, Hui, 2022). Thus, the possibility for brands to create a deep connection with the potential target audience will increase exponentially, through a positioning based not only on the aesthetics of the product, but on deep values, whose impact on the definition of one self as a 'social being' is decisive.

If in the Metaverse users can take on different guises and behaviours and consider this as one of the main motivations for joining, fashion brands will have to follow new guidelines to establish a successful dialogue with the audience, maintaining a consistent degree of recognisability and being as innovative as possible at the same time (Kotler P., Pozzoli R., Stigliano G., 2021).

For luxury companies, the solution to be preferred is to define their own branded Metaverse space, in accordance to the visual elements and value associations that define its uniqueness and make it recognisable in the physical world. Companies will consequently be able to create a virtual world offering tailor-made experiences, entertainment, inspiration and purchasing opportunities, all totally on-brand. Thus freeing themselves from formats and languages fixed by aggregators or third-party platforms, such as Roblox, and also opening up the possibility of intercepting much broader targets (Sayem, 2022).

For the fast fashion world, on the other hand, the Metaverse represents an opportunity to build distinctive positioning, develop customised conversations, release limited edition meta-product or NFT collections, to work towards building a sense of exclusivity that this format inevitably lacks.

According to my research, based on direct analysis of the most interesting case studies developed so far and on discussions with metaverse development project leaders in leading fashion houses, the advantages of a proprietary Metaverse are therefore multiple:

- autonomous assortment management of physical, digital and virtual products;
- customised interactions;
- content updated in real time;
- full creative control;
- management of the bond with the 'mother' brand;
- new potential target audiences;
- increased brand appeal among the younger target groups;
- conveyance of an accessible version of luxury, without risking of selling out.

Co-creation and sales models

The 'first engage, then sell' rule, also applies in the Metaverse. I made my own the experiential approach to the point of sale, in its fundamentals elaborated by Pine & Gilmore and the assumption on which environmental psychology is based, reconceptualising it in the metaverse.

If the administration of certain stimuli in an environment is capable of conditioning the emotional state of the recipients, up to the point of influencing their behaviour (Pine and Gilmore, 2013), then a new set of rules must be defined for brands interested in operating successfully into the Metaverse. Before planning any sales strategy, it is necessary to understand how it is possible to convey not only the functional characteristics of the product/service, but also the emotional ones (Ruiz, 2022).

Metaverse sales channels are not always, and not necessarily, only a virtual transposition of the physical ones, but the cost of integrating them into one's business should not be a source of undue concern: the potential profits, estimated at over a trillion dollars a year (Grayscale, 2021), exceed the initial cost of adoption, on whatever scale one decides to approach it.

Most interestingly, whatever retail format is chosen, whether a simple flagship showroom or a multi-brand mall, the Metaverse offers luxury and fast fashion companies the opportunity to set and customise incredibly inclusive, adaptive and scalable spaces.

By removing physical barriers, metaverse environments are built to work for any customer profile, intercepting people where they are and offering them an immersive experience that transcends traditional commercial, logistical and even conceptual boundaries (Weiss, 2022).

The future of physical and digital shops will be enriched by integration, in an infinite space for business optimisation and growth, with the potential to provide an even more immersive experience (Barile, 2022).

How does this affect the predominant distribution model, the omnichannel approach based on the integration and cooperation of the various channels organizations to interact with consumers, with the goal of creating a consistent brand experience? This model goes beyond marketing and sales, re-embracing in a broader vision also customer care, retail, logistics and supply chain (Palmatier, Sivadas, Stern, El-Ansary, 2019). It has proven to be more than valid, to intercept an increasingly nomadic, unfaithful consumer, eager for unique experiences.
One might therefore think that it would be enough to 'add' the Metaverse to the touchpoints involved in the omnichannel set, in order to dialogue effectively and timely with its inhabitants. This is not the case, for a number of reasons: only 4 out of 10 companies had already fully implemented an omnichannel customer experience strategy and less than 30% carry out deep analyses on the data collected (Politecnico di Milano, 2021).

Furthermore, according to my interpretation in the metaverse-economy the rules of engagement of the consumer are completely different, as

- the possibilities for developing ad-hoc products and services;
- the distribution channels;
- the identity of the points of sale;
- the data set.

There have been many attempts to represent the concept of experiential marketing and the topic of experience building in the Metaverse. The reinterpretation I elaborated, adopting the experiential framework and the "experiential continuum" approach (Filser, 2015) is one of the most effective:

Table 1. The experiential continuum in the Metaverse

Co-creation	Products	Examples
Weak	Physical products replica	Zara Live Glam phygital collection 
Intermediate	Limited editions Standard NFTs	Overpriced™ NFT hoodies 
Strong	Meta products Custom NFTs	Gucci Virtual 25 @roblox 

The ambition, for brands that want to build a solid position in the Metaverse, should be to position themselves in the experiential area where co-creation is best expressed: original content produced by the company is enriched by the contributions of creators, or it is the latter that become part of the company's assortment, because of their originality. The same applies to NFTs, where the degree of customisation drives up the value.

From social commerce to direct-to-avatar

The primary need to be satisfied, in a metaverse store, is that of inclusiveness in an experience that must remain exclusive. No less important, is the possibility to stimulate the highest degree of interoperability between the various virtual rooms, to be traversed also by assuming different identities. The greater the exchange, the more intense and enriched the experience will be (Varra, 2021).

As mentioned before, a conceptual and physical access route to an experience that is new for most of the metazens (Volponi, 2022) - young videogames enthusiasts or over 65 with plenty of free time to devote to exploring new technologies - is essential. And that is social commerce: the term iden-

tifies all transactions of products and services that take place via social media and involve sharing the experience with other users. A business that is estimated to reach 1.2 trillion dollars worldwide by 2025 (Group M., 2022) interesting to monitor for its possible evolution and integration with the Metaverse, far more so than classic, albeit advanced, ecommerce platforms.

When it comes to luxury fashion products, the nature of the exchange via social commerce intercepts above all, the will to share, throughout the customer journey, the path of discovery with a community of peers, possibly led by one or more influencers of reference. Therefore, using the social media most aligned with the group of users deemed strategic to re-engage and welcome them in a fluid, spontaneous and as natural as possible entry into the Metaverse, is the way forward.

What is needed, therefore, is a model based on the full integration of social commerce functionalities within a broader platform. And the Metaverse can define a 'never-ending commerce' experience, in which contacts between users and brands take place spontaneously, almost unconsciously, facilitating immersion in an ever-changing but perfectly functional experience of needs, availability and identity, whether physical or virtual (Park & Kim, 2022).

In my interpretation, the identity of retail outlets from traditional to Metaverse should evolve as follows:

Table 2. Point of sales' identity evolution.

	Traditional	Phygital	Metaversal
Identity	Purchase	Permanence	Interoperability
Need	Functional	Playful/ Emotional	Co-creation Ethic Values Democracy Exclusivity Inclusivity
Players	Staff Sales assistants	Visual merchandising Ambassador/ Storyteller Chatbot Customer service	Virtual assis- tants Avatar AI Robots Creators Metazens

In the Metaverse, POS (points of sale) should therefore

- convey experiences;
- modulate on the target's value set;
- support their self-perception;
- enhance participation and inclusiveness;
- maintain a sense of exclusivity and privilege.

Fashion industries need a change of mindset: a shift from the direct-to-consumer model to the direct-to avatar model. The former, while interesting for its potential to modulate strategies and offerings directly to the consumer, still relies heavily on third parties for shipping and handling and is forced to make heavy compromises in terms of profitability to offer the best service dimension. With DTA, this additional element of friction is removed and a direct dialogue with the consumer is possible according to new rules of the game, from which luxury brand storytelling can be enriched and enhanced.

Conclusions

To operate successfully in the Metaverse, luxury and fast fashion companies should first of all assign a new role to the points of sale. Shops of any format and size have been considered by fashion houses as mere empty boxes to be filled with clothes and accessories. A dangerous misunderstanding, which showed all its limits when cheap replicas and the phenomenon of counterfeiting exploded in all their drama. Even more, it generated disaffection and disloyalty to brands and their sales spaces when digital communication and alternative sales channels arrived.

In today's hyper-competitive world, a sales model based on the replication and imitation effect is obviously no longer sustainable, nor is it acceptable for an industry that makes the power of ideas its primary differentiating factor. It is time to break out of this impasse. Many other sectors have already done so, from food to consumer electronics, with excellent results and without compromising the brand value gained through years of serious work on positioning and brand equity. In this 'ultralogue in the making', a universe that goes beyond our traditional knowledge and is enriched by a series of unprecedented elements, it is possible to imagine a real revolution for the cultural and artistic scenes and for the possibilities of creative expression in many different fields, including fashion.

The Metaverse represents an unmissable opportunity for fashion houses, particularly those more reluctant to abandon withered laurels on which they have rested for too long, to consider the point of sale a social object in which the company dialogues with the outside world and the people who inhabit it.

A group of people searching for added-value relationships with the brand they love deployed with a completely new, emotional, experiential, ethical, inclusive and sustainable storytelling.

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Handle with Care/Inclusivity Adaptation of Cultural Heritage

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To *Handle with Care* in times of conflict, requires connectivity and creativity. The track Handle with Care/Inclusivity connects the fields of Inclusive Design, Design for Health and Well-being, and Cultural Heritage. This calls for creativity and a strong common starting point.

'Care' is a broad term with overlapping and diverging definitions used in different fields. Finding its origin in nursing theory, its study soon expanded towards sociology, anthropology, geography, philosophy, history, and conservation. Design sciences and heritage studies are challenged to merge and discuss insights gained in these fields into solutions that are inclusive, empathic, and attending to individuals', communities', objects', and buildings' particularities. The papers presented in two parallel tracks "Handle with Care" and "Handle with Care for Heritage and Conservation" cover a broad range of present and future challenges related to care in design and care for cultural heritage.

'Care in design' can be approached as bi- or even omnidirectional interactions with attention for reciprocity, between living beings -human and non-human- and technology, including objects, interiors and buildings. Both design as an outcome and design as a process are addressed in this respect. Design research with a focus on care aims at practice and policy in order to integrate implicit and explicit care into people's everyday life and create future proof environments. This is reflected in a broad variety of contributions related to design of and for technology, products, services, interiors, and buildings with focuses shifting from designed outcomes to design processes.

The section ***Design for/as Communication*** unravels the mutual connection between design and communication. Digital tools and design toolkits can enhance communication on sensitive topics. At the same time communication can be designed as a way of care.

Design for Diverse Users raise awareness for the diversity in people we design for and the challenges they face. Several authors stress the importance of gender related issues in design. Others draw attention to specific groups such as refugees, homeless people, or students. All strive to make design processes and outcomes more inclusive through an enhanced understanding of end-users' experiences, needs, and sensitivities.

The ***Care(ful) spaces*** sections discuss the role of the built environment, from urban, architectural, and interior perspectives. The papers combine insight into the impact of space and how it can be adapted, with theoretical and methodological reflections.

The section ***Co-creating care(ful) design*** focuses on a variety of design processes. By engaging end-users, often children, in the design process, authors aim to give voice to often unheard groups, empower them, and support (self-)acceptance.

Design(ers) & Learning unites papers on design education with a plea to educate designers about how to approach their daily design practice. Rethinking interactions between people, and between people and objects come to the fore.

The section Design & Theory sheds a light on how strong theoretical frameworks can open new perspectives on design outcomes and processes.

Last but not least, the section ***Design Ethos*** foreground the importance of ethics in design. It draws attention to the responsibility of designers to work in a social, societal, and cultural respectful way. Only by doing so a caring design practice can be achieved.

'Care for Heritage and Conservation' is one of the most meaningful aspect of life that needs an approach 'Handle with Care'. Due to increasing pace of change, cultural heritage field in the past decade have invested on responding to conflicts, disasters and sustainability. The motto "management of change" and policies following it were drafted in a reactive way specific to each challenge. In due course, overarching concepts already fell short of fulfilling their mandate, in the face of pandemic, climate change, migration and wars. The heritage field is very much responsive to its context. A good reading of international policies will reflect the changing spirit of its time, moving from monuments protection on

the losses of individual masterpieces to urban conservation following widespread destruction created by the world wars. The current global challenges, indispensable from the national boundaries, are forcing all fields of natural and cultural heritage to transform and adapt.

The section on **'Care for Heritage and Conservation'** aims to tackle the problem from an integrated point of view, acknowledging the fact that our natural environment, built environment and cultural inspirations and practices are forced to adapt to current and future global challenges. The key issue is how can heritage be the guiding resource in this transformation. Different research papers in this section, have addressed how creativity and scientific research can offer possible strategies on adaptation, learning from our heritage.

Inclusive Approaches to Intangible Cultural Heritage section explored envisioning design strategies for intangible cultural heritage activation; media art productions to create a bond between traditional arts and the younger generations; communication design tools and heritage contemporary enhancement as a resource for social changes, fostering diversity and inclusion.

Sustaining Traditional Crafts and Techniques section focused on material aspects of various cultural heritage objects, such as the affordances of design-led mediation towards sustaining an ancestral cycle of linen making; culture towards circularity; a design-led visual ethnography of traditional embroidery motifs.

Adaptation of the Built Environment section on one hand explored ways and which climate change and green infrastructure and on the hand how adaptive reuse can be instrumental.

The section on ***Participation and Role of Communities*** explored various ways of participation such as digital solutions for visitor participation in museums; looking participation at times of war; and role of communities in disasters.

The overview of papers in the sub-tracks 'Care in design' and 'Care for Heritage and Conservation' show how the two cover overarching topics and face similar challenges regardless of the different starting points and focusses. Whether we care for present or past buildings or objects, taking an inclusive approach is essential to realize societally relevant outcomes and processes.

This stance is not only reflected in the presented papers but also forms the common thread through the posters, workshops, and conversation groups that substantiate the 'Handle with Care/Inclusivity' track. A huge "thank you" to all contributors is well placed here.

Encouraging humanitarian assistance in conflict zones through animated public service announcements

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Abstract

Recent conflicts in parts of Eastern Europe, the middle East and Africa have resulted in increased numbers of Internally Displaced Persons due to their inability to reach the borders of their countries in pursuit of refuge outside affected countries. These humanitarian crises continue to reveal the rising, urgent and dire need for humanitarian assistance to the affected people. The coverage of events and humanitarian stories in areas of armed conflict is crucial in aiding relief organizations in expanding the scope of their humanitarian projects, as it conveys the magnitude of the crisis and the extent of the suffering, which can persuade donors to provide more aid to the needy. However, working in conflict zones is a significant challenge for humanitarian workers and journalists, as numerous deliberate and inadvertent attacks on aid workers and journalists have been documented in countries such as Afghanistan, South Sudan, Syria, the Central African Republic, Ukraine, Ghana and Yemen.

Studies have demonstrated that one of the most effective ways of encouraging donors to take action is to use a single case of suffering as opposed to relying only on statistics. Other studies have also concluded that when affected persons narrate their own story, it is easier to convince the intended target to empathize with them (Chang & Lee 2010; Kim 2014). To mitigate some of the aforementioned challenges and to uphold the anonymity of affected people, this practice-led research paper proposes and argues for animated public service announcements as a potential effective medium for promoting humanitarian stories of people living in conflict zones. Through engaging with existing literature and discourses, and conceptually lensing the discussions on theories of animation and concepts on framing humanitarian appeal message, the study designs, develops and produces a first iteration of an animated Public Service Announcement text inspired by an actual event. It then rigorously analyses this text with the intention of developing it to an effective Public Service Announcement for potential humanitarian donors.

Author keywords

Humanitarian stories; Animated PSAs; fundraising donor aid; conflict zones; representations; framing humanitarian messages.

Introduction

> Never before has the world been so generous towards the needs of people affected by conflicts and disasters, and never before has generosity been so insufficient (Miliband 2016:14).

Humanitarian and relief organisations continue to rely on support from individuals, governments and other donor entities to fundraise for their increasingly urgent and dire humanitarian projects. Many of these non-profit organisations are compelled to device novel ways of appealing to and attracting support from donors who may choose which entities to support. It is becoming increasingly important for media and marketing experts in these organizations to find new ways of delivering the humanitarian plea to their donors and to understand what makes these appeals effective and successful. In addition to the magnitude of humanitarian crisis facing relief organizations, working in areas of armed conflict presents numerous challenges and obstacles for humanitarian workers and journalists. Several deliberate and inadvertent attacks on aid workers and journalists have been documented in countries such as Afghanistan, South Sudan, Syria, the Central African Republic, Ukraine, Ghana and Yemen.

Reaching people in need in war zones is another big challenge for relief organizations. In many instances, humanitarian organizations are prevented from delivering support materials to people in need. There are reports of assaults, kidnappings or killings of relief workers, whether intentionally or inadvertently (Patel et al. 2017:79-80). In this research, interviews were conducted with three humanitarian organizations, namely the "Gift of the Givers Foundation", the "International Organization for Migration", and the "Jordan Hashemite Charity Organization" to gather information on the challenges they face when covering humanitarian stories in areas of conflict. These organisations reported facing additional challenges. One is that the global financial crisis of 2008, which had a negative impact on the rate of support reaching humanitarian organizations. The three organizations reported an increase in the demand for humanitarian projects in most areas where these organisations operate and a lack of financial support. This deficiency has an impact on the number of projects im-

plemented each year, as financial support is regarded as the artery that feeds the various activities and relief programs carried out by these organisations. Also, in some situation, there is a lack of cooperation by the hosting governments or local authorities in the area where the projects are implemented, which makes the transportation of relief workers extremely difficult and in some cases a threat to their lives.

Studies have demonstrated that one of the most effective ways of encouraging donors to take action is to use a single case of suffering as opposed to relying only on statistics. Other studies have also concluded that when affected persons narrate their own story, it is easier to convince the intended target to empathize with them (Chang & Lee 2010; Kim 2014). To mitigate some of the aforementioned challenges and to uphold the anonymity of affected people, this practice-led research paper proposes and argues for animated public service announcements as a potential effective medium for promoting humanitarian stories of people living in conflict zones.

We begin by briefly defining some key terms. The fundamental premise of animation is to display a series of static images that, when seen, give the illusion of movement. Cartoonists at the Zagreb School, however, strive to expand this description by emphasizing the creative and philosophical aspects of the craft. They say that animating is "to impart life and personality to a design, not by duplicating reality but by transforming it" (Wells 2013:10). Public service announcements (PSAs) are advertisements designed to enlighten a specific audience about certain concerns in order to increase awareness, draw attention, and urge action (Public service announcements 2015:2). Public service announcements may contain interviews, dramatizations, animations, and a variety of other visual and audio forms. The purpose of these announcements is also to inspire thought about certain issues in order to replace specific behaviours. PSAs are usually designed to be brief and concise for effectiveness.

Framing the humanitarian appeal message

Chang and Lee (2009:2913) define framing as the way in which a message is presented to its intended recipients. Kim (2014:708-709) proposes that there are two overarching approaches to communicate humanitarian messages which appeal to the potential donor's motivation. The first is what Kim calls altruistic appeals, which entail expressing concern for others. These messages emphasize the good effect of helping others and that assisting others should not be tied to the benefit of the donor; as a result, altruistic donors tend to be more concerned with the welfare of others than themselves. Kim terms the second approach as an egoistic appeal, these target people's self-interest. Kim proposes that egoistic givers concentrate on the rewards that will arise from their support, indicating that they are more concerned with their own welfare. Some of these benefits may include avoiding punishment, lowering taxes, or earning the appreciation of others (Kim 2014:708-709). Both approaches to message framing have their advantages and disadvantages when they are delivered to potential donors, and there is a lengthy debate about which one is more effective when presenting the humanitarian appeal. Kim's study (2014) also concludes that concrete and specific cases elicit a stronger response from donors compared to abstract and generic statistics.

Chang and Lee identify four components that they argue should be included in every humanitarian message. These include, "Clear and moving headlines, body copy, vivid case stories, and statistical evidence of a public issue to capture attention, elicit sympathy, and motivate giving" (Chang and Lee 2010:196). These four elements are also central to any successful production of Public Service Announcements. Chang and Lee's study (2010:198, 199, 212, 215) also identifies two ways to frame humanitarian appeals, positive framing and negative framing. These two can be likened to Kims (2014) altruistic and egoistic appeals. Positive framing, they note, emphasizes the positive outcomes of the donor's assistance. An example would be an appeal with an overall tagline such as 'with your donation, we can change the lives of the poor'. Negative framing approaches emphasize the negative outcomes of ignoring the donation request. For example, without your donation, dozens of poor people may lose their lives. The conclusion of the aforementioned study is that negative framing is more successful than positive framing since it might boost donors' emotional engagement and empathy when presenting humanitarian scenarios.

Humanitarian and aid organizations employ media campaigns, including shocking ones, to sway public opinion to support their cause. Darren Dahl (2018:89) argues that the traumatic images used in "shock advertising" demonstrate the victim's suffering in an effort to elicit viewer compassion. Shock advertising can be understood as a declaration that intentionally violates the social values and personal ideals of a targeted audience in the context of a charity in order to emotionally engage them. To demonstrate the severity of the issue to the public and elicit the intended response, these campaigns are highly emotive and often intentionally hostile towards viewers. The sensitive nature of the humanitarian appeal, which may be expressed by vivid visuals of someone's suffering paired with slogans, statistics, or information, plays an active role in conveying the message and convincing the intended audience (Albouy 2017:5).

Animation's Value Proposition in humanitarian PSAs

In the context of the aforementioned challenges faced by humanitarian and aid organisations and considering their fundraising needs and objectives, this section discusses some selected value propositions that animation, as a medium, can contribute to facilitate effective humanitarian media campaigns in order to attract funding from potential donors.

Honess-Roe (2011:2196), notes that "[...] envisioned information is easier to understand and retain", and that "much factual information is communicated more efficiently via animation than the spoken word". In addition to this convincing argument, human beings have been socialised to communicate effectively through story telling. Animation, alongside other forms of visual storytelling, offer the possibility of envisioning the spoken word. Instances that are characterised by a lack of existing live footage or photographic evidence, such as those experiences by humanitarian and relief organisation's media campaigns or instances in which accessing such footage would be too dangerous for either journalists or members of the relief organisations would benefit significantly from designing and narrating these media campaigns

using animation. As Honess-Roe notes above, animation can give life to spoken words and aid in visualising these events for a more effective or emotionally engaging experience from potential donors. Animation can play an important role when the story's protagonist requires anonymity. Although there are techniques in live action and photography that can be used to conceal the identity, voice and exact location of victims of conflict, these can be breached using contemporary software and technologies. Moreover, some of these techniques, such as masking the persons face or distorting their voice could potentially distance the viewer. Animated PSAs could be a more effective alternative to tell these stories powerfully in order to elicit empathy.

The use of live action footage or photography can be disturbing in certain situations and may end up subverting the intention of the relief organisation's media campaign objectives. Such visual material may expose viewers to extremely violent and disturbing scenes when documenting and narrating stories of wars and armed conflicts. This could result into an unintended consequence of losing and/or distancing some sensitive viewers in the target market. Using actual live action footage or photography can, in some instances, have the unintended effect of presenting locations such as damaged buildings and infrastucture, events such as violent attacks and in certain shots people such as refugees and corpses of victims in a generic and similar way. These kinds of representations could also have an effect of distancing or numbing the viewer. Animated PSAs could potentially offer a design solution to these challenges by curating these images without appearing to deliberately manipulate them and by individualising what may be construed as generic and similar.

Charles Forceville (2015:67) contends that, "If it is the live-action film's job to present physical reality, animated film is concerned with metaphysical reality - not how things look, but what they mean". He further proposes that animations enable the designer to lend a 'subjective perspective' to the story through visual metaphor. In some instances, and depending on the events, narrative and objective of the humanitarian media campaign, it may be more effective to use metaphors, imagery and other non-literal techniques to tell a compelling, emotionally engaging and effective story. These are strengths of the animated narrative as animation, due to its techniques and processes offer affordances that amplify and effectively apply metaphors, imagery and other non-literal storytelling techniques. These characteristics of animation enable the animators to portray plot themes that may be challenging to achieve with other formats of visual representations such as live-action and photographic material.

Honess-Roe (2011:217) asserts that animation can convey profound meanings and concepts by explaining difficult-to-achieve aspects or events compared to using other formats such as live-action and photography footage. Animation due to its fluidity, agility, style, context and format can also visually represent and capture abstract and non-visual events such as human feelings, memories, dreams, internal thoughts and internal conflicts more effectively, without disrupting suspension of disbelief. Visual ques, colour, shapes, movements and metaphors can be used in more dynamic ways to almost 'literally' represent some of these difficult to achieve events such as pain, frustration etc.

In a space where several humanitarian and relief organisations are competing for a finite pool of potential funders and volunteers, it is important to find ways to be novel in order to stand out and be different to the majority so that these media campaigns can be noticed. Majority of media campaigns use live action media in cases where motion picture is a preferred outcome, or photography where the target audience is inclined to this. Many use radio campaigns and other forms of aural campaigns. In the contemporary space in which the internet, social and other digital media platforms are gaining credence and popularity, the animated medium can provide this differentiation or novelty that would potentially enable a campaign to receive the desired outcome and stand out from the rest.

Methodology

In his seminal paper "Research in art and design" (1994), Christopher Freyling convincingly argues for the validity of practice research in the Art, Craft and Design fields. He grapples with questions of what research is, what it involves and what it delivers and discusses three overarching research categories which are: research into art and design, research through art and design and research for art and design. This study positions itself within Freyling's second category i.e. research through art and design and follows a practice-led research methodology. Hazel Smith and Roger Dean (2009:7) contend that research-led practice is a complementary term to practice-based research and that "scholarly research can lead to creative work" (Smith and Dean 2009:7).

The *golden thread* integrated a practice-led orientation, with a research-led thematic, which came to constitute the animated PSAs conceptual design. Connecting both the various approaches and methods herein was made possible by leveraging an inductive approach, where meanings derived from collected / relevant data (Creswell 2014:232-233) were sustained as a kind of persistent meta-synthetic activity experienced between moving between researching, conceptualising and making. As observed by Hawkins and Wilson (2017:83) practice-led research can contribute to research knowledge when the "work is challenging, probing, bringing into question or testing a conceptual model" (Hawkins & Wilson 2017:83). As already mentioned, the study begun by interviewing three humanitarian organizations: the "Gift of the Givers Foundation", the "International Organization for Migration" and the "Jordan Hashemite Charity Organization" to gather information on the challenges they face when covering humanitarian stories in areas of conflict. The study then engaged with conceptual and theoretical literature on framing the humanitarian appeal message as well as theories on animation and animated documentaries. These culminated into the production of the first iteration of an animated PSA titled *Child's Dreams: Between Dreams and Reality* which was premised on a transcript of an actual event provided by one of the humanitarian organisations mentioned earlier.

Analysis and Insights from the first iteration of the Animated PSA

The first iteration of the Animated PSA is titled *Child's Dreams: Between Dreams and Reality*. It is a two-and-a-half-minute animated PSA set in a desolate destroyed town. The

narrative's protagonist and only character in the story is a boy of about five to seven years whose voice over narrates the events. The story skilfully and creatively transitions between the desolate town, his lonely home and the hospital in which he is admitted after his home is destroyed, which is the protagonist's reality, and his dream world, which is a manifestation of his fantasies and wishes. The story opens in the fantasy world set by a beach as the protagonist is fishing. Through his voice over, he tells us that fishing and photography are his favourite activities and expresses his wish to live in a world without war, like other children. The fantasy world is positively framed throughout the narrative while the real world is framed in the converse. Here's a link to the animated PSA: https://vimeo.com/778893804.

As the first point of contact with potential donors and volunteers, the title of the animated PSA certainly needs some reworking so as to streamline it and to make it appeal more to its target market. The words in the title need careful consideration and curation to include key words that can immediately grab the attention of the target audience by calling them to action. As it currently reads, the choice and arrangement of words in the title are neutral and passive, and may not immediately pique the attention of the target viewer. In a space awash with competing content, the title needs to stand out. A title such as 'Stop the war: give children a future' or 'Every hour, war destroys a child's life' could pique the interest of potential donors. Streamlining the title could also entail reframing it to eliminate repetition of words and avoiding having it read like a logline.

Technically and narratively, the animated PSA could use the affordances of the animated medium more creatively to push the boundaries of representation. As Honess-Roe (2011:217) intimated, animation can represent and convey difficult to achieve events. Since the PSA has only one character throughout the story, animation techniques could be used to create dynamism and alternative focus points by representing the protagonists feelings, memories, dreams, internal thoughts and internal conflicts either visually or through imagery. Animation, for instance, could allow the audience to either literally or metaphorically journey into the protagonists heart, stomach, brain or injuries to visually externalise and represent pain, suffering, loneliness, frustration and other internal emotions that are often difficult to convey if other media such as live action and photography are used.

The world of the story may also seem implausible as it is currently represented. Although the protagonist mentions his family, the audience does not get to see them. No other people or animals are seen either in the real world i.e. the hospital, home, streets or in the fantasy world. Although the sense of isolation may elicit empathy from the viewer, suspension of disbelief may be disrupted if no other people seem to be in the protagonist's world either in his fantasy or his real world or both. There may also be a lost opportunity for emotional engagement by not including other people that the viewer could relate to or identify with. Showing a variety of people experiencing similar struggles and difficulties as the protagonist or even a pet in the protagonists world could broaden the Animated PSAs appeal to a broader and more diverse audience.

The wall-to-wall music may need a rethink as it could potentially distract the viewer from the events unravelling in the story. The choice of this sound track seems apt for setting the mood and tone of the narrative, however, it could potentially be counter productive to a fully immersive emotional engagement. Moments of silence or those that focus on diegetic sounds in the scene could, in some instances, be as powerful if not more effective than wall-to-wall music.

The punchline at the end of the PSA reads, 'children deserve a world without wars, so let's work together to make that a reality: with your support, we can realize their dreams. This is a powerful call-to-action punchline that has the potential to elicit empathy from the viewer. However, the PSA does not, in its narrative, offer ways in which the viewer can contribute to making the world a better place for children affected by wars. It also does not clearly articulate what kind of assistance it is seeking from the viewer. As identified in the section on the principles of framing humanitarian appeals, statistics are also essential in contextualizing and showing the magnitude of a problem. These aspects would need to be included in the second iteration of the PSA for it to be effective in achieving its objectives of eliciting financial support and attracting volunteers from its target market.

Conclusion

This practice-led research paper has proposed and argued for Animated Public Service Announcements as a potential effective medium for promoting humanitarian stories of people living in conflict zones. The study begun by interviewing three humanitarian organizations to gather information on the challenges they face when covering humanitarian stories in areas of conflict. The study then engaged with conceptual and theoretical works on framing the humanitarian appeal message. In this section, concepts such as altruistic and egoistic appeals, positive and negative framing and other techniques and approaches that elicit a strong response from donors were discussed. All these informed the production of the first iteration of an animated PSA which was premised on a transcript of an actual event provided by one of the humanitarian organisations. The paper finally analysed the first iteration of the Animated PSA discussing some of the insights gleaned from it and proposing points to be considered and included in subsequent iterations of the Animated PSA. Although these were not exhaustive, they will improve the second iteration which will then be viewed by the humanitarian organisations for their input in producing and designing the third iteration.

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The design of an engaging focus group discussion toolkit involving school-aged children following urotherapy

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Abstract

Lower urinary tract (LUT) dysfunctions, such as urinary incontinence, are a common condition among school-aged children (8 to 12 years old) and can negatively affect their quality of life. Urotherapy is the recommended first-line treatment, but patient compliance and motivation are low, resulting in a lower success rate. The traditional products used in urotherapy are often paper-based and outdated. In order to improve the products and services supporting urotherapy, it is important to involve users in the design process. This study describes the preparatory process for conducting focus groups and co-creation sessions with children following a 10-day urotherapy group training in the Wilhelmina Children's Hospital of UMC Utrecht, Netherlands. A literature search was conducted to design a focus group/co-creation toolkit and script tailored to the context of research on urotherapy supporting products with children. The toolkit consists of four key exercises: icebreaker and warm up exercise, collaging exercise, anonymous pen and paper exercise and a storyline character exercise. The goal is to optimize the products supporting urotherapy by defining patient needs and desires based on the current context and patient experiences.

Author keywords

Qualitative research; Focus group discussion; Co-creation; User Centered Design; Incontinence; Urotherapy: Pediatric patients

Introduction

Lower urinary tract (LUT) dysfunctions, such as urinary incontinence, are one of the most common conditions in school-aged children (5 – 13 years) (Austin et al., 2016; Anka J Nieuwhof-Leppink et al., 2019). Children with LUT dysfunctions often have low self-esteem and feel ashamed and stressed, which negatively affects the child's quality of life (Bower, 2008; Thibodeau et al., 2013). Urotherapy is the recommended first-line treatment (Chang et al., 2017), which involves re-education and rehabilitation of the bladder and pelvic floor muscles. It combines practice at home with regular follow-up counseling by a trained professional. Unfortunately, patient compliance and motivation for urotherapy are low (Nock et al., 2006), contributing to its lower success rate of 40% – 56% (Schäfer et al., 2018; van Gool et al., 2014; Vijverberg et al., 2011).

We believe the products and services supporting urotherapy play a crucial role in the effectiveness of urotherapy. The traditional urotherapy products are often paper-based solutions (e.g. bladder diaries and bedwetting calendars) and the little technology used (e.g. bedwetting alarms and reminder watches), can be perceived as outdated. In addition, the design methodology behind the existing products primary focuses on scientific evidence to make sure the design complies with evidence-based guidelines. In contrast, users' needs are not or insufficiently investigated during the design process, resulting in products that do not fulfill users' expectations (Klijn et al., 2006; Ku et al., 2004; Kwinten et al., 2020; Myint et al., 2016; A.J. Nieuwhof-Leppink et al., 2019; van Leuteren et al., 2019). To improve the products and services supporting urotherapy, we want to actively involve users in the design process as being experts of their own domain.

Qualitative research in the form of focus groups and co-creation session appears to be ideal to deliver rich insights on users´ needs and expectations (Barbour, 1999). However, conducting focus groups and co-creation sessions with children on one hand, and involving a sensitive topic such as incontinence on the other can be challenging. It will be our task to create a safe and inspiring context in which all participating children feel comfortable to share personal experiences in a creative and playful way. We will describe our preparatory process for conducting focus groups and co-creation sessions with children following urotherapy.

Methods

A literature search was conducted to create an overview of recommendations and examples for conducting focus group discussions and co-creation sessions with school-aged children. The search was designed as an open exploration, rather than an exhaustive systematic search. It was used to design a focus group/co-creation toolkit and script tailored to the context of research on urotherapy supporting products with children (8 to 12 years old), following a 10-day urotherapy group training in the Wilhelmina Children's Hospital of UMC Utrecht. The purpose of the focus group discussion in the follow-up study

is to optimize the products supporting urotherapy by defining patient needs and desires regarding urotherapy products/tools based on the current context and patient experiences, as well as evaluating and optimizing new concepts to support urotherapy in scope of the identified needs and desires

Results

Our literature search revealed several key recommendations that we took into account in the design of our focus group/co-creation toolkit and script. Specifically, we found that working in small groups of 4 to 5 children was recommended for children aged 8 to 12 years as it allows for facilitators to encourage interactive discussion while also ensuring that the session is not too noisy and difficult to transcribe (M. Gielen, 2013; Morgan et al., 2002). Gielen further recommends to start easy and let children feel they are not being tested as well as rewarding their participation and show appreciation. In addition, it is recommended to use variety in the exercises to keep participants interested and address a variety of skills, which makes the outcomes more diverse.

In the design of our toolkit and script, we ensured that it was adapted to fit children's cognitive and social-emotional skills. However, according to Hansen (2017), children possess a high degree of open-mindedness, enabling them to see new and creative opportunities beyond the mere function of an object or idea. To tap into this potential, we incorporated creative tasks involving imagination and play in our toolkit, as this was found by Starke (2012) to be a good outlet for children. We aim to use the toolkit to involve children in a playful and interactive way, allowing them to express their thoughts and ideas freely. Our focus group script includes several exercises with breaks in between to maintain the quality of comments and keep the children engaged. This was informed by Morgan et al.'s (2002) finding that the quality of comments began to decrease when the discussions carried on for longer than 45 minutes. To make the most of these breaks, Morgan et al. recommend keeping the cameras and audio recording on to capture any spontaneous or informal interactions that may occur. Finally, to enhance the validity and richness of our findings, we will follow the advice of Gielen (2013) to use informants who know the participants to evaluate the outcomes of the focus group discussions and co-creation sessions. In our case, the urotherapists who work closely with the children during the bladder training will serve as these informants.

The aforementioned use of recordings leads us to ethical considerations and data privacy, which emerged as crucial aspects during the literature review. They are of paramount importance in pediatric research, as children are considered vulnerable subjects (European Medicines Agency, 2016). In general, all studies involving human subjects must be submitted for review by an independent ethics committee (IEC) to ensure compliance with applicable standards and laws, including the Good Clinical Practice standard (European Medicines Agency, 2016) and the General Data Protection Regulation (The European Parliament and the council of the EU, 2016). However, studies involving children require special attention, particularly with regards to obtaining informed consent. The age at which children can legally provide consent to participate in research varies across countries (European Medicines Agency, 2019). In cases where a child is unable to provide legal consent, their assent should be sought, and consent from their parents or legal guardians is mandatory. To ensure that children can make informed decisions, it is important that the information provided to them about the study is comprehensive and explained in developmentally appropriate language (Heary et al., 2002). Clark (2010) recommends using simplified language and supporting pictures to help children understand the purpose of the study and their role in a focus group interview. Additionally, Heary et al. (2002) suggest explaining the importance of confidentiality in the introduction of the focus group, including how the children's information will be processed. In line with this recommendation, we will explain confidentiality and request verbal consent for the recording at the start of the focus group, in addition to the written consent already obtained. Following transcription of the focus group, we will delete the original recordings and store only the transcriptions with anonymized codes.

In addition to the preceding general recommendations, we used the literature to design specific exercises that form the four key components of our customized focus group/co-creation toolkit and script: (1) icebreaker and warm up exercise, (2) collaging exercise, (3) anonymous pen and paper exercise and (4) a storyline character exercise. These exercises were carefully selected and tailored to the specific objectives of our research on urotherapy supporting products with children. We will present these exercises in detail to provide a comprehensive understanding of how the literature was used to inform the design of our toolkit and script, and how it has been adapted to fit the specific context of our research.

1. Icebreaker and warm up exercise

The objective of the icebreaker and warm-up activities is to facilitate group communication, make participants feel relaxed, and establish an environment where sharing and listening are valued (Gibson, 2007). These activities also serve to reinforce the importance of participation and stimulate the minds of the participants (Visser et al., 2005). An example of an icebreaker activity found in the literature (Morgan et al., 2002) is throwing a ball to a group member, who upon catching it, must say their name and a personal fact and then throw the ball to another group member. Another example is a group mind-mapping activity, where associations are made in group to a given theme (M. Gielen, 2013).

In order to tailor these activities to the context of urotherapy, we have modified the traditional icebreaker game of throwing a ball around the group by replacing it with a toilet roll (Fig. 1). The first round of the game involves participants sharing per-

Figure 1. Icebreaker and warm up exercise: toilet rolls for personal facts and mind-mapping

sonal facts, such as their name, age, and hobbies, while passing around the toilet roll. In the second round, the research topic is introduced in the form of a group mind-mapping activity. A timer is set, and the researcher starts the game by saying a word related to urotherapy such as urinating, drinking, or bladder training. The child catching the toilet roll must say the first word that comes to mind, associated with the word the researcher said, and then throw the toilet roll to another child. This continues until the timer runs out, and the goal is to come up with as many words as possible before the timer goes off.

2. Collaging exercise

The collaging exercise in our toolkit is designed to elicit information about children's experiences and perceptions of urotherapy products and tools within different contexts. The process of creating collages allows children to access and express their experiences in a creative and interactive manner. After creating their collages, children will be asked to present it to the group. As demonstrated in previous research (M. Gielen, 2013; Stappers et al., 2004; Visser et al., 2005) this process facilitates deeper reflection revealing unmet needs and exposing aspirations for the future. Such insights are valuable for designers seeking to create effective solutions. To design our collaging exercise, we followed the guidelines recommended by Visser et al. (2005) which include using a diverse range of images with different contexts, people that reflect diversity in age, gender, and race, and a balance between positive and negative images and between specific and abstract images. Visser et al. also recommend to avoid using over-aesthetic images in one consistent style, but instead use a mix of styles that are open to interpretation. This approach allows for ambiguous images to be interpreted in many different ways, which is useful for helping different participants express their feelings and dreams. Gielen (2013) used a collaging map as a research tool to investigate children's fears. The children were asked to create several collages for different contexts: home, school and other locations. They were asked to make a collage with pictures and words describing their emotions connected to each place. This method allowed Gielen to have an in-depth understanding of the children's fears within different contexts.

The collaging exercise is tailored to the context of urotherapy by providing participants with the materials and instructions to create collage maps describing their experiences and emotions related to four different contexts of urotherapy and pediatric incontinence: home, school, individual doctor appointments, and in-hospital group bladder training (Fig. 2). A mix of specific images such as standard urotherapy products, including bedwetting alarms, paper bladder diaries, and toilet accessories, and abstract images reflecting emotions are used. Furthermore, the images used in the collaging exercise are printed in black and white to allow for ambiguity and diversity. Additionally, crayons are provided to allow the children to add color to the images, which can further enhance their creativity and imagination. The collages created will provide valuable insights into the children's patient pathway and inform the design of future urotherapy products.

Figure 2. Collaging exercise: A3 with four quadrants (home, school, doctor and hospital), mix of black and white images to cut out and box with crayons.

3. Anonymous pen and paper exercises

The use of pen and paper exercises provides an opportunity for children to reflect on their ideas and experiences without the pressure of an immediate question to answer (Morgan et al., 2002). This can also encourage more introverted children to participate by making the results anonymous (M. A. Gielen, 2008). In a study of children with asthma, Morgan et al. (2002) used this approach, where children were asked to write or draw 'good' and 'bad' things about having asthma, using pens and two large pieces of paper on the floor. The open-ended nature of this exercise was found to be extremely fruitful in elucidating children's values (Morgan et al., 2002).

Figure 3. Anonymous pen and paper exercise: cardboard toilet prop, sheets of paper in three different colors for 'good', 'bad' and 'ideas' and representations of the different urotherapy products.

In order to tailor this exercise to the context of urotherapy, we created a cardboard toilet prop (Fig. 3). The children will sit around the cardboard toilet and will be asked to write their thoughts about urotherapy products on three different sheets of paper: one for things they find 'good', one for things they find 'bad', and one for their 'ideas' for these products. The products include standard items such as bedwetting alarms, timer watches, paper bladder diaries, and uroflowmetry toilets, as well as new concepts. The children will complete this task individually and anonymously in the group setting. Afterwards, the research team will be able to link the answers to the individual participants by using a difference in ink color of the pens. Once the children finish writing, they will crumple up the paper and try to throw it into the cardboard toilet. The researcher will then randomly select a piece of paper and read it aloud to the group, starting a group discussion. This exercise is similar to the popular game "black box" and allows for a fun and interactive way for children to share their thoughts and feelings about urotherapy products, while also allowing for anonymity and encouraging participation from more introverted children.

4. Storyline character exercise

The use of a storyline character as a tool for children's understanding and interpretation of a research subject can

promote free thinking and imagination, as it allows them to detach from the limitations of their personal context. Gielen (2008) utilized a character creation exercise in a study on children's outdoor play, in which participants were provided with a collection of images of various body parts and asked to create a collage character. This character was then used as the protagonist in subsequent storytelling exercises, as a means of exploring the children's understanding and perceptions of outdoor play (M. A. Gielen, 2008).

Figure 4. Storyline character exercise: arts and crafts material to create a superhero with a bladder problem

In order to apply this concept to the context of urotherapy, we will provide children with various arts and crafts materials and ask them to create a fictional character, a'superhero', who also happens to have a bladder problem (Fig. 4). By analyzing the characteristics and traits of the superhero created by the children, the researchers can gain further insights into the children's perspectives and desires related to urotherapy products. This exercise is implemented at the end of the toolkit to conclude the session on a fun and positive note.

Discussion

In this paper, we described our preparatory process for conducting focus groups and co-creation sessions with school-aged children on the sensitive topic of incontinence and urotherapy. Our literature search was conducted as an open exploration and is not exhaustive. However, we hope it can serve as a useful guide and inspiration for others to apply similar approaches in their own research contexts. We emphasized the importance of thoroughly planning and conducting qualitative research in the form of focus group discussions to ensure the most valuable insights are obtained. In our view, this toolkit holds significant relevance as it has the potential to engage children and generate rich insights, in contrast to a traditional conversational question-and-answer method. Additionally, we consider it our obligation to reduce the burden on children during the research process and to ensure that their participation is a pleasant experience, as they are generously contributing their time to our research. Our research process, like our design process, should prioritize the needs and comfort of our participants, particularly in the case of pediatric patients. With this engaging toolkit, we believe that we can improve the overall research outcome, which can be used as input for design, ultimately leading to improved products.

In the next phase, it is essential to conduct pilot tests to identify any potential improvements in the toolkit and script. These evaluations will be incorporated into our subsequent study, where we will implement the toolkit with children who undergo a 10-day urotherapy group training at the Wilhelmina Children's Hospital of UMC Utrecht in the Netherlands.

Conclusion

In conclusion, a child-friendly and engaging focus group discussion toolkit tailored to the context of urotherapy for school-aged children (8 to 12 years old) suffering from incontinence was developed. The toolkit consists of four key exercises: icebreaker and warm up exercise, collaging exercise, anonymous pen and paper exercise and a storyline character exercise. This toolkit aims to facilitate researchers to gain a deeper understanding of the experiences and needs of pediatric patients in regards to existing and newly proposed urotherapy products. The toolkit was designed with a literature-based foundation and will be evaluated in a pilot study with children following urotherapy. The findings from the pilot study will be used to improve the toolkit and support future research in this area.

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Inclusive transformation of age friendly communities based

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Abstract

The world's population is ageing. New measures and concepts of population ageing are significant for assessing the living conditions and living arrangements of the elderly, their contributions to society, and their needs for social protection and health care. In 2018 the World Health Organization (WHO) published a report subtitled "Looking back over the last decade, looking forward to the next", which explicitly mentions technology as a support for age-friendly environments. Although the WHO has discussed the involvement of technology and computers in terms of access to information etc., and uses technology as a "supplementary indicator" regarding "internet access," in 2019 Marston and van Hoof are critical of WHO's Age-Friendly Cities and Communities model, which lacks reference to and recognition of technological solutions in multiple domains. Increasingly, scholars are finding recognition of the importance of technology and digitalisation as the third pillar of age-friendly cities and communities, particularly in terms of use-friendly and sustainable design, acceptance of technology, and implementation and caregiver needs. The creation of genuine multisectoral action based on cooperation between the various disciplines make it possible to achieve a truly age-friendly society for present and future generations. In the context of active ageing and global digital trends, this study focuses on the analysis of two digital practices (digital twins and artificial intelligence) in the built environment of age-friendly communities, discusses inclusive transformation strategies for age-friendly communities, presents a proposed framework for inclusive digital age-friendly community transformation, illustrates future trends in age-friendly community design planning, and provides a reference point for future research.

Keywords

Inclusive transformation; Age-friendly community; Digital technology; Digital twins; Artificial intelligence

Introduction

According to data from *World Population Prospects: the 2019 Revision*, one in six people in the world will be over age 65 (16%) by 2050, up from one in eleven in 2019 (9%) (United Nations, 2019). Demographic change brings enormous challenges and pressures in areas such as social welfare, healthcare, public policy, and infrastructure (Davern et al., 2020; van Hoof et al., 2018). Urban ageing (van Hoof et al., 2018; van Hoof & Kazak, 2018) raises questions for communities in all areas of urban life. New measures and concepts for population ageing will have a profound impact on the quality and way of caring for older people and their potential contribution to social production.

According to the World Health Organization (WHO), *"An age-friendly city is an inclusive and accessible community environment that optimises opportunities for health, participation and security for all people, so that quality of life and dignity are ensured as people age (WHO, 2007b)"*. The concept of age-friendly cities and communities was introduced as a response to two global trends, *population ageing* and *urbanisation*, whereas the third global trend, *digitalisation*, has been overlooked (Reuter et al., 2020). Meanwhile, technology still does not appear in any of the eight domains of the WHO Age-Friendly Cities, despite the need to create smart age-friendly ecosystems that meet the needs of the various sectors that assist communities to work together (Marston et al., 2020). There is therefore an urgent need to develop a proposition that recognises the role and impact of digital technology in the inclusive transformation of ageing populations and age-friendly communities, and to apply it to a wider range of areas.

Age-Friendly Community (AFC)

The "age-friendly" community is where *"policies, services, environments and structures support and enable active ageing (WHO, 2007b)"*. In addition to accessing geriatric care and services within the local community, older people can live in a community they are familiar with and maintain a degree of independence and dignity (Zhang & Pan, 2021). Scholars agree that creating and maintaining age-friendly environments is a core component of a positive approach to the challenges of population ageing (Lui et al., 2009).

Social inclusion is linked to the health and well-being of older people, enabling the ability to maintain significant relationships with others, the ability to engage in meaningful community activities and the continuation of lifelong interests (Graham et al., 2014). International policies on ageing have begun to focus on promoting more socially inclusive societies (Keating & Scharf, 2012). In socially inclusive commu-

nities, people can participate in meaningful ways (Scharlach & Lehning, 2013). AFC characteristics can mitigate social disadvantage by providing more inclusive and supportive communities (Lui et al., 2009; Scharlach & Lehning, 2013) and enable physical and social environments that promote the social inclusion of older community members and provide opportunities and support in multiple domains (Scharlach & Lehning, 2013).

Figure 1. Age-Friendly City domains (WHO, 2007b, illustrated by authors).

Figure 2. Eight domains for age-friendly action (WHO, 2018a, illustrated by authors).

In 2006, WHO categorised the key characteristics of AFC into eight domains: outdoor spaces and buildings, transportation, housing, respect and social inclusion, civic participation and employment, social participation, community and health services, and communication and information, see figure 1. Over time and in response to changes in the social environment, the framework has expanded to emphasise three additional themes that transcend the domain of age-friendly environments—the physical and social environments, and municipal services (Ronzi et al., 2020), see figure 2, with different elements but overlapping and interrelated domains, demonstrating the multifaceted nature of caring for older people in a complex reality (Menec et al., 2014).

Measuring the Age - Friendliness of Cities and Communities

To assist cities in becoming more age-friendly, the WHO established *the Global Network of Age-friendly Cities and Communities (GNAFCC)* in 2010. The age-friendliness of a city is measured by a set of "core indicators" that are based on the characteristics of the eight domains of AFCs (WHO, 2007a). The indicators can be used to measure the city's age-friendliness baseline level and monitor how it changes over time as relevant interventions are implemented. They can also be leveraged to foster political and social commitment, which can lead to further actions to promote and sustain age-friendly cities (Davis & Kingsbury, 2011).

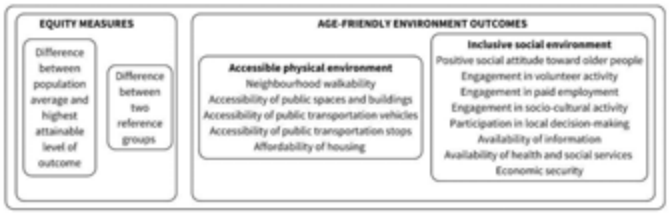

Figure 3. Core Indicators of Age-Friendly Cities (WHO, 2015, illustrated by authors).

The fundamental principles reflected in the core *indicators are equity, accessibility and inclusiveness* (WHO, 2015), see figure 3.

Supplementary indicators are *accessibility of priority vehicle parking, accessibility of housing, participation in leisure-time physical activity in a group, engagement in life-long learning, internet access, public safety, and emergency preparedness* (WHO, 2015).

The supplementary indicators listed were strong candidates for inclusion in the core indicator set but were not included for various reasons (see indicator selection criteria described by WHO, 2015). Where appropriate, these indicators should be considered for inclusion in a local context, along with the core indicators.

Digital Technology

In *The Global Network for Age-Friendly Cities and Communities: Looking back over the Last Decade, Looking Forward to the Next (2018b)*, the WHO states that age-friendly cities enable residents to age actively in their families, communities and civil society, provide a wide range of opportunities for older people to participate in their communities, and should make cities and communities more inclusive, while technology can act as a support for age-friendly environments. However, the WHO model of age-friendly cities and communities does not explicitly consider the involvement of technology (Marston & van Hoof, 2019). Over the years, technology has become one of the necessary conditions to support the rapid development and digitisation of society. The development of smart cities seeks to ensure that the needs of senior citizens are met and to promote solutions that suit their digital literacy, skills and perceptions (Podgórniak-Krzykacz et al., 2020). In recent years, digital technologies which support the inclusive transformation of AFCs came into view. While there are several digital technologies available for study, including Internet of Things (IoT), mobile applications, Augmented Reality, and Virtual Reality (VR), among others, Digital Twin (DT) and Artificial Intelligence (AI) were selected to be analysed in depth for the purpose of this paper, because of their potential in improving the quality of life for older adults through physical built environment transformations, personalised solutions and real-time feedback.

DT and AI are two examples of digital technologies that can be utilised to boost age-friendliness in urban areas and improve the livability and accessibility of the built environment for senior citizens. These technologies have shown promise in a number of fields, including healthcare, transportation, and smart home environments. For instance, Lin et al. (2022) created a smart healthcare system based on AI for ageing monitoring and fall detection, while Madubuike et al. (2022) explored the potential of DTs in healthcare facilities. Similar to this, Colnar et al. (2020) observed that age-friendly smart homes and AI have the potential to improve life quality.

Moreover, the quality of life for an increasing number of older persons with declining functional capacities could be improved through the use of intelligent, age-friendly surroundings with embedded ambient-assisted living technologies, which can be provided through DT and AI (Kavšek et al., 2021).

As with all digital technologies, the use of DT and AI presents a number of possible issues, challenges, dangers, and limitations. This includes concerns with acceptance and

adoption, cost and resource constraints, bias and discrimination, privacy and data security, and accessibility challenges. The processing of personal data may give rise to privacy problems, and some AI algorithms may exhibit bias against specific populations. Additionally, elderly users may show hesitation towards implementing such technologies, and older persons with disabilities may experience accessibility challenges, which could limit their effectiveness. It is also worth mentioning that the implementation of AI and DT systems requires significant investment in infrastructure, hardware, and software.

Considering the above, this paper proposes a general framework which can be used to address gaps in the existing framework, in order to support cities' initiatives to build more liveable and inclusive communities for residents of all ages.

Methods

This research utilises and builds upon secondary sources including published, peer-reviewed literature, journal articles and reliable sources of information as well as verified media sources and medical opinions regarding ageing populations. For the purpose of this article, the methods rely on data collection and narrative assessment of existing case studies, which are relevant to the fields of digital technologies and ageing. The case study selection is subject to a number of criteria as follows:

1. It concerns itself with ageing populations aged 65 and above.
2. It incorporates one or more uses of digital technologies (i.e. DT and AI models) which are relevant for this article.
3. It relates to and builds upon the pillars for age-friendly living environments.
4. It was conducted during the past 10 years and was documented in the English language.

Based on the aforementioned criteria, the selected case studies will be analysed in order to assess the impact of digital technologies on fostering age-friendly living environments, as well as the impact on the livelihood and wellbeing of individuals as a direct result of interacting with such technologies. Following the assessment, a framework of suggested recommendations for technological support of AFC will be extracted and synthesised, in order to lay a foundation for future research.

Case Studies

This section provides a brief explanation of the digital technologies relevant to this research, and supports the selection with a case study which portrays the impact of said technology on the livelihood of ageing populations.

Case 1 - Digital Twins (DT)

DT technology is one of the digital tools for the physical environment, which has the potential to transform the way we design and manage AFCs. It is a real-world representation of physical things (people, activities, situations, processes) (Grieves, 2014; El Saddik, 2018). Digital transformation has been enriched with the help of the IoT, which enables easy implementation of DT, which is used in many areas, including age-friendly support (De Maeyer & Markopoulos, 2020; Kobayashi et al., 2022; van Leeuwen et al., 2022). Below are a few examples of how DT can be used in the built environment and smart cities to support an AFC:

Smart Transportation: van Leeuwen et al. (2022) mentioned age-friendliness for older people with DT based on three workshops in Spain, Finland, and Belgium conducted by H2020 URBANAGE. They proposed the data for older people in their daily life. Some of these data can be used for public transport to estimate the walkability of the city for older people. So, it could help the policymakers to provide inclusive spaces for all. It is also possible to calculate the distress of elderly on their daily route using wearable devices (Ahn et. al, 2020).

Architecture and Design: De Maeyer & Markopoulos (2020) give insight into their study on a theoretical overview of ageing in place with DT which can have several categories according to intention and fed data such as layers of medical, lifestyle, home, or workplace. Data can be obtained from medical devices for the medical layer, wearables for the lifestyle layer or devices inside a house. Ambient Assisted Living (includes technical systems for elderly people for their special needs in their daily life, Dohr et al., 2010) can be used for older people's status and health monitoring, providing independent living, providing a secure and safe environment with the help of IoT (Dohr et al., 2010; Hsu et al., 2017; Risteska Stojkoska et al., 2017), providing engagement with their community remotely, giving a chance to explore several scenarios, and making simulations for predicting future situations. It is aimed to protect and demonstrate the autonomy of the elderly and their safety in the environment they live in (Dohr et al., 2010).

Intelligent Monitoring: Kobayashi et al. (2022) proposed a DT tool that mirrors the mental health and living spaces of older people. They provide a DT agent in roles regarding the support functions for mental health and society cooperation and monitoring indoor and outdoor spaces using distributed sensors. The DT agent is applied to the smartwatch to monitor the elderly. Their experimental study provides recognition of the early stage of cognitive and liver function disorders. DT abilities can also be used for historical records to prevent the future actions of the elderly.

Predictive Maintenance: With the help of smart sensors, DT can be used to predict the maintenance of built environment problems (Zhao et al., 2022). These problematic places that older people encounter in the built environment may be areas such as sidewalks and resting places (van Leeuwen et al., 2022).

According to the use cases mentioned above, one of the benefits of DT in AFCs is their ability to provide real-time data and analytics. Another aspect is facilitating collaboration and communication. Here, the designer's first task is to understand these DT before using them in design. The final section of DT includes the service layer for management, advice and decisions (Lu et al., 2020; Emir Isik & Achten, 2022). Within this, DT can facilitate dialogue and decision-making between designers and communities by providing a common platform for stakeholders to hold and analyse data. It can be especially vital in AFCs where the needs and preferences of older people are not represented in the traditional planning process, as in the digital planning process. DT systems can help assess the accessibility and usability of public spaces, transportation, and other infrastructures. It can also support monitoring the health and well-being of older people. By providing a real-time, comprehensive view of a community's infrastructure, servic-

es, and resources, it can be subsidiary to identify and chart the needs and monitoring faced by older adults. They can also help optimise systems and services, leading to more efficient and sustainable communities.

Case 2 - Artificial Intelligence Applications (AI)

The current rise of AI applications as well as their adaptability to a majority of fields and industries make this a widely discussed and timely topic. Through providing older persons with enhanced access to resources, support, and opportunities, AI applications can help them lead safe, comfortable and independent lives.

American Association of Retired Persons (AARP)'s "Ageing in Place: The Role of Technology" (2020) explores how technology, especially AI, can help older persons age in place and live independently. In "The Potential of AI to Enhance Quality of Life for Older Adults" (Gao et al., 2020), a review of the potential applications of AI to assist older adults and enhance their quality of life is provided. These applications include those related to healthcare, transportation, and home environments. "Ageing in the digital world: difficulties and opportunities" (European Union Agency for Fundamental Rights, 2019) examines the opportunities and challenges associated with using digital technology, such as AI, to assist older individuals' rights and autonomy.

There are various instances of how AI can be utilised in the built environment and smart cities to support ageing populations:

Smart Transportation: by utilising self-driving cars or on-demand ride-sharing services, AI can be used to enhance older folks' transportation alternatives (Abduljabbar et al., 2019). Even if they are no longer able to drive, these technologies can assist older persons in keeping their independence and access to the community.

Architecture and Design: by using assistive technology and smart home technologies, for example, AI can be utilised to construct age-friendly homes and cities (van Hoof et al., 2019). These innovations can make it safer and more comfortable for senior citizens to live in their homes while also giving caretakers information on the health and wellbeing of their loved ones.

Intelligent Monitoring: AI can be used to keep an eye on older people's security and safety in the built environment, for example, by using wearable tech or sensors that can spot situations like falls (Security World Market, 2021).

Predictive Maintenance: using sensors and machine learning algorithms, AI can be used to forecast and avoid maintenance problems in the built environment (Rampini & Cecconi, 2022). This can lower the costs and inconveniences related to maintenance while also ensuring that the built environment is safe and usable for older persons.

In conclusion, the application of AI to the built environment and smart cities can assist senior citizens in many ways, improved access to transportation, architecture that is age-friendly, intelligent monitoring, and predictive maintenance are few of which. It is necessary to take into account the potential of these technologies to support age-friendliness and improve the livability and accessibility of the built environment for older residents, while also considering their social integration and inclusion into their respective communities.

Ethical and Inclusive Integration of Digital Technologies

"Ageing in the Digital Era" (UNECE, 2021) outlines the potential of digital technologies to support healthy ageing and improve the quality of life for ageing populations, and emphasises that these technologies are used in an ethical and inclusive manner, which prompts a critical outlook on data privacy and ownership concerns.

For example, the ethical issues and privacy problems regarding the usage of DTs are covered by De Maeyer and Markopoulos (2020). Although DTs may increase productivity and cut costs, the authors contend that such models could be exploited to establish a surveillance state or for nefarious intentions like cyberattacks, which is one of its possible threats. The authors also point out that the usage of DTs to gather enormous amounts of data on people could result in privacy violations and other ethical dilemmas.

The authors provide a framework for ethical and privacy considerations in the usage of DTs in order to alleviate these concerns. Four primary concepts that make up this framework: accountability, justice, respect for privacy, and transparency, which should be incorporated into the design and deployment of DT and AI models from an early stage.

Moreover, Harper et al. (2021) studied user privacy concerns and preferences in smart buildings, focused on how users perceive and prioritise privacy concerns in the context of smart buildings through surveys and interviews with participants in the UK.

Participants in the research expressed concern about a variety of privacy issues, including the collection and use of personal data, surveillance, and the possibility of hacking and data breaches. The survey also discovered that participants had varying preferences for the collection and use of their data, with some preferring to have control over their data and others willing to give data for specific advantages, such as energy savings.

The authors advise designers and decision-makers to adopt an inclusive, user-centric strategy for privacy. Further research is recommended to examine how user privacy preferences and concerns can alter over time as smart building technologies, including DT and AI, continuously advance.

The proposed New AFC Framework

Based on existing research in the literature and the current state of technological development and application, we find that a new inclusive digital AFC is emerging. It is therefore essential to add digital technology to WHO's original AFC framework, which facilitates the residential experience and quality of life of senior citizens in city and community environments, and helps to promote an inclusive transformation of all-age community residential environments. This proposed new inclusive Digital Age-Friendly Community Transformation Framework (DAFCTF), see figure 4, is an extension of the WHO model with DT and AI digital practices, which proposes four aspects and levels of technology involvement in AFC transformation based on the perspective of policymakers, architects and user groups: problem identification, data analysis and testing, monitoring and prediction. As the effectiveness of the collection and application of technical data is more difficult to measure and has no uniform standards in the social environment area, the four aspects have a relatively high weighting in the physical environment and services,

which will provide greater improvements, while the social environment is yet to be further developed, with data Analysis and testing having the least weighting. These four aspects are described below:

Problem Identification: accessibility, transport, social isolation and healthcare are a few representative examples. A city might conduct a study of older people to learn about their social connections, mobility, access to healthcare, and general contentment with the neighbourhood. Meanwhile, examining information on ageing-related patterns and problems, such as the incidence of long-term illnesses or the accessibility of housing. Based on this data, the city may decide what issues need to be addressed first in order to make the community more age-friendly. For instance, in the social sphere, utilising natural language processing to examine the content of social media posts or survey responses from elderly citizens could be analysed to find recurring themes and areas of concern for ageing populations.

Data Analysis and Testing: AFC should establish a data platform and regularly assess its impact. It is vital to test new projects and technologies and gather data on how effective they are. It may be necessary to evaluate new technology or methods through experiments or pilot programs, and to use data analytics to assess how these activities affect age-friendliness in the neighbourhood. The responsible parties can modify the digital strategy as necessary based on the findings of these assessments. For example, a DT of a city centre might be used to test how different architectural modifications, such the inclusion of parklets or the rearranging of streets, affect the area's accessibility and suitability for senior citizens.

Monitoring and Evaluation: data platforms need to be monitored and evaluated on an ongoing basis to ensure the accuracy of implementation. For example, a DT and AI-powered system in a city centre may be used to track the usage of age-friendly infrastructure and gather information on how effective it is, such as accessible bus stops and sidewalks or building entrances.

Prediction and Evaluation: it includes an evaluation of the city and community's current digital technology situation and plans how it can be used to address the difficulties experienced by older residents. To promote age-friendly initiatives, this may involve using DT and AI in the built environment.

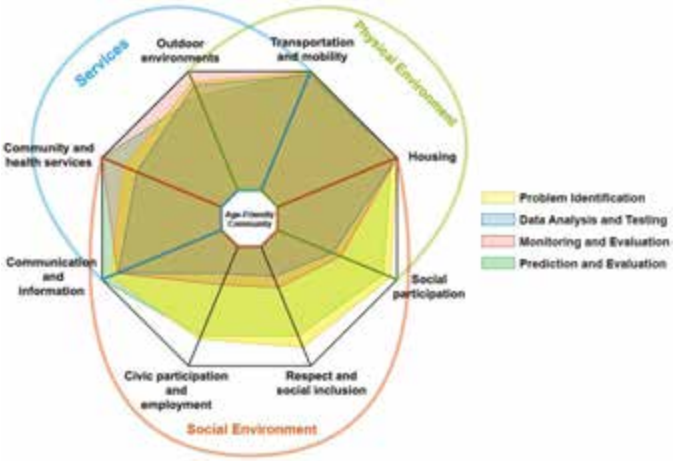

Figure 4. The proposed inclusive Digital Age-Friendly Community Transformation Framework (Source: authors).

For instance, the city may take into account using chatbots powered by AI to assist and enlighten senior citizens, or using DT to simulate and assess the effects of various design and policy changes on age-friendliness. To improve the accessibility and livability of the community for senior citizens, the city may also consider the use of other digital technologies, such as connected devices or VR. Although VR devices for example have been found to cause discomfort, disorientation, and even motion sickness in some users (Chang et al., 2020), studies have revealed that VR technology can be helpful for seniors, especially in the context of encouraging social engagement and minimising loneliness (Balki et al., 2022). Using VR to imitate social scenarios can help senior citizens connect with others in a secure setting.

When implementing various instances of emerging digital technologies in AFCs, it is crucial to employ a user-centred approach. This involves useability testing with senior citizens to make sure that the technology is accessible, pleasant, and does not lead to discomfort or disorientation (Doré et al., 2023).

Also, it's critical to give elderly users who might be less technologically-proficient the proper instruction and assistance. This may entail offering approachable user interfaces, detailed instructions, and human assistance as required, such avenues could be explored in further research.

As we propose this new DAFCTF, we acknowledge that it may not be suitable for all countries and regions' AFC, which means that the framework will need additional adaptation to meet different contexts and realistic foundations. However, what has to be acknowledged is the necessity of updating this framework. Future research should be complemented by the involvement of other disciplines and the inclusion of stakeholders in decision-making processes to validate the application and acceptance of the new model, as well as assessing the limitations of the suggested technologies and methods of implementation.

Conclusion

In line with the state of art on ageing, the WHO introduced a framework with definitions and iterative processes requiring periodic reviews and revisions. However, several aspects of the limitations of the framework stem from the fact that this is an evolving field of science and is not involved with digital technology yet. Some limitations point to specific topics that need further research and technological interventions. The rapid development and widespread use of digital technology offers the possibility of realising the vision of a truly more inclusive and age-friendly society for present and future generations.

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Taking care of the elderly through the tools of animated communication design: a useful and ethical imperative

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Abstract

"Care" according to Heidegger is the fundamental structure of existence and the totality of determinations of being of Dasein (which is the being-there is both being with). Care is the expression of the relationship between man and others and can be inauthentic or authentic. Inauthentic care takes care away from others by directly providing them with what they need; it is therefore directed towards objects more than towards men. Authentic care, on the other hand, helps others to take on their own care and therefore to be free to realize their own being; it is an expression of "coexisting". According to Heidegger, therefore, authentic care is a care that concerns people and that allows people to possess the tools to be-there.

This difference, apparently subtle but very profound, offers an interesting ground for reflection in the field of design and on the role that the designer can assume in this context. Can design tools, methods and processes be exploited to take care of others in the Heideggerian sense of the term?

This contribution wants to offer an example of taking care of the elderly through the tools of design. The research presented is part of the field of animated communication design and has as its objective the construction of a series of strategies to be offered to the designer in order to produce inclusive animated artifacts towards the older segment of the population. Through the presentation of three case studies carried out following these strategies, it will be clear how creating an inclusive animated product towards seniors is more inclusive also for all the other users.

The taking care of the elderly by design not only makes sense from the point of view of wanting to reach as wide an audience as possible, but it also assumes an ethical imperative. The digital technology universe can offer a wealth of information, empowerment, and potential; it is therefore not possible to deny this possibility to a large part of society.

Author keywords

Communication design; motion design; senior; inclusion; project tools;

Introduction

Taking care is an act that belongs to different disciplines; it does not only refer to the affective field, but has its reflections in many other fields, including sociology, psychology and philosophy. According to the German philosopher Martin Heidegger, "cure" is the fundamental structure of existence and the totality of the determinations of being in being there.

Since existence, for Heidegger, is being in the world, therefore being among others, care is precisely the expression of the relationship between man and others. According to the philosopher, there are two extreme possibilities for ways of caring. On the one hand, caring can in a certain way relieve the other from "caring" by replacing him in caring, stepping in his place. This taking care assumes, on behalf of the other, what one has to take care of. Heidegger calls this type of care "inauthentic". On the opposite side, there is the possibility of taking care which, instead of intruding in the place of others, presupposes them in their ability to be existential, not to deprive them of their "care", but to authentically insert them in it. This form of taking care, which essentially concerns authentic care, i.e. the existence of the other and not something he takes care of, helps the other to become transparent in his own care and free for it (Heidegger, 1929). Therefore, inauthentic care takes care away from others by directly providing them with what they need; it is therefore directed towards objects more than towards men. On the contrary, authentic care, according to Heidegger, is a care that concerns people and in particular that allows people to possess the tools to "be there".

This difference, apparently subtle but actually very profound, offers an interesting ground for reflection in the field of design and on the role that the designer can assume in this context. Can communication design tools, methods and processes be exploited to take care of others in the Heideggerian sense of the term?

This contribution aims to offer a reflection, through the presentation of three case studies, on how through the tools of design, with particular reference to the animated communication field, the designer manages to "take care" of the older part of the population.

The seniors: a growing range of users with some peculiarities

The seniors represent a growing segment of the population: the lengthening of life and the decrease in birth rates promises a growth in the number of people over the age of 65 at a global level: it is estimated that in the next fifty years, 30% of people in Europe will be aged 65 or over which is 10% older than they are now (European Commission, 2020; Eurostat, 2020a).

The intersection between the progressive aging of the population and the diffusion of technology in many aspects of daily life (work, education, health care, information, socialization, bureaucratic duties, physical activity, etc.), brings an ever-increasing number of over 65s online (Eurostat, 2020b). In fact, not considering seniors, with their unique needs and abilities, as possible users of a digital communication product implies the potential exclusion of an increasingly large segment of the population from using that specific product, with all the resulting disadvantages.

Beyond that, the use of technology has the potential to play a critical role in supporting older adults to maintain healthy levels of sociability, foster connection, learning and recreation while bringing significant benefits to their lives. (Oppenauer, 2009; Wister *et al*., 2021).

So, given the explosion of various forms of social media and online learning programs, given the ubiquitous use of technology in everyday life and the importance of it in maintaining independent living, it is understandable how much it is important to contribute to finding design strategies that can meet the needs, preferences and abilities of older people in using digital products or services. Therefore, when well designed and easily accessible, they can contribute to well-being and quality of life, support independence and self-reliance, and help with age-related issues and other limitations. (Neves and Vetere, 2019; Rogers et al., 2020).

Proper attention to design in all its processes is the key to eliminating the frustrations that are often linked to the use of new media by the elderly.

Although the data on the increase in the viewing of online videos by seniors are encouraging (Ericson Consumer & IndustryLAb, 2021) it should be stressed, however, that unfortunately the elderly are also the least expert class in the exploitation of digital technologies; precisely for this reason, compared to young people, there is a substantial gap also due to the disparity of digital skills and less experience in the use of new technologies (Friemel, 2014; Guo, 2017; Hargittai et al., 2019; Hunsaker and Hargittai, 2018; Moore and Hancock, 2020).

These differences in experience and technological proficiency are important to consider when designing digital products, services and systems. Any designer has the task of considering that the experience, competence and attitudes of the elderly towards technology are different from those of young people: not considering it in the design phase can potentially exclude a very wide range of possible users.

To these social and historical problems are added the physical and cognitive limitations related to age, which sooner or later almost everyone experiences during their elderly life.

Animated project tools for an inclusive design for seniors

Although there is substantial variability among the elderly in terms of skills, attitudes, experience and preferences, and this variability should not be ignored, younger or older adults vary some of their psychophysical characteristics in a predictable way: some of the most relevant differences are related to perceptual and cognitive abilities, movement control, experience and attitudes with technology (Boot et al., 2020; Panadisi, 2022)

For each of these areas, there are some design strategies to consider, which are derived from existing guidelines and scientific literature on the subject, as well as from design experience in motion design.

When you think of watching a video on a smartphone screen, you immediately think of seeing and hearing: These represent the most important forms of exchange with the environment and both senses are subject to significant age-related loss that begins quite early in adult life (Wahl Hans-Werner, 2003).

As for the field of vision, one of the main problems is the inability to see all the elements on the display correctly; the vision problems that most frequently occur with advancing age include the lesser amount of light reaching the retina, the yellowing of the lens, more difficulty focusing in cases of sudden changes in brightness and the early stage of cataract causes blurring (McLaughlin & Pak, 2020).

If the product is designed to be used on multiple platforms - in the field of visual intelligibility - it must above all be visible and readable on the different screens and in different formats: the 16:9 format, for example, which is most often used to create videos on smartphone screens, is definitely an outdated format and should be replaced by vertical or square formats. The excess of information, the overlapping of images and graphics in the same picture and the use of bright, high contrast colours can also lead to visual disturbances.

Like sight, hearing is one of the senses that deteriorates with age. The ability to listen can affect the ability to interact properly with systems. In fact, a hearing problem in the context of modern technology means losing touch with people and things. Hearing is often thought of as a backup sense to sight, although it has advantages over vision: It works 360 degrees around the body and provides greater acuity to detect rapid or minimal changes in the environment (Michels et al., 2019). In this case, the important variable is the context in which the user is viewing the video: The use of subtitles to accompany the voiceover and describe sounds or music is a very useful element. It is important that everything can be understood without sound or with possible background noise in the environment. On the other hand, heavily synthesised voices should be avoided for voiceovers. Prefer voices recorded by humans, which have more understandable frequencies (McLaughlin & Pak, 2020).

There are other important factors to consider when designing an animated artefact that adds to hearing and seeing: these are cognition and movement.

Cognition refers to all the processes by which the brain receives sensory input - whether from the eyes, ears or other senses - and transforms, reduces, processes, stores, retrieves and uses that sensory input (Boot et al. 2020). Some of the most important cognitive aspects that a communication designer dealing with audiovisual content must take into account are processing speed, which includes the speed of recognising letters and numbers, reading and understanding language; attention, which concerns our ability to process information; and finally, working memory, which refers specifically to the ability to keep information active until it is used (Czaja et al., 2019). In the cognitive domain, one of the most effective design strategies is to create short, clear and simple content, as the attention threshold of a normal user is always lower and therefore audiovisual content that does not exceed 90 seconds is the most effective. To overcome some of the most common cognitive problems, it is useful to include images and diagrams in the animation to clarify the text and the narrative voice, take into account that the user does not need to remember and therefore minimize the viewer's memory load by not overload-

ing the attention span by presenting too much information and text. The last characteristic to be considered is movement; both accuracy and timing of movement tend to decrease with age, without any particular pathology.

The main problem in the area of physical capabilities, which mainly concerns animated artefacts with an interactive component, is that smartphones are often used to watch short videos and the small size of their displays and buttons can make them difficult to use. Besides choosing an appropriate size and visibility of the buttons that appear in the interactive videos, it is much more important to increase the time for inputs by avoiding timeout operations. Therefore, it is advisable to add motion interactions to extend the time for answering a question or making a choice.

Starting from the deepening of some of the physical and cognitive characteristics of the elderly considered relevant in the interaction with an audiovisual product, the definition of the strategies in detail was completed, during the PhD research period, thanks to the systematization of these together with the principles and guidelines in subject of graphic design for displays, UI, UX and web accessibility, the principles of Universal Design and design for digital products and systems intended for elderly users and the technical peculiarities of motion design.

Application of senior-friendly project strategies: three case studies

Motion design is the most widespread of the new forms of communication: In recent years it has permeated a wide range of applications, brand building and identity design, digital product interfaces, data visualisation, design for TV and channel brands, exhibitions, advertising and much more. It uses the principles of visual communication and animation to convey a message in an engaging and effective way (Brian Stone & Wahlin, 2018). It is the synthesis of different disciplines and combines the static language of visual communication (graphic design, illustration, photography and painting) and the dynamic language of animation (film, sound, VFX) (Shaw, 2015).

Although the term motion design is still quite new (Kubasiewicz, 2005), both animation and motion graphics are anything but new techniques. The first dates back to the nineteenth century (Rondolino 2003), the second emerged in the 1950s through the opening credits of films and short animated interludes of television channels (Betancourt, 2013). It is important to look at the roots of this language: From being a language of communication limited to a few specific categories, it has evolved over the last decade into the main language of the internet, where short animated videos are distributed to promote, inform, educate and raise awareness on a variety of topics, products and services. Motion design is not a common visual language for older people, but it is also not too innovative to discourage its use.

Therefore, designing animated artifacts that are accessible to seniors is important both on an ethical and communicative level: in fact, excluding the elderly from a communicative message excludes a large segment of the population.

The videos chosen for the case studies are some of those made in the context of the PhD research as part of the verification of the strategies for producing inclusive animated artifacts towards seniors; they are made with different animation styles and techniques ranging from 2D to 3D. The application of the design strategies already took place in the pre-production phase starting from the concept.

Video 01 | Falls prevent

The first of the three videos that will be presented below deals with the topic of preventing accidental falls in the elderly. It is a very sensitive issue for the elderly and is one of the most frequent problems of hospitalization.

Moderate physical activity is one of the main strategies for preventing the risk of falling, maintaining good muscle tone and improving joint flexibility. The video presents some exercises developed by physiotherapists which, if performed consistently, can contribute to the prevention of accidental falls.

The minimal and clean scenography leaves room for keywords and subtitles, and the figure performing the exercises is placed at center stage as the main element of the narrative (see Figure 1).

Given the need to make the exercises as understandable as possible, the choice was to create a 2D animation with very simple characters and backgrounds, colored with flat colors without shadows, outlines or shades, just to put the focus on the exercise and not on the character or scenery.

Figure 1. Frames from Case Study number 1 | Link to video 01

The main design strategies used to make the artefact inclusive for seniors were:

- Avoid using bright contrasting colors
- Use a soft, neutral color for the background during the exercises to make the main subject stand out.
- Using a single pattern for the whole scene to avoid creating optical disturbances.
- Present the keywords with very large fonts: in this way they become graphic elements.
- Insert animated graphics (arrows and lines) to improve the understanding of the animation and the exercise.

Video 02 | The stages of feminism

The second video represents some essential stages of the feminist movement that took place in the time frame that goes from its birth to the present day. The animation tech-

nique is a hybrid between 2D and 3D that can be described with 2.5D; two-dimensional elements are used (in this case the path, numbers and texts) but within a 3D environment with a camera that therefore moves in three dimensions. The scenography is practically empty, a choice designed precisely to keep the viewer's focus centered on the stages, without distractions of any kind.

The whole narration is conceived as a long sequence shot to accentuate the idea of fluidity of the path that the viewer ideally follows while watching the video. The choice for the style is to use white for the background and black for the few elements in the foreground: the sinuous line that simulates the path and for the dates and small texts that accompany them, exaggerating the contrast between the elements (see Figure 2). In this particular case the guidelines to be taken into consideration are those to achieve cognitive ease and avoid short-term memory overload.

Figure 2. Frames from Case Study number 2 | Link to video 02

- The video is very short.
- Only two colors are used with a very evident contrast between the background (white-grey) and the foreground elements (black).
- The dates and the short texts that accompany them are deliberately made out of proportion precisely because they themselves represent the protagonists of the narrative.
- The decision to create a practically bare environment, with the exception of the main elements, is strategic in order to avoid distractions on the part of the viewer during the course of the video.

Video 03 | Save waste, save lives

The reduction of food waste is the theme chosen for the third video, created with a 3D animation technique: all the elements are modeled in the three-dimensional space, which becomes a real set with the camera and the lights positioned in order from film studio. The setting is that of a simplified food industry in which a machine in the center acts as a display of data and graphics while various types of food move on a rear conveyor belt. The background is monochromatic with no other elements to allow the viewer to focus on the main element. Even the camera is fixed and only graphics, elements and texts are animated. The narration therefore presents a single layout for its entire duration: this element is both functional to underline the importance of the main element of the scene which is always placed in the center, and to facilitate the understanding of the video without tiring the viewer (see Figure 3). Since this video is informative and has a good amount of data in relation to the duration time, the guidelines are taken into account to ensure that this data is well received and assimilated.

Figure 3. Frames from Case Study number 3 | Link to video 03

- The main element that hosts the data is always placed in the center of the layout.
- Along with the data, graphic elements are also displayed inside it that help clarify the narrative.
- The user does not have to make any effort to search the screen for information because it is always placed in the same position.
- The colors used are not particularly bright, but offer a good contrast between the relevant information and the background.

Conclusions

In recent years, thanks also to the Covid-19 pandemic, there has been an increase in the use of new media by seniors, with a particular increase in the use of motion design artefacts. This is an important point to ponder: older people, as we have noted, are a growing demographic worldwide and a significant class of digital media users; consequently, it is important to consider their specificities in design. It is considered that after the theoretical analysis of the design of inclusive digital systems and products and the psychophysical characteristics of seniors that are most stressed when interacting with an audiovisual product, the designer should consider a set of strategies to be applied when designing a motion design artefact. It was clear from the case studies illustrated in this paper that, if put into practice, these strategies will facilitate the resolution of certain visual, auditory, cognitive and physical problems of seniors mainly related to age. Animated

communication design artifacts created by considering the physical and cognitive characteristics of users can be a valuable tool in increasing the confidence in the use of new media by seniors, with all the potential benefits that will derive for them. After testing these videos with two groups of over 65 users (for a total of 100 users) the response was very positive, and the design strategies needed few adjustments especially for the audio part of the project.

As we have seen with these three videos, it is absolutely possible to produce animated artifacts that are inclusive towards seniors and also more understandable for all other users without affecting aesthetics and animated dynamics. For a designer, taking care of a senior user in the authentic form also means making sure that the communicative product is not only aesthetically satisfying, but above all understandable, accessible, and usable even for less young users.

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Pee Poo Period: exploring the intersection between shame, bodily fluids, and sustainable design

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Abstract

More and more designers are engaged in developing products and services that can accommodate both the urgency of an ecological crisis and the needs of consumers. Although many reusable solutions have reached the market and been brought into our homes, some products are more resilient to change, especially those connected to bodily taboos, sanitation, and hygiene. It is imperative that designers concerned with sustainability are also equipped to recognize how feelings of shame can sustain social practices with a negative environmental impact. This paper aims to describe what can happen when designers use concepts of shame and bodily taboos to navigate the design process and discuss how this applies to sustainability research. The paper is a result of a two-day qualitative workshop in which eight professionals from design, architecture, and art were asked to revise disposable products connected to urination, excretion, and menstruation (e.g., incontinence pads, toilet paper, and sanitary pads/ tampons) and create interventions that could make such products undesirable or obsolete. Divided into three groups (pee, poo, and period), the participants were introduced to various prototype design tools to give them a vocabulary to identify and talk about shame and its relevance to design. As a result, the three groups consolidated their ideas into three design concepts which were presented and given feedback. By the end of the workshop, a survey was sent out to the participants, and an open discussion was held to evaluate the course of the workshop and the usefulness of the tools. The outcome of this workshop shows that decoupling sustainability with concepts of shame can be a fruitful way to support design research with new insights and critical perspectives. Having the tools to include such considerations in the design process seems crucial to facilitate consumers' uptake of reusable solutions. However, the workshop also indicated that the provided tools could be further developed to create more concrete and applicable solutions to sustainability issues.

Author keywords

workshop; sustainable design; reusable products; shame; bodily taboos; design practice

Introduction

The widespread use of single-use plastics has led to a shift in the perception of plastic as a valuable material to a waste product with a limited usage period (Greenwood et al., 2021). However, nowadays, many consumers are becoming more conscious about their ecological footprint and aspire to a more sustainable lifestyle (Lubowiecki-Vikuk, Dąbrowska, and Machnik, 2021). Along with this increase in environmental awareness, many reusable alternatives to single-use products have reached the market and been brought into our homes. However, some of these products seem more resilient to change. Next to practical, economical, or health-related reasons, the embarrassment of the topic the product connects to can act as an additional threshold to changing behaviors (Peberdy, Jones, and Green., 2019), such as products linked to perceptions of hygiene, the human body (Lamont, Wagner and Incorvati, 2019), and the fluids (Kama and Barak-Brandes, 2013) it produces. There is a significant taboo surrounding reusable hygiene products, especially those connected to urine (e.g., diapers), excrement (e.g., cloth wipes), and menstrual blood (e.g., menstrual cups), which still results in significant negative environmental impacts caused by their disposable counterparts (Hait and Powers, 2019). While the reluctance to adopt these reusable products might be rooted in common perceptions of convenience, cleanliness, and hygiene, it is not always clear whether these perceptions are grounded in scientific data or an outspring of social constructs. For example, multiple studies have found that reusable menstrual products are just as effective at maintaining menstrual hygiene (van Eijk et *al.*, 2019; Van Eijk *et al.*, 2021; Metha *et al.*, 2022).

A few designers have engaged with taboos and bodily fluids such as menstruation blood (Søndergaard, 2020), urine (Helms, 2020), and excretion (Wilde, 2022) through domains of norm-critical and social design. Still, the implications of considering shame and taboos to sustainability seem unexplored, leaving designers unequipped to recognize how taboos and feelings of shame can sustain social practices with a negative environmental impact.

This entanglement between sustainability and taboo also represents the intersection of the two research projects this

paper is connected to. One is concerned with creating long-term usage of reusable alternatives for single-use products, and the other investigates how shame affects behavior and plays a role in design. While shame can be experienced as a social threat and painful momentarily, it can also be a motivational force for prosocial behavior (Scheff, 2003). Shame is a self-conscious emotion that depends on social conditioning and tells us something about right and wrong (Tangney, Stuewig, and Mashek, 2006). It can act as a social control mechanism and a behavioral agent with both positive and negative effects (Trondsen and Boks, 2022). In some cases, shame can nudge us into more socially healthy behaviors (e.g., avoiding littering in public), while in other cases, it can act as a threshold to doing things differently (e.g., swimming naked). Considering the social and moral capacity of shame, it becomes interesting to question how this plays out in the context of sustainable design. In this paper, we aim to discuss how taboos concerning bodily fluids impact sustainability and the acceptability of solutions. We also explore the usefulness of including different shame tools and to what extent this helps designers to identify and work with these taboos to create more effective interventions.

Workshop: Pee, poo period.

A two-day workshop was held on the 13th and 14th of June 2022 in Trondheim, Norway. The workshop was named "Pee, poo, period: an explorative workshop exploring the intersection between shame, bodily fluids, and sustainable design." As indicated by the title, the goal of the workshop aimed to investigate sustainability in a taboo context, focusing on disposable products related to urination, excretion, and menstruation (pee, poo, and period) and the pitfalls of their reusable counterparts. The workshop included eight participants of experienced practitioners and researchers from different areas of design, architecture, and art recruited through a physical and digital poster. A diverse group of people with different cultural backgrounds participated, including two men and six women, with seven different nationalities (from North-American, Asian, and European countries) and ages ranging from the early twenties to mid-fifties. During the workshop, the participants were randomly divided into three groups, each focusing on a different bodily fluid (pee, poo, or period). Each group was asked to "develop and visualize a critical or speculative design concept in which disposable pee, poo, or period products become undesirable or obsolete." We specifically challenged the participants to think more critically and speculative to ensure that they would open their creativity to think beyond what we consider and often take for granted as being normal. To do so, the groups would follow a design process facilitated by a booklet containing information about different exercises and tools. The booklet was based on an earlier workshop done by one of the researchers in Antwerp in February 2022.

The workshop was planned and conducted by the two design researchers, who shared the roles of moderator and notetaker. The first day focused on introduction, group discussion, and gaining insights, and the second on problem framing, ideation, and concept development. Each step of the design process introduced the participants to various shame tools and exercises, giving them a vocabulary to talk about and identify shame, and discuss its relation to norms and social behaviors. These tools were prototypes based on previous iterations, and a significant part of this workshop's agenda was testing how the participants would use these tools and factor them into their design process. At the end of the workshop, the participants filled out a questionnaire to evaluate the course of the workshop and the tools they used. Finally, we held a discussion to assess the workshop more in-depth together with the participants.

Activating a sustainability mindset

The participants were introduced to a range of sanitary products connected to their topics and asked to start the workshop by doing an exercise to "activate their sustainability mindset." This exercise prompted brainstorming on more environmentally friendly solutions connected to their topic. It could be by redesigning an existing product or creating a new one, or by removing a specific problem or introducing a new one. During this exercise, eager discussions arose within the three groups, including sharing various critical perspectives. They questioned societal expectations and cultural differences, asking why women have to hide their menstruation to be perceived as productive, why it is embarrassing to ask for a toilet break in social settings, or whether it is more sustainable to use water or toilet paper. Although this first exercise focused on sustainability, the group's discussions quickly questioned shamefulness and normality regarding these three bodily fluids. Perhaps due to the overall topic and openness of the workshop challenge (i.e., "make disposable products obsolete"), the participants engaged with cultural extremes, social differences, and historical discourse right from the very start. As a result, most of the proposed solutions following this exercise would attempt to challenge the current norms, create openness towards other social practices and counteract taboos.

Using a "shame lens."

After giving an introductory lecture on shame, the participants were provided with two tools to help them map out their topic, investigate shame more in-depth, and search for new insights. The first tool prototype, *social concept cards*, is a card deck of 64 different cards divided into 16 categories that provide a vocabulary to discuss and identify how shame takes place through socio-cultural phenomena. Examples could be guilty pleasures, cringe, euphemisms, forbidden fruits, stigma, taboos, softening, and stylizing. However, rather than using all the cards one by one, the participants were free to pick the social concepts they found most relevant, interpret those to their topic, and use them as general inspiration to bring about insights (see figure 2).

The second tool, *shame stretching*, can be used in combination with the first one and is an exercise in which the participants find various cues or signs of shame (including those extraverbal) and place them on a canvas, stretching between extremes and exploring nuances of shame. These cues (or signs) of shame could be memes, Instagram posts, research articles, forum threads, Wikipedia articles, news headlines, advertisements, etc., that participants found important for their topic (see examples in table 1). While collecting these cues, they were also continuously arranged and rearranged on a shame-stretching spectrum, where implicit-explicit, affirmative-critical, hidden-accessible, private-public, and clean-unclean were some of the extremes or opposites explored. Some of them were suggested, and some were self-conceived.

Combined with printed images and text found online, these two tools were proposed to guide the groups to investigate their topic through a "shame lens," enabling them to identify and dig into products' entanglement with social behaviors and norms. Although the tools were prototypes and tested as part of this workshop, the exercise was received positively and sparked exciting discussions. Some of these discussions concerned the meanings and definitions of shame, changing social norms surrounding shame, and the influence of these norms on individual feelings and behaviors. The tools helped the participants spin off each other's associations, thinking, and ideas, contributing to collective thinking. New social concepts were suggested to be included in the card deck, and the participants' experimentation with different polarities on the shame-stretching canvas illustrates how these tools engaged them to open their minds and include new perspectives.

Figure 2. Left: Pee-group discussing and organizing the cues they have printed out. Right: Some of the cues the Poo-group found and inspired by the social concept cards (pictures taken by the authors).

Table 1. Example of some cues the three groups collected

Social concept	Cue description	Source
Euphemism	"Have to go number two"	Dictionary
Stigmatizing	How to smuggle a tampon into the bathroom	Wikihow article
Guilt tripping	"Mistakes you do during your period"	Healthywom-en.org
Closeting	"Urine Gone! Stain and odor eliminator"	YouTube video
Dark humor	Saran wrap toilet prank	Forum thread
Stylizing	"Go Girl"s pink peeing funnel for women	Advertisement

Making the implicit explicit

The second day of the workshop started with summarizing the previous activities by using a *discourse tool* (right and wrong statements). This exercise was given to help the groups close in on a problem statement by supporting them in expressing norms and conventions in a somewhat absurd yet more explicit manner. To make this a tangible task, it was suggested that the groups could animate a chosen product and give it a voice to make statements about right and wrong. For instance, the poo groups could use the toilet paper as an example and ask themselves, if the toilet paper could speak, what would it say would be acceptable and not.

Presenting ideas

For the ideation phase, the participants did a group exercise using *forced associations* which is a tool meant to override logical thought processes and support out-of-the-box thinking. In short, this is a creative technique in which the participant uses a card deck of adjectives to develop new ideas based on improvisation and artificially paired words. Afterward, the participants selected their three top ideas and presented them to an external audience consisting of a small group of employees from the design department. Based on this feedback session, each group spent the remaining day developing a final concept and preparing for a presentation.

Table 2. Summary of the pee, poo, and period group's concepts

	Pee	Poo	Period
Idea	Critique to norms con-si-dering urine as a waste product that is dirty and needs to be disposed of.	Critique of modern toilet practices and its lack of attention to the health benefits of other historical prac-tices.	Critique of the cultural belief that periods limit productivity and are something that needs to be "fixed" and hid-den.
Concept #1	A bodysuit that ex-tracts heat from urine and circulates it around the legs and body.	Using water to clean and a reusable towel to wipe afterward.	A retreat room in the workspace/ schools dedica-ted to someone on their period.
Concept #2	"Free Pee Tivoli", an amusement park where you can have fun with pee.	"Poop Journal", an app with the possibility to keep track of toilet routines.	A state regula-tion that makes a retreat room mandatory in every new building.
Concept #3	A nationwide cam-paign to negatively frame products that hide pee.	A quiet, artistic place where you can poo but also reflect.	Educational infor-mation about men-stru-ation and sustainabil-ity.
Final concepts	**Pee yourself:** A counternar-rative to the embarrassment of peeing one's pants. It is situated in a bit of sci-fi, and dystopian fu-ture, where there is less electricity and water is acces-sible. It provides people with body wear that allows them to utilize their own pee to warm up their bodies and reuse the fluid to provide drinkable water. Thus, disposables are phased out, warmth is ge-nerated without electricity, and water is saved.	**Gentle water:** A solution that is both sustaina-ble and artistic, providing people with a space of contemplation and retreat. The cleaning mecha-nism is based on using water and takes inspiration from Japanese culture and activities with a ceremonial character and a sense of aesthe-tics. As opposed to the seman-tics of modern toilet paper, this concept allows people to add care and attenti-on to their toilet practice.	**Retreat space:** A safe retreat space in office- and school buil-dings dedicated to menstruating people. Some-what inspired by practices from other cultures, the concepts at-tempt to create a public space for menstruation. Instead of trying to normalize the condition by ignoring it, hiding it, or making it a private matter, the concept ma-kes a statement by increasing awareness about the very real needs and bodily reactions of menstruating people.

The results of this are shortly summarized in table 2 and in the following paragraph.

Questionnaire

An anonymous semi-structured survey was shared among the participants at the end of the workshop. The first block considered a general evaluation of the workshop: whether they enjoyed it and what part they found most memorable. The next block highlighted the shame aspect: how freely they could talk about the topic and what made this easier or more difficult. The following block emphasized the tools: whether they provided some new perspectives, helped complete the workshop goals, and the option to give detailed feedback on each tool separately. In the end, there was an option to give suggestions and general comments. The results were processed mainly qualitatively in Excel, using descriptive statistics for the closed questions and open coding for the open questions.

The results showed that the participants enjoyed the workshop, with group conversations, working in small groups, and using the toolkit indicated as the "most memorable" parts. Many participants found the workshop inspiring and noted that it helped them feel creative and free. One participant found the workshop somewhat limiting, mentioning that the gender gap and the sensitive nature of the topic made it difficult to express themselves fully. However, although most participants did not know each other up front, they felt comfortable discussing the topic as no disclosure of personal information was required when using the different tools. Amongst the tools used in the workshop, *forced association game* was the most popular, as it helped generate new connections and create ideas. However, one participant felt that it dictated the process too much and led to unrealistic solutions, not in the least because of the limited time available, leading to the first associations often being accepted as a starting point for the next discussion. *The shame stretching* exercise was helpful in categorizing materials and identifying tensions, but some participants found it confusing to interpret the results. Another observation was the fact that participants ideally have access to a browser and printer to find and 'play' with (and stretch) the found social manifestations of shame. The *discourse tool* with right or wrong statements effectively highlighted social norms and values, but the focus on sustainability was not always clear. In terms of improvements, participants suggested making the topic more specific (e.g., focusing on a single product or product category) and being more explicit about the critical and speculative design part. They also suggested emphasizing the body, prototyping, and using more visual materials. Overall, the workshop provided valuable perspectives and tools, although some participants felt the resulting concepts could have been more realistic.

Post-workshop discussion

After completing the survey, we had a half an hour discussion with all the participants to evaluate the workshop in-depth and get more detailed feedback. The workshop was well received by participants, who appreciated the opportunity to tap into their creativity and step outside their usual mental frameworks. In particular, the *social concept cards* and *forced association game* received positive feedback, with many participants expressing interest in using them in future design workshops and assignments. The *forced association game* was especially effective at generating new insights, though some participants noted that such wild ideas sometimes pulled their focus away from sustainability. The direct application of some tools, such as the *shame stretching* and *social concept cards*, was confusing for some, most likely due to the lack of a guide on using them since the participants were free to use them as they saw fit. The hands-on activities, such as printing and making tangible materials to work with, were generally well received. The booklet provided a clear structure for the workshop, and the second day, more focused on the creative process and generating ideas, was the most enjoyable. However, the first day was considered necessary to prepare for the second day, think on a deeper, less generic level, and enable an atmosphere where one could discuss and collaborate more freely.

Discussion

The workshop provided a platform for exploring the intersection of shame and sustainable design through qualitative data collection. Both researchers analyzed the data together, and the evaluation survey was discussed in-depth with all participants, improving internal validity.

The original idea of the workshop was to experiment with a design process combining sustainability with taboos. While the workshop promoted considering both of these elements, the discussions and concepts presented by the participants took much of a norm-critical character. Although sustainability was not lost in the process, it became more focused on social issues such as inequality, stigma, and freedom and less on the environmental dimension. Interestingly, when challenged with designing with both environmental and social concerns in mind, all groups leaned towards problematizing the social conditions. Thus, the three final design concepts concerned bringing social norms and conventions up for discussion, whereas environmental sustainability became a secondary outcome of challenging those norms. While not intentionally planned, this direction did not come unexpectedly, as including shame concepts and tools invited a socially engaged and critical mindset. Furthermore, the participants' knowledge (mainly researchers) may also have affected the results. Still, we believe that the open interpretation the workshop allowed for, together with guidance from tools, were the main drivers of these speculative design tracks. Especially the last ideation tool could have influenced the design direction, allowing for more wild and speculative ideas and steering away from more pragmatic scenarios. Albeit well received by the participants, the tool could have been added earlier in the process, allowing them to reflect and ground their ideas into a more realistic setting before moving on to a final concept.

Although sustainability concerns could have been more emphasized in the workshop, providing more precise guidelines, the overall theme and setup received tremendous positive feedback. Such a free and open-minded exercise allowed the participants to include different and more critical perspectives than other Design for Sustainability approaches. They participated eagerly in their discussion, showing curiosity, enjoyment, and signs of having fun. Some participants mentioned that the context allowed a safe space for bringing in arguments, and one could question if being able to engage with taboo-prone topics playfully causes attraction in itself. Although the mundanity of the topics can bring about con-

nections to one's personal experience, the participants indicated that the exercises in the workshop facilitated discussion while allowing them to stay on a non-personal level and making it possible to engage with excitement without feeling vulnerable or exposed.

Overall the workshop setup was proven valuable as the tools provided supported the participants in bringing new insights to their topics. Given more time, it could have been interesting to challenge the participants to use these critical ideas as input for designing more realistic concepts, considering how shame acts as a strategy for affording more sustainable behaviors rather than just a narrative for norm critique. As the tools provided during the workshop were seen as helpful in broadening perspectives, this also can act for opposing a more dictated process directly aimed at specific sustainability-focused goals. Limiting to a more specific problem area and product category or emphasizing barriers and enablers of hygiene-related products could have helped to counterbalance this, which is important learning for further research by the authors. Focusing on a particular tool or exercise from the workshop, and in closer connection to one particular sustainability issue and/or combined with other Design for Sustainability tools, could be another approach to investigate the value of the shame tools more in-depth and more explicitly in an environmental context.

Although not mutually exclusive, this workshop's result indicated a spectrum where a sustainable and norm-criticality mindset could appear in an alliance but also position themselves as opposing extremes. This polarity also reflects the meeting point of our research topics, a conflict worth discussing. Despite some discontent that the environmental dimension was less present in the final concepts, making them more speculative than realistic, value also arises when detached from conventional thinking. This was evident among the participants as they made new connections between culture, behavior, and design and included perspectives that would have been hard to imagine initially. One participant also mentioned that the workshop made them think differently about sustainability, not as a technical checklist to be completed but as a much more complicated system of human factors. Another participant said: "We will not be 'done' even if we can change everything disposable into reusable products." Thus, indicating a value shift from consumerism and productivity to care for the environment by recognizing its entanglement with human relations.

Conclusion

The workshop provided exciting insights into the usefulness and practicality of shame tools in sustainability design challenges. The results demonstrated that a better vocabulary and awareness of shame could support designers in identifying how this emotion can hinder and promote sustainable practices. Using the tools, the participants could effectively design with shame in mind, resulting in ideas that attempted to challenge and counteract societal norms and taboos. At the same time, the sustainability aspect moved somewhat into the background during the workshop, indicating that further development of the tools is needed to generate more practical and applicable solutions to sustainability issues. It would, for example, be interesting to put more emphasis on the possibilities of using shame to drive consumers towards more sustainable practices and behaviors. However, incorporating shame into design research provided valuable insights and critical perspectives on sustainability. Finally, the workshop reflected a complicated but perhaps non-avoidable entanglement between sustainability, taboos, and social concerns and exemplified how designers can respond to this.

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Feminist value sensitive design of self-tracking technology based on female body data

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Abstract

Self-tracking technology is widely used in the field of digital health to track physiological data of the body to predict physiological processes. More and more women are using self-tracking devices for health-related management, such as menstrual management, pregnancy management, or gynecological disease prevention, to better understand their health status. However, in digital health tracking applications that consider gender in advance, there are still generalized and objective value presuppositions based on the male body, resulting in some data content that does not truly reflect the changing physical experience of women. To address this problem, we use value sensitive design (VSD), a method that emphasizes the integration of ethical values into the design process, and feminism, a theory that helps reveal the gendered power structure of things and aims to construct a discourse system of gender equality. The two combine to form a framework that promotes reflection on existing gendered tracking application devices. They also improve the match between women's physical experiences and quantitative data. Finally, we illustrate this approach with a case study of a period-tracking app called Meet You, revealing important value needs for those with irregular periods and demonstrating insights that are conducive to reflection and design.

Keywords

Menstrual body data; self-tracking technology; value sensitive design (VSD); feminism

Introduction

We have entered a digital society, and digital technologies are transforming the economy and society, especially in the area of women's health. Self-tracking technology has become dominant in the field of digital health, with health-tracking apps and devices dominating women's health management markets. According to Research and Markets, the global women's health App market is expected to reach $9.42 billion in 2028. The market is expected to grow at a compound annual growth rate of 21.8% between 2021 and 2028. This huge market size reflects the importance women attach to their health in their daily lives. These tracking apps quantify a woman's physiological data into visual data that they use to learn about her body and health. However, this kind of digital health tracking of women implies the generalization of the male body and the value presupposition of female stereotypes. This paper tries to put forward some countermeasures to solve these problems in order to better promote the application of female body data.

Methods: Feminist value sensitive design

Value sensitive design and feminism

With the rapid development of the digital field, value-sensitive design (VSD) has become an effective method for solving the ethical problems of user autonomy, unbiasedness, privacy, and trust in technology (de Reuver et al., 2020; Mok & Hyysalo, 2018; Strikwerda et al., 2022). VSD is based on a methodology of conceptual, empirical, and technical tripartite investigation, which can conceptualize these problems and develop new design solutions. The core points include identifying the value of stakeholders and possibly solving the value tension (Friedman et al., 2013). This helps to identify the fundamental values held by underserved user groups, assess whether these values are supported in the design, identify and end negative impacts on society, and allow stakeholders to reflect and discuss them (Popa et al., 2021). The logic of its application is to assume that many technology-related problems are due to the lack of participation in certain values in the design, and we need to examine these values in order to properly use them in design (Donia & Shaw, 2021).

However, because VSD is descriptive rather than normative, it has often been criticized for lacking a normative basis (Costanza-Chock, 2020; Mander-Huits, 2011). VSD requires designers to intentionally encode values in the designed system, but it doesn't propose any specific value set at all. This means that in VSD, to a large extent, it depends on well-meaning professional designers to integrate value into the design through moral imagination. This is one way to explain why the ethical issue of gender bias persists in health-tracking products designed for specific gender groups. In view of this problem, some scholars have put forward a wealth of opinions. Borning and Muller (2012) suggest that VSD highlight the voices of researchers and designers because their perspectives and positions can provide a more authoritative and impartial survey tool to address the question of the value. It is also suggested to learn its research methods from feminism, which has the common goal of promoting social justice and

social moral values with VSD. Feminism opposes generalized narration and design, focusing on marginalization, which can provide a more comprehensive perspective on value issues (Bardzell, 2010; Bardzell & Churchill, 2011). Friedman et al. (2019, 2021) proposed that the use of ethical theory can provide a more transparent and systematic way to distinguish between true ethical values and pure stakeholder preferences so as not to fall into unconstrained value risk. In some specific fields, such as medical health (van Wynsberghe, 2013), war (Cummings, 2006), and politics (Borning et al., 2005), well-established ethical theories have been drawn upon to regulate technical design. However, VSD's exploration of genderization in the health field has been limited. Therefore, in response to gender bias in women's health tracking, we not only need to be sensitive to the role of values in the design process but also need to prioritize and legitimize certain values as principled judgments for specific situations. Feminism is a social and political movement aimed at eliminating gender discrimination and ending the oppression of women (Delmar, 2018). As the theory and practice of questioning gender oppression, the feminist perspective is an effective theoretical approach for reflecting on design issues. Feminist ethics is an ethical theory aimed at women's liberation that is criticized and constructed from a feminist perspective (Jaggar, 2013). It constructs an ethical theory that emphasizes equality between men and women and criticizes the ethical theory and moral practice that demeans and discriminates against women. Based on the ontological and epistemological interpretation of feminist ethics (Concepcion & Eflin, 2009), and the description of the characteristics of mid-level ethical theories that emphasize principle and constraint (Jacobs & Huldtgren, 2021), We try to take feminist ethics as a normative ethical theory to constrain VSD in order to solve the problem of inequality in the field of gender. Feminist ethics reveal the existing design of gendered power structures, emphasis on emotional care, respect difference, relationship reciprocity, and equal participation (Benhabib, 1992; Burton & Dunn, 1996; Gilligan & Attanucci, 1988; Wicks et al., 1994). It can provide the basis of proof and argument for ethical claims and considerations of equality and inclusiveness.

The feminist VSD discussed in this research is a methodology combining feminist values on the basis of the VSD method. It emphasizes the role of women's experience, which can avoid the problem of being influenced by dualism for a long time and unintentionally embedding the values related to male generalization. Therefore, in the gendered design of gender-specific products, spaces, or experiences, to avoid the gendered design easily falling into traditional gender stereotypes and assumptions, the constraints of feminist moral principles on various abstract values obtained from the investigation will help guide the correct direction of values.

Feminist VSD process

Based on the above discussion of VSD and feminism, the specific design process of feminist VSD will be described in detail in this summary (see Figure 1). Based on the summary of the existing VSD method process, we add the values held by feminism in the field of ethics to be constrained and extend the VSD the tripartite methodology including conceptual, empirical, and technical investigations to the whole design process, encouraging the iterative use of a variety of investigation methods in the design process so that specific values can be fully explored, verified, and realized.

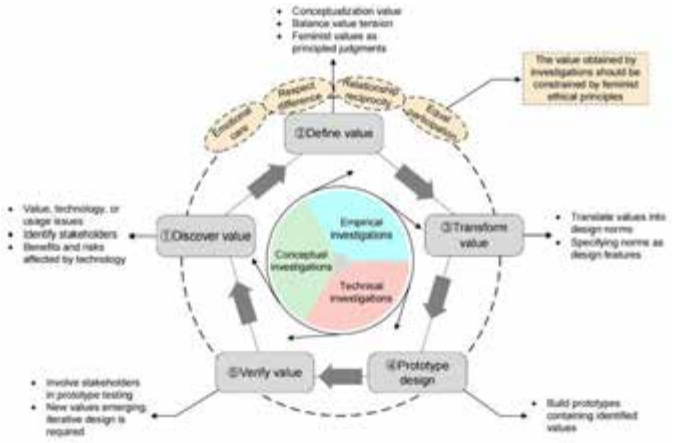

Figure 1. Feminist VSD process

The first stage of discovery begins with a value, technology, or usage context, explores the problems existing in a particular context, and conducts an in-depth study of the status quo through an analysis of the characteristics of stakeholders, the current status of the product, and the attitude of stakeholders toward the product to find the demands of stakeholders. Specifically, the analysis includes the following elements: identifying direct and indirect stakeholders and the potential impact of their interaction with technology (Czeskis et al., 2010; Yoo, 2017) and mapping harm and benefit to corresponding values. These element analyses can be completed by any of the three surveys. The second stage is the definition of value, which is divided into two steps. The first step conceptualizes the identified values, resulting in a list of values determined by the stakeholder communities themselves. For the value acquired in the design context, we need to rely on the philosophical literature to provide a standard definition of the specific value to guide the empirical evaluation. When the key values are defined, the second step is to balance the value tension. When the key values are defined, we need to examine the potential conflicts or tensions that exist between them. Through the integration of solutions proposed by previous researchers to generate value tension (Flanagan et al., 2008; Poel, 2021; van Wynsberghe, 2013), we think value tension can be solved from the following two directions: (1) compromise and (2) transcend and dissolve. The focus of this study is to take the values of feminism as a specific position by means of compromise to deal with the problem of gender bias still existing in gendered design, emphasizing the attention paid to marginalized groups who are often ignored. Value transformation in the third stage refers to the activities that embody or express these values in system design and convert the value concepts in the second step into corresponding design specifications involving specified design features (Poel, 2013). Specifically, it is to transform ideas, intentions, and concepts into material forms through design activities, thus exerting good design values. "Good design values" are design decisions that are aligned with the needs, preferences, and values of users and that result in positive outcomes for individuals, society, and the environment. In contrast to traditional functional goals, good design values also meet the functional requirements of a given system. The trans-

formation step should be as specific as possible so that the essence of the value is correctly explained. The fourth stage is prototype design. It builds physical prototypes of related technologies based on the design specifications and requirements of the previous step to demonstrate value in technical artifacts. After transferring technologies from the design environment to the field test, design decisions that may become difficult to control and even implicate other values can be recalled in the design environment for examination and modification (Umbrello & Van de Poel, 2021). The fifth stage is value verification. This step is not only to determine that a particular value has been successfully realized in the prototype but also that its realization does not interfere with other design goals. In general, prototype testing requires technical feasibility testing of designed artifacts, which must consider their influence on stakeholder behavior, society, and values in the design (Umbrello & Van de Poel, 2021). Value verification activities are an essential part of the iterative feedback loop, in which implementations are tested using various methods to determine whether they meet the designer's intentions.

Investigation activities are not carried out in a fixed order (Watkins et al., 2013). For example, the "discovery of value" step occurs early in a design project, but it may continue as the design process progresses to the end of the product. Even when technologies initially meet the requirements of value-based design, they can evolve in unexpected ways and have undesirable effects. They may not achieve their intended value or may have unforeseen side effects (van de Poel, 2021). The addition, removal, and change of additional value design features that need to be considered lead to new value options, and the design goes through an iterative phase of transformation and validation.

Application of feminist VSD: Ethical evaluation of the menstrual-tracking app

This chapter will illustrate the application of the feminist VSD method through a period-tracking application. By familiarizing ourselves with the research topic and the initial survey, we arrived at an initial list of direct and indirect stakeholders. We then narrowed it down to a small group of stakeholders involved in the research activities, taking into account resource constraints. In this study, we give priority to the under-represented stakeholder groups, namely irregular menstrual groups, to gain a wider understanding of marginalized or hidden stakeholders.

Value-oriented semi-structured interviews

Based on the value-oriented design method of VSD and feminist ethical values, this study conducted semi-structured interviews with users with irregular periods and paid attention to and determined their statements on the usage status and vision of the period-tracking application as the collected textual data. We chose Meet You, a period-tracking app and the most downloaded app for women's health management in China, as the technical equipment for the ethical evaluation of this study. We post recruitment information on social software and forums, and qualified interviewees conduct online interviews in the form of one-on-one interviews. The interviews lasted about 30 minutes and were recorded and transcribed. The interviews began with closed-ended questions to determine information about demographic characteristics, physical conditions, and the use of period-tracking apps. The interviews focused on what they valued during period tracking to capture their preferences and values. Each interviewer took an average of 30 minutes to complete. The participants who finish the interview will be given a nice gift as a thank you for completing the interview. All interviewees used pseudonyms to protect their privacy.

We finally interviewed 18 interviewees, all of whom confirmed that they had been treated for irregular menstruation before the interview, and had used the Meet You app. The specific demographic characteristics of participants are shown in Table 1.

Table 1. Descriptive statistical results of the samples

Attributes	Category	Population(n = 18)	Proportion(%)
Age	18–22	2	11.1%
	23–30	13	72.2%
	31–40	2	11.1%
	41–50	1	5.6%
	51 and up	0	0
Menstrual condition	occasionally irregular	4	22.2%
	Often irregular	12	66.7%
	Never regular	2	11.1%
Frequency of menstrual application	Record monthly	6	33.3%
	Occasional record	7	38.9%
	Once recorded monthly, not now	5	27.8%
Years of self-tracking (Y)	$0 \le Y < 6$ months	6	33.3%
	6 months $\le Y < 1$	6	33.3%
	$1 \le Y < 2$	3	16.7%
	$2 \le Y < 3$	2	11.1%
	$Y \ge 3$	1	5.6%

Data coding and analysis

In the early stages, we collected and integrated literature and legislative policies on the important value of health digital tracking. This paper focuses on validating and supplementing values through empirical investigation to conceptualize values that are important to users with irregular periods. We encoded the text data obtained from the value-oriented semi-structured interview in the previous step; the encoding method was based on the value coding method used by Dadgar and Joshi (2015, 2018) to explore the important values of patients with chronic diseases. The philosophical interpretation of value categories came from a list of human values with ethical significance provided by Friedman et al. (2013) and other references discussing values (Andel et al., 2015). Philosophical interpretation can help us identify, evaluate, and prioritize these values.

After coding the value of the stakeholder description text, we then analyzed and defined the benefits and risks that a period-tracking application provides to potential stakeholders through the revealed values to assess the values that are important to users of a period-tracking application.

Table 2. Value-coding examples of interview texts

Value statement—what users consider important when using a menstrual app	Revealed value	Value category	Value included (or not included) in the current menstrual application design
"I simply type in my menstrual cycle every month, and I can easily see my physiological changes over time..."	Simply record the menstrual cycle	Accessibility: Ease of access to and use of equipment	Accessibility is achieved by allowing free use by different groups, implementing simple operations, and providing easy-to-understand text and images
"I have a bad memory and I need the app to record data for me, which makes me feel safe..."	Monitoring one's health with tools	Health: Refers to maintaining or improving people's physical and mental health and happiness	Health value is achieved by people actively recording their periods, contributing to their physical health
"I was on long-term estrogen medication, but I had doubts about the accuracy of the data when it wasn't documented..."	Data can accurately reflect their situation	Reliability: Refers to the expectation of equipment performance	The application presets the composition of body data as not affected by other factors in advance, resulting in some people's poor expectations
"When I see people in the app community who are going through the same thing as me, it makes me feel like I'm not an anomaly, and it makes me comment below that I'm going through the same bad situation..."	Seek people with the same experience	Trust: Refers to the interactions between people and their experiences of expressing kindness and vulnerability to each other	The app provides a community networking function that allows people who have gone through the same experience to exchange experiences and relieve anxiety
"I have polycystic ovary syndrome and the application prediction has never been accurate or given feedback, and I don't think this software is right for me..."	Information data feedback	Feedback: Influence, improve or strengthen the behavior of the object by transmitting information related to the object	Because the technology is not designed to support irregular menstrual groups, it does not provide additional care and feedback, leaving such groups with no incentive to use it
"I input a lot of data about my body, and I am afraid that my privacy will be leaked out..."	Control and keep your privacy secret	Autonomy: Refers to the degree to which a person can live according to his wishes	Privacy Settings in apps are inadequate, making it difficult for users to control where their data goes

Table 3. Implied value of the period-tracking application and its benefits and risks

Value	Subcategory	Benefit	Risk
Health	Health	Track, record, and predict periods	Privacy may be compromised
	Health	Continue to monitor menstrual changes	Relying too much on quantitative data is prone to health anxiety
Trust	Trust	Provide a platform for sharing personal privacy experiences	Sensitive personal content may be disclosed
	Trust	Provide a window to inquire and buy medicine	Deceptive marketing may occur
Autonomy	Autonomy	Data content set in the application can be input	There are limited recording items to choose from
	Autonomy		There is not enough transparency in how data is obtained, stored, and used
	freedom from bias	Users with menstrual periods can record their periods once a month	People with irregular menstruation may be limited in recording menstrual periods
	Privacy	Users can turn privacy settings on and off independently	Private information may be abused without consent
Feedback	Feedback	Provide visual charts and analysis reports of menstrual conditions	There may be errors in the information, and the content of analysis is not targeted
	Feedback	Provide a wealth of health information	The content quality is uneven
	Feedback	Information reminder	Reminders may not be timely.
Accessibility	Accessibility	Open the mobile app and you can use it	Persons with disabilities may be difficult to use
Usability	Usability	Respond to user queries and provide useful resources	Advertising may appear
	Usability	The navigation system is intuitive in design and provides easy-to-understand icons and characters	
	Usability	Provide a simple operation process	
Reliability	Accuracy	Predict the coming time of menstruation	Can't be completely accurate
	Technical	The algorithm is scientific and effective	An algorithm model for irregular menstruation is difficult to establish
	Technical	Mobile devices compatible with different operating systems	The system may flash back

Survey results and discussion

Correlation insight

Based on the previous questionnaire survey on women's menstruation, it was found that more than half of them had irregular menstruation cycles, and the score of this group on the application of menstrual tracking was lower than that of the group with regular menstruation. Therefore, this study focuses on underserved people with irregular periods in the application of period tracking. Through the above investigation, we learned that most of the women in the interviews suffered from common gynecological diseases, such as polycystic ovary syndrome and menopause menstrual disorder, and some of them had long-term irregular menstrual periods for unknown reasons. These groups are different from the general group with regular menstruation. Their physical data on menstruation are generally unstable, and there is a certain gap between them and the feedback results of menstrual-tracking applications. Through the analysis of the above survey data, we can gain the following insights into the correlation between women's physical experiences of menstruation and the data content. First, menstrual physical data are strongly influenced by life experiences. Through the survey, we found that people think that the most likely causes of menstrual health problems are diet and rest habits, mental pressure, physical weakness, and other factors that are greatly affected by the outside world. In fact, the proportion of menstrual health problems caused by their own diseases is very small. Therefore, period data also have implications for our daily habits and various physical experiences. Second, the lack of data content feedback will lead to women being prone to health anxiety. While the use of such period-tracking apps has enhanced and expanded people's physical sensory abilities and made it easy for them to clearly view health information, in the discussion, 7 people said that the lack of positive feedback has led to their frustration with the experience, which reveals why more people are intermittent users and some even give up. Preset objective data make people with irregular periods prone to health anxiety, which leads them to record more and reflect less on their physical conditions. Finally, the visual content of the interface deviates from the description of a real menstrual physical experience. When it comes to period-tracking apps that focus on health management, there's no avoiding medical expertise or covering up professional descriptions of the menstrual body. However, the survey found that users reported that images and text in the app reflected gender stereotypes.

Value tension and value verification

By analyzing the benefits and risks of the above values, we find the existing value tension. The most significant source of value tension is the complex relationship between people with irregular periods and service providers of period-tracking apps. Service providers chose relatively homogenous groups in the user research stage, ignoring the needs of groups with irregular menstruation who pay more attention to personalized body data management, which ultimately leads to the poor user experience of this special group. In view of the value tension generated in the process of investigation, we take a feminist stance and balance the value tension in the form of a seminar. During the workshop, we will also discuss solutions for period tracking applications to determine design specifications and requirements, including building a product information architecture suitable for the menstrual irregular population and identifying technologies to support these value needs. In the prototype design, we will refine the existing period-tracking application in detail to maximize the identified benefits and minimize the anticipated risks. Finally, to verify whether the matching between menstrual body experience and data content is improved, we will ask users to use the prototype test and, through user interviews and questionnaires, ask them to rate the embedded value, and then compare whether all advantages in the previous investigation are covered and whether the risks are reduced; this is to test whether the new design meets people's value appeal.

Reconstruct the design framework of period-tracking technology

Feminist VSD can incorporate equal, inclusive, personalized, and diversified viewpoints into the design framework, breaking the previous presupposition that "regular" is equal to "normal" menstrual body so as to build a menstrual cycle–tracking technology applicable to a wide range of menstrual groups. In this study, this approach helped us reveal the values that were important to the use of digital tracking technology for menstrual irregularity. We found that such menstruators use period-tracking apps to monitor menstrual changes and manage health problems. However, period-tracking apps may cause health anxiety for groups with irregular menstruation through pre-preset objective data, and the lack of positive feedback leads to disappointment among these groups regarding usage experience. Currently, such menstrual tracking applications cannot well meet the value demands of health, trust, feedback, autonomy, reliability, and accessibility that groups with irregular menstruation value, resulting in insufficient service for such groups. We recommend the establishment of multiple criteria for measuring menstrual health, with special attention to the impact of the life experience of such menses on their physical health, as well as the importance of feedback on their physical changes to help them pay attention to their physical health. This focus on data tailored to an individual's body could lead to a future of more inclusive body-tracking tools for women.

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Spatial "mutual altruism" as a relationship of care for homeless people. How design impacts social re-integration

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Abstract

The paper reports on the potential effects of spatial "mutual altruism" on the social reintegration of homeless people and the key role played by design in establishing this kind of relationship. Nowadays, temporary reception offered by homeless dormitories is still considered strategic, given the prevalence of people who, according to the data, only need accommodation temporarily. On the other side, these places are frequently viewed as containers of discomfort, abandonment, and unwelcomeness. One of the main research objectives is to make third-sector organizations and service providers aware that spatial quality is a fundamental factor that influences the process of social reintegration; "beauty brings beauty." Participatory Design is seen as the driver of the research, which was conducted using quantitative and qualitative research approaches. Using the quantitative method, which included data and book references, a general background has been set up. A deeper understanding of the study's issue has been gained through the qualitative method, which includes participant observation, semi-structured interviews, and questionnaires, with the involvement of social and public actors engaged in the fight against homelessness. Due to the complexity of the housing exclusion problem and the consequently complicated design solutions, one of the outputs of the research is a framework used to analyze the efficacy of existing homeless facilities, creating a paradigm that can be traced across all hospitality models. The framework refers to the categories of needs for usability, well-being, safety, management, and sustainability. Inside the category of well-being, "domesticity" in temporary housing has been a key concept explored. Domesticity is defined as the ability of guests to directly and independently change the space. It stresses how important it is to give guests the chance to create a place where they can feel safe, considering both their physical and emotional needs. The main expected result is to create, design, and offer a sense of belonging for people who may have few social connections. Activating one's resources and forming new connections require favorable conditions, which design can help to achieve.

Author keywords

Spatial "Mutual Altruism"; Homeless Dormitories; Spatial Design; Social Design; Participatory Design.

Introduction: social bond and extreme poverty

Homelessness is a social phenomenon that comes from the structure of our globalized society, a society of excess and surplus that produces waste and marginalization (Bauman, 2013). Experts agree that extreme poverty increases proportionally with the weakening of social networks (Gnocchi, 2009; Landuzzi & Pieretti, 2003). Hence the importance of analyzing the homeless' condition not only in terms of material deprivation but also in terms of loss of capacity; moreover, we know that the relational capacities of people living on the street deteriorate steadily (Meo, 2000). Thus, relationship support is the primary tool enabling people in a state of severe marginalization to recover. Mastropasqua (2004) explains how social problems are generated by social relations and how the quality of those relations determines the possibility of problem solving. The individual expresses himself only within a system of belonging. The methodological and logistical problems in surveying this phenomenon, combined with scientific community disinterest (Fazzini, 2015), have led to a knowledge vacuum. The current study aims to evaluate the homeless receptive system by developing an evaluation framework. The study begins with an examination of the system's current state of the art and then focuses on the relationship of care between the individual and the space within homeless shelters, emphasizing the significance of spatial quality for social reintegration. The paper is a result of the author's master's thesis for the Interior and Spatial Design course at Politecnico di Milano. In terms of participatory design, the primary purpose of the research is to promote a means of developing beneficial interactions between people and within physical space. Places and how people experience them influence human actions and relationships.

State of the art of contemporary homeless receptive facilities

In the current social services landscape, factual evidence demonstrates that the majority of homeless individuals are *houseless*, defined by Ethos classification as "guests of homeless shelters" (Amore et al., 2011). Therefore, a major portion of the population resides in a dormitory, which was specifically created to handle this demographic (Grigis, 2015). The primary function of the first shelters, formed in the United States (U.S.) in the aftermath of the American Civil War, was to contain and govern the homeless. They were

emergency facilities put up in the basements and hallways of public buildings, sometimes at the local police station (Davis, 2004). Even today, they are typically situated in buildings that were originally intended for another function.

Hospitality approaches

Nowadays, the scenario is more complex. There is a wide range of specialized services available, each with its own set of goals and functionalities. Peculiarities that also differ from country to country. The most significant distinction is between the two main internationally recognized approaches: *the Staircase Approach* and the *Housing First Approach*. The *Staircase Approach* has been the base of the entire receptive system since the 1960s in the U.S. and later in other countries. This *Staircase* was created to gradually prepare someone for living independently in their own home. Similar in morphology but different in logic, there is another approach named *Holistic or Multidimensional*. The fundamental difference with the *Staircase Approach* is that the path each person takes is not determined by a progressive logic established in advance in a standard educational process but is adapted to the individual within an individualized relationship with a social worker (fio. PSD, 2015). The *Housing First* is a more recent revolutionary concept that places housing as the first step in the process of social reintegration. It focuses on helping people live in their own homes as members of a community, aiding them in the administration of their houses and on the road to rehabilitation (Pleace, 2016).

Hospitality facilities

In the *Multidimensional* and *Staircase Approaches*, a variety of structures cover the diverse needs of homeless people. From the lowest to the highest step, the services typologies included are:

- Emergency shelter: open only at night and often only at specific times of the year (in winter). It is a service with a low threshold, meaning it satisfies minimal basic demands. In general, it is suitable for all. Typically, the period of stay ranges from a few days to a few months.
- Transitory shelter, with social care: in these shelters, social assistance is provided in addition to accommodation. It houses people according to specific categories: gender, geographical origin, and age. The requirements for staying are stringent. Generally, the period of stay ranges from a few months to a couple of years.
- Supportive housing, with medical care: this kind of housing is uncommon, resembling a hostel yet functioning as a hospital. It houses individuals who have been discharged from health care facilities but still require care. The length of the stay corresponds to the hospitalization (usually a few weeks).
- Micro-community: typically, has both individual rooms and communal amenities, such as a kitchen, that are conducive to socializing. Similar to a multi-room apartment, it accommodates a limited number of individuals (according to certain categories). It provides avenues for social and occupational reintegration. The average length of stay is between one and two years.
- Temporary housing: for single or family occupancy. Access is typically granted through a public call for applications or social worker notification. There is a very small monthly contribution to the rent. The duration of stay ranges between one and two years.
- Housing Led accommodation: combination of residential accommodation and care, nursing, and social support services. It consists of "assisted" co-housing, with the presence of operators and volunteers at particular times of the day. It is a sustainable housing autonomy experience, both from the perspective of relationship dynamics and the economic perspective. The length of stay varies greatly.
- Public housing: generally located in entirely dedicated buildings or neighborhoods. The governmental administration owns the property. Provides housing for those who cannot afford rent on the private market. Access is granted through public notice, and lodging is typically not assigned on a short-term basis. There is no end to permanence.

The difficulty of guiding the homeless through the many stages of the rehabilitation process of the *Staircase Approach* generates a block in the system and is one of the most pressing concerns. Due to a lack of facilities suitable for more sophisticated types of housing (fio.PSD, 2015), the large number of people taken into care and placed in emergency facilities almost never progress to the subsequent type of reception. Because of this problem, people stay longer than they need to in emergency rooms and other places that aren't meant for long stays.

Social design as a method of research

The word "design" has become so commonly used that some critics question its significance, as it is often paired with any other noun or verb. Alison J. Clarke (2015) argues that the overuse of the term may lead to its loss of power or be the outcome of its humanist, inclusive, and plural vision. However, by linking the term "social" with the term "design", the process of promoting positive social transformation is being referred to. In 1980, Swiss sociologist and urban planner Lucius Burckhardt spoke of a *socially oriented* design capable of altering the quality of social relations (Moretti, 2019).

A document from the European Commission (2013) defined "social design" as a term "used to describe particular approaches to social innovation. [It is] meant to empower people at local level to invent together solutions to economic and social problems" (p. 8). A report by the Arts and Humanities Research Council (AHRC) and the University of Brighton (Armstrong et al., 2014) describes social design in terms of a number of essential factors: the term "social design" highlights the concepts and activities implemented within participatory approaches to researching, generating and realizing new ways of achieving collective and social change. Participatory research methods appear to be the tipping point, as they increasingly build a practice that is considerate of people, their relationships, and their beliefs.

Participatory activities for qualitative research

In the current research, participatory design activities were required to address and understand the complexity of the system. Research was undertaken in two main phases that frequently overlapped and interlaced. One phase systematized the phenomenon by studying data and literature from

the fields of design and sociology. The other phase was founded on an observational activity that generated an interpretive process. This has been accomplished using a variety of methods, including participant observation, interviews, and site visits.

The methodology applied to this research was based on the researcher's long-term, direct experience in the context of the inquiry. This supported nonintrusive ethnographic fieldwork (Pieretti, 2003). Observing daily routines and conducting empathic discussions form the project's initial baseline (Meroni et al., 2018). As the subject of this research is complex and characterized by stereotypes, informal interviews with numerous actors were essential for collecting data, notions, and ideas. Municipal policymakers, designers specialized in housing deprivation, sociologists, and various social actors from the third sector operating in the city of Milan, from managers to volunteers, were involved. During these meetings, it was possible to outline an overall picture of the city context, in terms of quantitative capacities and of the welfare system's approach and its gaps. Visiting receiving facilities and interacting with the operators and guests were key to the research, as was seeing the practices and dynamics that happened in the space.

Time based responses

The complexity of the problem of housing exclusion and the correspondingly complex answers that might be presented to the problem introduce almost limitless variables into the definition of design solutions. Assuming that the variable represented by the length of stay on the street is the one that influences a person's lifestyle and identity traits more than any other factor (Meo, 2000), it can be argued that the temporal dimension might play a strategic role in contrasting responses. Case studies were then selected focusing on the duration of their interventions: permanent, temporary, and mobile solutions. The mobile response buffers the highest risks of street life by protecting individuals from the cold. Temporary solutions are the most developed and diverse, with diverse goals based on shelter type, while permanent solutions are the most rare and complex to pursue (Cinelli & Mastrantoni, 2022). The selection of case studies was conducted on a global basis, with the most significant findings occurring in Europe and the United States.

The framework

The instrument used for the analysis was a framework to measure the effectiveness of existing homeless facilities in terms of physical-environmental factors and services. The definition of the framework is to be interpreted as the result of bibliographic study, particularly the studies conducted by architects and lecturers Cristian Campagnaro and Roberto Giordano, as well as the results of interviews and site visits. The framework refers to the categories of needs for usability, well-being, safety, management, (Campagnaro & Giordano, 2017), and sustainability (Fig. 1). The framework evaluates these components of a project and, by extension, hospitality models on a scale ranging from 0 to 100.

Usability includes spatial, functional, and perceptual elements. *Well-being* means that the physical, functional, relational, and emotional needs of homeless people must be met. *Safety* is

Figure 1. Needs categories framework.

fundamental in terms of theft-prone items, human safety, and health. *Management* is concerned with the services provided, which vary according to the type of reception. *Sustainability* factor needs to consider technological, economic, and sociocultural plausibility throughout the design process.

Findings

A comparison of the selected case studies according to the needs categories framework, suggests that permanent housing models are more effective than mobile and temporary responses in meeting the needs of individuals experiencing homelessness. This is likely due to the stability and security provided by permanent housing, which enables individuals to access support services and work towards achieving long-term social and economic stability. This also underlines the need to adopt a "widespread reception" model that promotes a territorial network ever closer to the Housing First and Housing Led models. However, it is important to note that mobile and temporary responses still play an important role in providing immediate assistance to those in need, responding to emergency situations. These responses can help mitigate the risks associated with living on the streets and provide individuals with access to basic services and support.

Investigating people's perceptions of places is challenging. In fact, a huge amount of information is needed to build an articulated and dynamic set of stimuli (Del Nord & Peretti, 2012). According to Del Nord and Peretti, the contexts' ability to conform to users' needs must be analyzed, as well as how much the environment shape users' experience and behavior. When someone who had previously lived on the street enters a dorm or a house, all the dynamics of residing in a private, or semi-private, space and the ensuing relationships with the space are at play. Designing spaces properly and rethinking them in terms of their function, type of activity, and users can help improve the relationships that happen inside the receptive structures. People who have a bad image of themselves are thrown off by a beautiful place that seems to be "designed" for their happiness. People are more likely to take care of themselves, their own spaces, and other people when they see beauty (Porcellana, 2019; Porcellana & Campagnaro, 2013). In this case, the beauty of a space is not only about visual aesthetics, issues that must be investigated, but also about how it is cared for and maintained. It is essential to provide the guests with the opportunity to cultivate an environment with which they may identify. Identification involves personalizing places in accordance with requirements that are not only practical but also emotional. From the adaptabil-

ity of the furnishings to accommodate the various practical needs of the guests to the incorporation of personal objects that can be associated with personal memories or interests. Making a "domestic space" means having decision-making authority over space events. This is the basis for establishing an emotional connection with the environment: a sort of "mutual altruism" (Haines-Gadd et al., 2018) relationship by forming an emotional bond with the space and subsequently caring for it. A way to foster a sense of mutual altruism is to involve the homeless community in the design process through co-design activities and tools (Campagnaro, 2019). This would empower them to have a say in how their living space is configured and what amenities it includes, increasing their sense of security and belonging.

Conclusion: Design impacts

Social phenomena are not always perceptible. One of the most important functions of social science and statistics, together with the design discipline, is to reveal patterns that are otherwise unseen to those living in or managing societies (Murray et al., 2010). Involving people, including third sector organizations, service providers, policymakers, social workers and homeless people, into participatory design, serves as the institutional framework for the establishment and maintenance of cooperative relationships predicated on dialogue and mutuality (Sennett, 2012).

As a result of the research, two correlated levels of design impact emerged. The first level is the interpersonal relationship dimension. The need for care and wellbeing can only be met if the encounter with the other is guaranteed. This requires the establishment of a third sector comprised of relational procedures and processes made up of listening, closeness, competence, difference, and singularity (Mastropasqua, 2004). The second level is the link between people and space. The spatial quality is a feature that influences the social reintegration process, highlighting the significance of a design that takes into account the needs categories framework.

Today, as social inequality, housing crises, and the lack of basic amenities continue to increase, the interplay between design and the social dimension is once again a fundamental concern. The designer assumes social responsibility with the understanding that design actions are change agents. By advocating co-design and non-professional design models inspired by anthropology, Victor Papanek encouraged designers to adopt a responsible production role and make tangible changes to improve the lives and living environment of people (Kries et al., 2018). The social repercussions of design are intrinsic; hence it cannot be peripheral. Design has always played a social and political function (Manzini, 2015) and the more complex society becomes, the more design decisions will have environmental, ethical, social, and economic consequences.

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I'll be There for You: exploring a sense of belonging to enhance student engagement

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Abstract

"I'll be there for you ... this song from the series "Friends" was produced by students at a Musical Comedy. The performers, business students from various programs within the Grenoble Ecole de Management, clearly enjoyed presenting their show. They worked together in a sporty and entertaining way, at an excellent level. At the end of the performance, each student was called on stage and individual contributions were valorized, showing support, warmth, and encouragement for each student. Their mutual support was remarkable.

Seeing students perform with such commitment and being so supportive to each other was inspirational, specifically, since we had just discussed a decline in student's study engagement in the classroom with staff and student representatives. What if ... we could build a community with students willing to motivate one another beyond this theatre challenge, encourage one another in their studies, in the development of their creativity and in multiple other activities. A warm, supportive environment could lead to keen students, and to a greater alumni network.

An exploratory project "I'll be there for you" was born to investigate this issue. In a Design Thinking class, 101 students of 4 different programs, from bachelor to MBA's, were asked to develop projects to reinforce peer culture, to imagine how to help each other more. During these Design Thinking projects, the insight emerged that some students are feeling lonely. From the outside it looks that students are having a great time. Knowing that some of the students feel lonely is not fitting within the culture we would like to have in our institute. Moreover, research indicates that when students have a sense of belonging, their happiness increases and with it their engagement in learning and academic performance.

Author keywords

Sense of belonging, community building, inclusion, peer support, peer culture, design thinking, creativity

Introduction

The students' peer support showed to be an important factor to bring the musical comedy at a high level. The performance provided an insight on the influence of mutual support and the group cohesion that it created. What if we could stimulate peer support to enrich students' engagement in their study and to strengthen their sense of belonging?

Multiple scholars indicate the importance of the social context in which learning happens. Rode et al. (2005) found a significant link between life satisfaction and student performance. Inclusive classrooms (Rangvid, 2018) and a sense of belonging (Zosel, 2018) contribute to student engagement. Berg (2022) resumes this by stating that students will choose to be in classrooms where they feel they belong, valued, and loved. Bloom (2013) describes education as a learning experience through which students, faculty, and staff learn together and support and challenge each other".

How does a sense of belonging contribute to enhance student engagement?

A first assumption is that a supportive attitude from staff, helps to motivate students in smaller and larger programs.

Secondly, peer support could also improve students' self-development. Helping one another requires soft skills, such as empathy, the capacity to give constructive feedback, and a positive attitude. These qualities are needed to become a supportive manager.

Lastly, after graduation a sense of belonging to a learning community, strengthens the alumni network. If students have helped one another during studies, why not continue in later life ...?

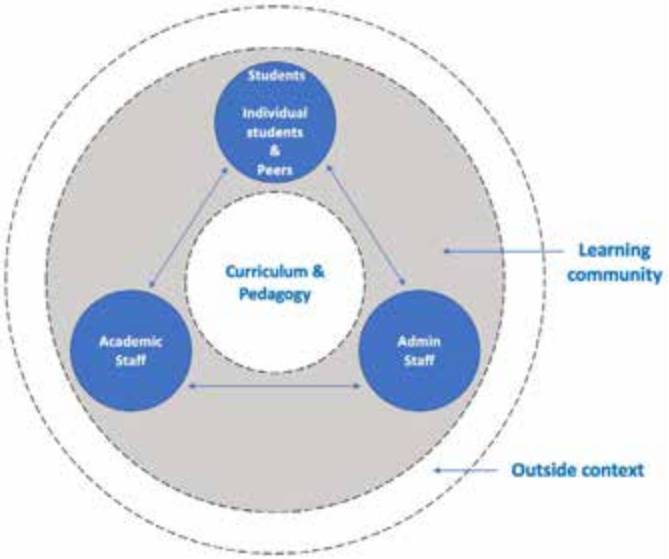

Figure 1. Learning model

The below figure aims to visualize how a sense of belonging fits into an education setting. The programs and its pedagogy

are surrounded by two structures, its learning community, and the outside context.

Central in this model are curriculum, the program's content, and its pedagogy, the teaching method. In general, our pedagogy makes students, active participators in the classroom, with a lot of teamwork, variation in topics and activities and exposure to the international context.

The learning community is formed by students, academic and administrative staff. All are part of the learning community and influence student experience and engagement. The way students step into the learning process, with a growth or fixed learning mindset (Dweck, 2015), is essential. Student's self-confidence, self-concept happiness, study organization, capacity to focus, and ability to avoid procrastination are also important factors. To achieve a supportive peer culture, students need empathy for other learners, curiosity to learn about others' opinions, and ought to understand differences in personalities. They should know how to give constructive, hands-on feedback (Berger, 2013) and need the tools and mindset to use their collaborative instincts (Tamm, 2015).

The contacts that students have with teachers and administrative staff, such as program coordinators and student services influence their student experience and sense of belonging.

Teachers can create a welcoming atmosphere in the classroom, by for example at the start of classes checking whether students know at least each other's names and by initiating with some "getting to know" activities. Even in a smaller class of 20 students, learners often do not know each other.

The outside world, with international student exchange, internships, and the job market influences the learning community and its curriculum. The same counts for external events, as the Covid-19 pandemic shaped on-line teaching.

In all this, a sense of belonging is the transversal factor that brings trust, support, and constructive exchange. From a student's perspective it is shaped in the interactions of students among peers within and outside the classroom, with student associations, with teachers, and with student services and program administration.

An exploratory case study, based on the students' perspective.

Students from 4 different programs were asked: *"How might we create or reinforce a peer-culture?"*. The students used the Stanford Design Thinking process (Doorley et al. 2018) to explore this question and to propose solutions. This happened during in-class modules, that varied from a 12 to 21 hours duration, depending on the program. A total of 101 students were involved, approximately 45% with the French nationality and 55% international students.

- 39 international students in the MSc ISE Innovation, Strategy & Entrepreneurship (15 hours)
- 24 international students in the 3rd year Bachelor BIB Management in the Fashion & Design Industry (15 hours)
- 26 mostly French students in the 1st year PGE Ulysse Grand Ecole Program (12 hours)
- 12 MBA students from the University of Kentucky following a Design Thinking module in our institute (21 hours)

Additionally, 7 staff members from the Student Experience & Employability center were asked to reflect on activities that already take place within our school to create a sense of belonging and peer culture. Also, a debriefing reflective session took place with one program, having 39 students.

At the Grenoble Ecole de Management, approximately 70% of the student population is studying in the French Grand Ecole program, and most students in this program are native French speakers. The students of the international programs use English as the common language in their program but speak a variety of languages among them.

The students in the French Grand Ecole program lead a variety of student associations. The integration into those associations is not easy for international students. Selectivity through admission interviews, and a language barrier hinder their integration into the associations. Knowing how to join associations, or joining events planned by the associations is not clear to several international students. The integration for French students entering the campus at the 2nd year of the French Grand Ecole program was also said to be more challenging.

Before working with students, the instructor assumed that ideas for peer support would mostly emerge in study-related activities, and in life-style improvements: fitness activities, and helping each other to stop smoking. Nevertheless, the need for friendship and social support appeared very strongly. Loneliness and feeling excluded showed to be an important issue. Some students indicated to feel lonely at multiple occasions: in class, during lunches, in free time, or in the evening. A team of French students from the 1st year PGE program, clearly pointed towards solitude of students and inactivity, caused by this solitude. Some students rather stay at their apartment, than being seen as lonely (Figure 2). They also indicated a lack of contacts between the different programs.

Students recommended a large variety of "buddy" program. These buddy projects are described below in point 1 to 5. Proposals also included activities to meet others from the Grenoble Ecole de Management throughout the year (point 6 to

Figure 1. A team of French students indicating a lack of integration, solitude, and inactivity.

8), and physical space in the building for leisure and to meet (point 9 & 10).

Finally, proposals for co-working study space (point 11 & 12), GMAT study support and sharing of study notes and time-management (point 13 & 14).

1. Multiple early buddy programs, prior to arrival at our school were proposed. Such an early buddy program assigns incoming students (see figure 2), to their buddies before arrival at the campus.
2. Other buddy programs start with the beginning of the academic year. At present, the Grenoble Ecole de Management proposes multiple sessions in the welcome week, to make it easier for new students to get to know the school, its services and all it offers. Students propose to integrate a buddy program into this orientation week.
3. Other projects connect international and French students for a complete buddy week or a welcome challenge.
4. An orientation buddy proposal formally reinforces the contact between French and international students. It implies an international student pairing up with a French student buddy. For this we would have a formal buddy link into our intranet (see figure 3).

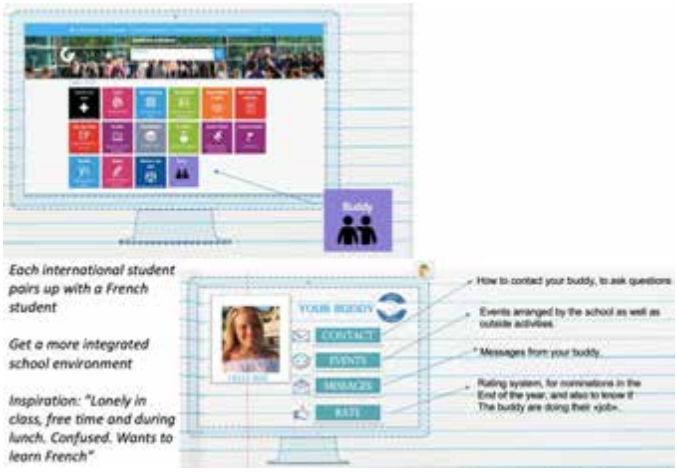

Figure 3. Orientation Buddy project (BIB3 2019-2020)

5. Some buddy projects propose a professional buddy approach with follow up throughout the year, a training, a contact person for the buddy, and nominations for "best buddy".

A second cluster of propositions concerns meeting other students at GEM throughout the year.

6. Multiple ideas for breakfast & debate, international breakfast, lunch, or dinner at minimal to no cost were suggested (figure 4). As well as "After School" inclusion and drop-in events, specifically indicating, that one does not have to be a member of one of GEM's association to participate.
7. Other proposals, in the form of applications (apps) or organized events, intend to meet others at GEM for activities: either inside the building to have lunch together, or for activities elsewhere, such as skiing together, or traveling. Specifically international students like to visit places in France or Europe and can abandon their travel project, not liking to go alone.
8. Other collective activities include climbing, swimming, dancing, yoga classes or tennis for people, specifically for those students not member of an association.

One student had doubts about an application to meet other students for activities: the student liked the idea but expressed concerns that it might end up as a *"tinker for students"*.

Figure 4. Activities for student interaction throughout the year

In term of physical space in the building for leisure and meet others, students advocated for:

9. A playground or playrooms to meet others and create more interaction between students. The suggested lounge has different spaces to project movies, to allow different activities: plays, culinary courses, exchange fairs for clothing ...
10. Also, the concept of an international corner is recommended. This room is dedicated to cultural and language exchanges. A place where students can study and relax, read the world press, meet, and exchange with students from all over the world, with free access.

Concerning spaces to study:

11. One of the students observed that students are hesitant to ask sharing a table when a student is already using this table. They might not want to disturb the student. Having a small lamp integrated in the table that turns green, allows anybody to sit at that table, or red when the student needs to focus (figure 5).
12. When our building is fully occupied, students might be looking for a space to meet for teamwork. A sugges-

Figure 5. Welcome sign to share study space.

tion is a digital board on the 1st and 2nd floor, that indicates available spaces.

For study support, the following projects were put forward:

13. One proposal concerns a GMAT support group. Several universities require a GMAT score, at the level of the top 10% of students. The GMAT support group invites students who have passed the exam to teach students who are preparing the exam.
14. Awareness projects for improved time-management and less use of social media are also on the agenda, as well as a student platform with study resources shared by students. Such a platform is also imagined to be useful to share information about housing, jobs, and a second-hand market for furniture and items (especially for exchange students).

Conclusion

This exploratory study contains proposals by students to enhance student interaction. Loneliness was a theme expressed by students. It indicates that not all students feel included. Students from the French and the international programs miss occasions to meet. International students have fewer options to integrate the activities of the primarily French student association.

In their projects, students recommend multiple buddy projects, events to meet students from other programs, and activities for which one does not need to be a member of a student association. They suggested a rich panorama of possibilities to improve student experience.
Integrating the students' suggestions has consequences on the design of multiple school events. It could also have impact on the spatial design in our building, for example to upgrade an existing space or create a playful student lounge area.

The students' viewpoint is important and an eye-opener. Most students give the impression to have an enjoyable study time, but the study shows that not all students are in this situation. The awareness on this inclusion gap is a first step. Creating a sense of belonging at an institutional level based on the principle *"I'll be there for you"*, next to testing buddy projects is a very good next one.

Acknowledgments

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Inclusive design in the context of performative gender through product form

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Abstract

Inclusive design is a design approach that aims to provide equal opportunities for all individuals to use products and services. When considering gender as an aspect of inclusive design, it is important to clarify the perspective and context of gender being addressed, as the concept of gender has evolved with the emergence of feminism, gender studies, and queer theory. The concept of gender has evolved to be shaped by social context rather than determined by biological sex. Gender norms, which are tied to socially constructed categories like "men" and "women," are shaped by performative behaviors influenced by cultural and social norms. These norms are not only related to behavior, but also to materiality, such as gendered product design and marketing. This can lead individuals to hesitate to use or purchase products that do not align with their gender identity. In this study, the aim is to examine inclusive design in the context of performative gender and support gender-equal design solutions by studying product form features using a material-semiotic methodology.

Author keywords

Gendered product; inclusive design; performative gender

Introduction

Equality is the principle of ensuring equal rights and preventing discrimination based on differences such as gender, ability, and age. Inclusive design aims to provide equal opportunities for all individuals to use products and services regardless of their characteristics (da Silva & Almendra, 2007). Gender is an important consideration in inclusive design as it significantly impacts individuals' experiences and needs. Therefore, it is important to reevaluate gender for inclusivity and equality, as the concept of gender has evolved with the emergence of feminism, gender studies, and queer theory. Inclusive design practices can challenge binary gender norms and reduce the reliance on performative behaviors and norms to reproduce and reinforce existing gender norms. This study aims to examine inclusive design in the context of performative gender and support gender-equal design solutions in household electronics design using a material-semiotic methodology.

Theoretical background

This section will provide an overview of the concepts of inclusive design, performative gender and gendered products.

Inclusive design

Inclusive design is a design approach that aims to create products and services that are accessible to all individuals, regardless of their specific characteristics such as gender, age, or ability (Clarkson & Coleman, 2015). This approach is similar to other approaches like universal design and design for all, but it goes beyond these approaches by considering the functional, emotional, and identity needs of users across the entire population (Keates & Clarkson, 2003). Inclusive design takes into account the social and cultural context in which the product will be used and should be "reasonably" possible for everyone to use (Persson et al., 2015). To achieve inclusive design, designers should consider inclusivity at all stages of the design process and consult with a diverse group of users when possible (Warburton, 2003).The Addressing Framework, which consists of nine different identity considerations, can assist designers in understanding the range of potential users and the complexity of human identity and experience. These considerations include age/generation, disabilities, religion and spirituality, ethnic and racial identity, socioeconomic status, sexual orientation, indigenous heritage, national origin, and gender (Patrick & Hollenbeck, 2021). Inclusive design has the potential to increase the marketability of products by considering the needs of individuals with disabilities in the design process, leading to an increase in potential buyers and sales (Owen & Johnston, 2003). Additionally, inclusive design is an important area of study for gender-inclusive design. Millennial consumers prioritize socially conscious purchasing decisions and want brands to consider the lifestyles and personalities of their target users, rather than categorizing them based on traditional criteria such as gender, race, or age (Rukmangadhan, 2019). However, designs that are based on gender stereotypes can have a negative impact on inclusivity. Metaxa's research found that web design can influence an individual's sense of belonging to a particular community or culture, and the design of web interfaces can perpetuate gender biases (Metaxa-Kakavouli et al., 2018). Gendered physical products can also lead to the provision of products that do not appeal to different users. In conclusion, inclusive design practices challenge and move beyond binary gender norms and create a more welcoming and inclusive environment for all users, regardless of their gender identity or expression. Designers should consider inclusivity at all stages of the design process, consult with a diverse group of users, and take into

account the social and cultural context in which the product will be used to ensure that the needs of all users are met.

Performative gender

The sex and gender have been widely studied in various fields, including psychology, sociology, design, architecture, and engineering. However, using these terms interchangeably in researches and everyday language can cause confusion (Gentile, 1993). Basically, sex is based on biology, while gender is based on social and cultural norms. The definitions of these two terms provided by the Cambridge Dictionary are as follows: Sex; "The physical state of being either male, female, or intersex" (Cambridge Dictionary, 2023b). Gender; "A group of people in a society who share particular qualities or ways of behaving which that society associates with being male, female, or another identity" (Cambridge Dictionary, 2023a). Judith Butler argues that gender should not be equated with dichotomies such as masculinity/femininity, male/female, or man/woman, but rather should challenge these dichotomies (Butler, 2005). Gender roles, which are behaviors attributed to particular genders, are shaped by social norms and discourse, resulting in the development of culturally specific gender identities like femininity and masculinity (Johnson & Repta, 2012). These identities can change over time and vary across cultures. Gender roles are not determined by sex, but rather are socially and culturally constructed. By distinguishing between sex and gender, it is possible to use terms like "feminine" and "masculine" descriptively, meaning they do not necessarily reflect an individual's biological sex or gender. In this study, these terms will be used to convey gender perception rather than refer to gender or sex. However, through the process of socialization, individuals identified as "women" are seen as one of the binary genders that make up society, and their individual and gender identity is shaped. From infancy, gender identity is influenced by gender roles, stereotypes, and culture. Gender roles often portray women as having domestic responsibilities, such as caring for the home, family, and children, as well as cooking (Kaypak, 2016). Queer theory and performative gender theory challenge traditional definitions and roles based on biological characteristics. Butler suggests that gender is a social construct shaped by cultural and social factors, rather than being an inherent, fixed identity (Butler, 2005). Simon de Beauvoir famously stated that "One is not born, but becomes a woman," emphasizing that biological characteristics are not related to gender norms (De Beauvoir, 2014). Similarly, Butler argued that gender is imposed through binary systems and is constructed through performative behaviors that are determined by culture. The way individuals present their bodies through performative behaviors helps to reproduce and reinforce existing gender norms. These behaviors, which are shaped by cultural expectations, can be seen as signs that carry the history and cultural meanings of gender. The social consequences faced by those who do not conform to binary gender norms, such as punishment or stigmatization, serve to maintain and preserve these norms (Butler, 1988). Social expectations about gender roles and behaviors can manifest in many different ways, including the stigmatization of men who engage in traditionally feminine activities like housework (Doğanay, 2021). Gender is given meaning through performativity, as well as the material aspect of performative behaviors, such as the gendered design and marketing of products, supports the continuation of binary gender codes (Canli, 2018). Additionally, the perception that certain household products are only intended for women can also reinforce gender norms and perpetuate unequal gender roles. On the other hand, behaviors, which can include the way an individual presents their body and engages with gendered products, help to reproduce and reinforce existing gender norms. In summary, performativity is not just a "performance," but encompasses identity, behavior, and the formation of norms as a technical concept.

Gendered product

The concept of "product gender perception," or "gendered product," refers to products that are not designed specifically for use by a particular gender, but are perceived as suitable for one due to factors such as design, advertising, and branding (Alreck, 1994). Studies have shown that social and cultural structures, as well as individuals' gender identities, can influence these perceptions (Allison et al., 1980; Golden et al., 1979; Iyer & Debevec, 1986; Milner & Fodness, 1996). Previous research has indicated that women tend to prefer products they perceive as feminine, but do not mind using products considered masculine. Men, on the other hand, tend to use products perceived as masculine and avoid those seen as feminine (Van den Hende & Mugge, 2012; Wolin, 2003). However, it is important to note that these behaviors may have changed over time and may vary depending on different cultures and societies. Designers consider various types of information when creating a product, including aesthetic, semantic, and symbolic elements, in order to facilitate consumer evaluation and use, making the product a means of communication (Alreck, 1994). However, research has shown that visible design characteristics, as well as advertising and promotion, can also influence perceptions of gender for products (Güngör, 2016; Wolin, 2003). Gender perceptions of products can affect marketing strategies and ultimately influence purchasing behavior (Ritnamkam & Sahachaisaeree, 2012). Advertisers can use techniques such as color, shape, sound, and graphics to emphasize masculine or feminine qualities of a product to appeal to a wider market (Güngör, 2016; Stuteville, 1971). Consumers can interpret the gender codes on a product and this can influence their decision to purchase a product that aligns with their own gender identity (Drake & Radford, 2018).

In summary, there are multiple factors that can affect the perceived gender of a product, and it's important to consider social and cultural structures, as well as individual's gender identities, when designing products. Adopting a socially inclusive design approach, taking into account factors such as design, advertising, and branding can lead to more equitable and inclusive results.

Methodology

According to Law (2019), material semiotics is a set of approaches to social analysis that focuses on exploring how practices in the social world are shaped by the physical stuff involved in those practices. It includes a range of traditions and disciplines, such as actor-network theory, feminist material semiotics, anthropology, cultural studies etc. Material semiotics is a tool that we can use the study of how objects and materials communicate meaning through their form, appearance, and function (Law, 2019). This field of study examines how the design and use of objects and materials convey

cultural values and norms. For example, the color, shape, and function of a product can all convey cultural associations and meanings that are specific to a particular context. In this study, this approach was only applied through product form in the context of gender.

Product form

We use our senses, such as sight, touch, smell, hearing, and taste, to interact with products. The way a product is used, as well as variables such as the timing, environment, and manner of interaction, can affect how we use our senses. Sight is typically the first sense we use when interacting with a product, followed by touch, smell, hearing, and taste (Fenko et al., 2010). The shape of a product can also play a significant role in our perception of it (Norman, 1988). We gather information about products through our interactions with them and use this information to form opinions and assign values to the product. These opinions and values can be influenced by cultural, personal, and social experiences, and may vary between different societies. When interacting with physical products, the design features can convey information about its use and purpose, and also affect our aesthetic experience of it. The form of the product can influence our perception of it and potentially convey gender references, which can be intentional or a result of the required form for the product's function. Intentional gender references may be influenced by cultural and symbolic codes are associated with a particular gender and shapes can be perceived as feminine or masculine (Van Tilburg et al., 2015). Likewise, anthropomorphism, or giving a product human-like qualities, can also affect how we perceive its gender (Van den Hende & Mugge, 2012). However, the formal features of a product are not only determined by the designer's decision. They may also be influenced by various standards, regulations, and technological capabilities etc. This is a question that will not be addressed within the scope of this study. Geometric shapes and graphic arrangements used in packaging design can impact the purchasing decisions of male and female consumers. Female participants in the study preferred curvier, curved, and freeform shapes, while male participants preferred cubic and angular shapes. When it comes to graphic arrangements, female participants preferred symmetrical and curved designs, while male participants preferred straight and intersecting lines (Ritnamkam & Sahachaisaeree, 2012). These preferences may be influenced by gender stereotypes and how certain physical characteristics, such as round versus defined body shapes, are perceived as more feminine or masculine (Van Tilburg et al., 2015). However, individuals may not feel comfortable using products or services that do not align with their gender identity (Fugate & Phillips, 2010). While there is a parallel between the feminine or masculine shapes preferred and the individual's gender identity, this strengthens the relationship between shape and gender and reinforces the gendering of products. The amount of gender-based stereotypes carried by a product can also affect its perception as masculine, feminine, androgynous, or gender-neutral. For example, products with more "masculine" elements and angular, non-curved shapes may be perceived as more "masculine" and convey a strong, dominant image. The masculinity of a product can also be used to distinguish the quality of similar products that serve the same function, with products featuring more features often being perceived as higher quality based on gender stereotypes. The following products were ranked based on their prices in December 2022 on Trendyol.com, which is an online shopping platform widely used in Turkey. It can be observed that products with superior performance and higher prices tend to feature more masculine shapes, with sharper and more angular lines. The use of color, material texture, and shine also reinforces the gendered implementation.

Figure 1. Grundig Hair dryer designs, ranked based on their prices in December 2022 on Trendyol.com from most expensive to least expensive and from highest to lowest in terms of technology and performance

Epilators are a product category often targeted towards women. Despite the act of removing body hair not being gendered, gender stereotypes can influence the design of these products. Personal care products are associated with the body and also have a cultural influence on shaping individual visual identities. As a result, gender stereotypes are more effectively reflected in personal care products that shape the body, in comparison to small household appliances like vacuum cleaners and kitchen appliances used in the home. The listed epilators are ranked from most expensive to least expensive and from highest to lowest in terms of technology and performance. It has been observed that, as with hair dryers, epilators with more advanced features and higher prices tend to incorporate traditionally masculine elements. On examining the formal connections between epilators, it becomes apparent that they exhibit characteristics that are traditionally regarded as feminine, such as having an oval, curved, and soft-lined design. With the advancement of technology, we observe that these formal features are slowly evolving from an oval shape to flatter ones, which brings them closer to the shapes typically associated with masculinity. For example, the most expensive and technologically advanced epilator from the same brand shares a similar design with their electric shaver (see figure 3).

Figure 2. Braun Epilator design, ranked based on their prices in December 2022 on Trendyol.com from most expensive to least expensive and from highest to lowest in terms of technology and performance.

Figure 3. Braun epilator design (left), Braun electric shaver design (right)

The existence of gender perceptions based on product form is also seen in countless examples in the global market where products are consciously used to reach a wider audience. However, according to research by Tilburg, products that are more strongly gendered tend to have higher sales than those that are less gendered (Van Tilburg et al., 2015). Nevertheless, increasing sales or user preferences due to the gendering of a product does not necessarily mean that gendering the product has positive results. While there may be commercial success, the impact on society is a controversial issue regarding gender equality and inclusivity. As mentioned above, repeated gender patterns reproduce existing gender judgments and thus continue to be sustained. The increased sales or user preferences resulting from the gendering of products can be presented as evidence that existing gender patterns are being continued. From a feminist perspective, this should be evaluated not as a success but rather as evidence that impedes gender equality. As previously mentioned, when discussing performative gender, evaluation cannot be made solely through the lens of binary gender. There are many people with different gender identities. In this diversity, presenting products as only divided into two groups and evaluating the sales and preference rates does not coincide with the idea of a system that works inclusively from a feminist perspective. However, as shown in the examples, when comparing the gendering of products and their performance, reinforcing gender inequalities by using masculine elements in the gender codes of high-performance and expensive products means that gender inequalities in products are being continued. A product does not necessarily have to be made stronger, more durable, and expensive by using masculine elements.

Concluding discussion

The provided information highlights the significance of inclusive design in product design and advertising, the influence of gender on product perception and the role of social norms and expectations in shaping gender performance. To create inclusive products and advertisements that are welcoming to all individuals, regardless of their gender identity or expression, designers should consider avoiding the use of gender stereotypes, seeking input from a diverse group of users during the design process and taking into account the needs and preferences of a wide range of users. Additionally, designers should be aware of the impact of advertising and promotion on the perceived gender of a product and how this can affect purchasing behavior. It's crucial to analyze these factors together to have a more extensive understanding of the intersection between inclusive design and gender. To achieve inclusive design solutions that take gender and performative gender into account, designers should consider;

- The functional, emotional, and identity needs of users across the entire population, taking into account the social and cultural context in which the product will be used.
- The Addressing framework, which consists of nine different identity considerations, such as age/generation, disabilities, religion and spirituality, ethnic and racial identity, socioeconomic status, sexual orientation, indigenous heritage, national origin, and gender.
- Avoiding the impact of gender stereotypes and the perpetuation of binary gender norms in product design, advertising, and marketing. Because, the impact of gendered product design on purchasing behavior and the potential for reinforcing unequal gender roles.
- The importance of considering the needs of individuals with disabilities in the design process in order to create functional and aesthetically pleasing products.
- Consider the visual and symbolic elements, such as color, form, shape, and graphic arrangements, on gender perceptions of products to avoid inequality.
- Consider the influence of social and cultural structures on gender associations with products.
- Consulting with a diverse group of users to gather input on the design process.
- Understanding the diversity of gender identities and expressions and the potential impact of design on these identities

There are several limitations to this study that should be considered when conducting future research. One limitation is that the information provided is largely based on research conducted in the past, and it is possible that social and cultural expectations around gender and gender roles have changed since this research was conducted. Additionally, the research provided is largely based on Western cultural perspectives, and it would be valuable to consider the experiences and perspectives of other cultures.

In conclusion, it is clear that gender and performative gender play a significant role in the design and perception of products. Designers should be aware of the impact of social and cultural expectations on gender roles and how gender stereotypes can influence the design and perception of products. By considering these factors, designers can create more inclusive and welcoming products that consider the needs and preferences of a diverse range of users. Further research is needed to better understand how social and cultural expectations around gender and gender roles may have changed over time and how these expectations vary across cultures.

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Landing the internship: the role of gender in finding ID internships

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Abstract

Professional Industrial Design (ID) internships support student success and entrance into practice. Students experience work culture, processes, and different types of industrial design settings while gaining a highly valued line on their resume.

Despite gender parity in ID education, females make up only 19% of the ID workforce. The on-going disparity between male and female identifying industrial designers as they make the transition from school to professional practice necessitates (further) investigation. The authors hypothesize that internship experiences and who receives them has a snowball effect on student success and ultimately in their ability to join the ID work force at the same rate as their male peers.

The lack of women in ID moving forward into the workforce has broad implications for the field and for the success of Research & Development (R&D) teams. Research is critical for identifying barriers to women's success in ID, making it possible to address inequity in ID education and create strategies to increase gender parity in the workforce. This study explores if gender was a factor in how students obtained their internships; in particular if students were personally referred to the internship, they obtained the internship through networking, or if they responded to a job/internship posting without connections to those working there. This study employed quantitative methods for data collection and analysis. Student surveys and semi-structured interviews were administered in ID programs at Western Michigan University and the University of Kansas, both 4-year comprehensive universities in the United States. Respondents included current 3rd and 4th year students, as well as alumna 4 months post graduation, in the hopes of understanding application rates, internship experiences, hiring process, and perception of internship value for their education and for their preparation for employment. This is an initial investigation at our institutions and is a model for further research.

Author keywords

gender; equity; internship; industrial design; design education

Introduction

Understanding what factors lead to the under-representation of women in Industrial Design (ID) practice is complex and multifaceted. Currently, 81% of ID professionals are male, meanwhile ID education has achieved gender parity with equal numbers of male and female identifying students (Coroflot, 2022). In comparison to other related fields such as architecture or engineering there is little research investigating the disparity we find in ID. It is difficult for educators and practitioners to understand the causes for these demographic disparities because there is so little information available. At this time, there is no published demographic data regarding participation in ID internships, nor is there published demographic data for entry level industrial designers. Education must be able to make thoughtful developments to improve the success rate of all students regardless of race or gender. This includes making adjustments to pedagogy and approaches to mentorship and support for students, as well as ensuring equity and access to quality internships which are proven to help students succeed in entering a competitive field. This research investigates if gender is a factor in internship participation, how students secure an internship, and perceived value of the internship experience. By better understanding internships, we strive to build understanding of the participation gap occurring during the transition from student to professional industrial designer.

Literature Review

The following literature review frames four key aspects to our research, including the current demographics of students and professionals in the field of ID, the impact of diversity in the workplace, the value of internships, and barriers to internship participation. This review also reinforces that there is a need for further investigations and research into gender and racial disparities in the field of ID, specifically internship participation and understanding factors contributing to women participating in the field of ID.

Current Demographics of Students and Professionals

The profession of ID is heavily male dominated, with only 19% of the ID work force identifying as female (Coroflot, 2022).

However, ID academic programs are increasing enrollment of women, who make up 49% and 45% of industrial design students at our respective institutions. Compared to other professional fields with a large disparity between male and female participants (such as architecture and engineering), there is little research about this inequity in ID, specifically regarding experiences of students in their undergraduate studies and how that affects their ability to successfully enter the profession. This gap between academics and professional practice deserves further inquiry.

Impact of Diversity in the Workplace

Research tells us that gender inclusivity only improves innovation and corporate outcomes. Teams that are gender-balanced see an increase in creativity and innovation and a 15% rise in performance. Women are able to produce higher sales, employee engagement, team self-confidence, high psychological safety, and are more likely to promote and yearn for sustainable practice (Page, 2007). The lack of women in ID moving forward into the workforce has broad implications for the field and for the success of R&D teams. Research is critical for identifying barriers to women's success in ID, making it possible to address inequity in ID education and create strategies to increase gender parity in the workforce.

Value of Internships

Professional internships support academic success and facilitate entrance into the student's chosen field of practice. Interns experience work culture, processes, and different types of industrial design settings while gaining a highly valued line on their resume. While academic coursework focuses on learning core skill sets and theory, the soft skills, professional expectations, and understanding of the realities of the field are often learned through an internship. Students who participate in an internship related to their profession are more likely to find employment in their field (Binder et al., 2014).

Participation in internships has the added benefit of giving students the opportunity to develop workplace preferences, helping ensure the jobs they seek after graduation are a good fit (and avoiding the necessity of career trial-and-error). They also often lead to full-time job opportunities with the internship employer (Maertz et al., 2014). Students who have internships are perceived as being ready to enter the workforce, with students receiving 14% more job interviews if they have internships than those who do not (Nunley et al., 2016).

It's not just students who benefit from internship experiences; companies that employ interns gain the opportunity to complete lower priority projects at a lower cost of labor. Internships are also an excellent recruiting tool. At the point when a full-time job offer is extended, interns have already worked at the company, demonstrating their interests and capabilities and building on-the-job knowledge. Even when there isn't an opportunity for further employment, students who have a positive internship experience are likely to share that with friends and family, raising the reputation of the employer (Maertz et al., 2014).

Barriers to Internship Participation

Despite internships being highly valued, not all students are able to participate in them. Internship placement is intensely competitive, with employers seeking out students with sophisticated professional work. If upper-level student portfolios don't reflect previous internship experience, their job opportunities may be limited (Barnhart, 2022).

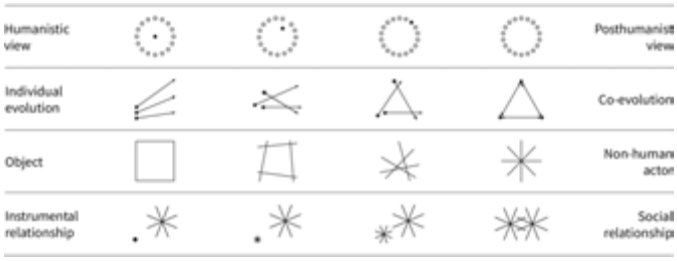

Figure 1. The key concepts for shifting from a humanist to a posthumanist perspective.

Beyond simply not being able to 'land' a job, considerations that make it difficult to pursue an internship include heavy course loads and the need to maintain a full or part-time job. Financial considerations make it especially difficult for students to take on an internship that requires relocation or a low-paying or unpaid internship. These issues often have an outsized impact on historically marginalized student populations (Hora et al., 2021).

Research Setup and Focus

The lack of data and previous literature regarding males entering the field of ID at a greater rate than their female counterparts led to the following three assessments. The first was to investigate if there is a disparity in internship participation rates between our male and female identifying students. Second was finding how male and female identifying students were obtaining their internships. Third was investigating if there is a gendered difference in the perception of value of the students' internship experience. To study this, ID students at Western Michigan University and the University of Kansas in their 3rd and 4th year as well as students who graduated the prior year (n=77) participated in a survey.

Survey Measures

Predictor Variable

The central predictor variable for this study was gender. Participants were asked: What gender do you identify as? Options included Male, Female, Non-Binary/Non-conforming, Transgender, and Other. One participant responded with an identity other than Female or Male. This participant was excluded as there were insufficient data to conduct analyses.

Outcome Variables

This study included three outcome variables of interest. First, participants were asked: Have you participated in an internship since starting in the ID program? Respondents could answer Yes or No. Participants who answered "Yes" were then asked: How did you land your internship(s)? Please select all that apply. Options included: someone personally referred you to the company, you responded to a job/internship posting, you met someone at the company through networking, and an other category with an open response. Three respondents provided "other" answers, which were reviewed by two of the authors and classified within the most appropriate existing category.

Because this study was interested in investigating the role of social connections in internship placement and gender, the responses to this second question were recoded into two categories including: 1) any personal connection involved (including the original responses: someone personally referred you to the company and you met someone at the company through networking) and 2) applied without any personal connection (including the original responses: you responded to a job/internship posting).

The final set of questions focuses on the perceived impact of the internship. Participants were given the following prompt: How would you rank your internship's impact on each of the following? (With 0 showing no impact, and 5 showing maximum impact.). Below the prompt were 3 sliding Likert scales for 1) career/professional learning, 2) benefit to your future, and 3) benefit to your industrial design education.

Analysis Plan

The aim of the analyses was to evaluate whether having an internship, how participants landed the internship, and the perceived impact of the internship varied by gender. Cross-tabulations between the categorical outcomes and gender were conducted and descriptive statistics by gender were calculated for the scale variables. Bivariate logistic and ordinary least-squares (OLS) regression were conducted based upon the outcome variable. For the OLS analyses, the R-squared and effect size (calculated with Cohen's d) are provided.

Several sets of sensitivity analyses were conducted. First, a bivariate multinomial regression using three categories instead of two categories for how participants landed their internships was conducted. In this alternative specification the categories included: 1) only applied, 2) only personal connection, and 3) both applied and personal connection. Second, for the binary outcome variables, Chi-square tests of independence and tests of proportions were conducted. Third, because Likert scale outcomes may not meet the criteria for parametric tests, a Mann-Whitney Wilcoxon rank-sum test was conducted on the variables that used the Likert scale rankings.

Findings

Table 1 provides cross-tabulations for the categorical variables (Panel A) and descriptive statistics of the scale variables (Panel B) by gender. The cross-tabulations show that among the 77 participants included in the analyses, 47% were women. In total, 68% of participants had completed an internship (n=52) with 63.9% of women reporting an internship compared with 68.3% of men. Overall, more participants reported landing an internship with a personal connection than through applying alone (53%). Among women who had landed an internship, 52.2% reported applying alone and the remaining 47.8% reported use of any personal connection. By contrast, 42.9% of men who landed an internship reported applying alone while 57.1% reported use of personal connections. Importantly, 1 participant did not report how they landed their internship.

With regard to the perceived impacts, only 42 of the 52 participants who had an internship answered these questions. The median scores on these questions differed by gender. On the career/professional learning, the median score for women was 3 versus 4 for men. Similarly, on the benefit to your future scale, the median score for women was 4.5 versus 4 for men. Finally, on the benefit to industrial design education scale, the median score for women was 3.0 versus 3.5 for men.

Table 2 provides the results of the bivariate analyses using regression. Although the cross-tabulations and descriptive findings suggest potential differences by gender, none of the regression models showed any statistically significant differences by gender. Despite the lack of statistical significance, other indicators provide some preliminary support for the idea that gender may be associated with our outcomes of interest. First, for the binary outcome measures, the odds ratios provide insight into the effect of gender. For example, in this sample, men were 21.7% more likely to have had an internship than women and they were 45.5% more likely to land this internship using a personal connection of some kind. While these values do not rise to the level of statistical significance in this sample, the results are suggestive of potential differences. Second, the R-squared demonstrates that 6.5%, 2.8%, and 1.4% of the variation in responses to the career, future, and education impact scales are attributable to gender, respectively. The estimates of Cohen's d suggest small to medium effects, but the confidence intervals around this estimate suggest the results are not reliable.

Sensitivity Analyses

The sensitivity analyses conducted did not differ substantively from the findings presented above.

Interviews

To further understand the experiences of our students, informal, semi-structured interviews (n=8) were conducted with 4 students from each participating program, equal numbers of

Table 1. Cross-tabulations and Descriptive Statistics by Gender for All Outcome Variables

Panel A: Cross-tabulations			
	Female (n=36)	Male (n=41)	Total (n=77)
Had Any Internship	63.9%	68.3%	n=52
How Participant Landed Internship			n=51
Applied Only, No Personal Connection	52.2%	42.9%	n=24
Any Personal Connection	47.8%	57.1%	n=27
Panel B: Descriptive Statistics			
Perceived Impacts	Female (N=20)	Male (n=22)	Overall (n=42)
On Career			
Median	3.0	4.0	4.0
Minimum	1.0	2.0	1.0
Maximum	5.0	5.0	5.0
On Future			
Median	4.5	4.0	4.0
Minimum	1.0	2.0	1.0
Maximum	5.0	5.0	5.0
On Education			
Median	3.0	3.5	3.0
Minimum	0.0	0.0	0.0
Maximum	5.0	5.0	5.0

Table 2. Bivariate Logistic or Ordinary Least Squares (OLS) Regressions between Outcome Variables and Gender

	(1)	(2)	(3)	(4)	(5)
	Any Internship	How Landed Internship	Perceived Impact - Career	Perceived Impact - Future	Perceived Impact - Education
Gender (Ref= Female)					
Male	1.217	1.455	0.591	0.382	0.364
	(0.588)	(0.823)	(0.355)	(0.354)	(0.491)
Constant	1.769	0.917	3.500***	3.800***	3.000***
	(0.614)	(0.383)	(0.257)	(0.256)	(0.355)
R-Squared	-	-	0.065	0.028	0.014
Cohen's d	-	-	-0.514	-0.333	-0.229
95% CI			-1.127 - 0.105	-0.941- 0.279	-0.835- 0.380
Observations	77	51	42	42	42

Models 1 and 2 use logistic regression and exponentiated coefficients are provided. Models 3, 4, and 5 use OLS regression. Standard errors in parentheses
+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

self-identifying male and female students were interviewed. These qualitative interviews were conducted to understand the students' process for finding an internship and their actual experiences if they had or did not have an internship. Students' positive and negative reflections, as well as barriers to participating in internships, were recorded.

Questions that were asked:

- Can you walk through your internship experience?
  - How did you find internships, and how many did you apply for?
  - Which internships did you apply for? Was it based on...
    - Who you know, particular interest in the field, geographic location, financial compensation, or something else?
- How much pressure did you feel to get an internship?

Questions for students who participated in an internship(s):

- How would you describe the hiring process you went through?
- How many interviews did you go through? What were they like? Are there any questions that stood out to you in particular?
- What was your day-to-day experience?
- How many/what sort of projects did you work on? Who did you work with?
- What (if any) value did your internship(s) have for your education?
- What (if any) value did your internship(s) have for your job preparedness?

Questions for students who did not participate in an internship(s):

- Were internships an option for you while studying ID?
- Did you apply for any internships? (How many do you think you applied to?)
- What (if anything) do you think you're missing by not having had an internship?
- Do you have any sense of why you didn't get an internship? Was there anything in particular holding you back? (Geography, finances, time, etc.)
- If you were going to go through the process of applying for internships again, what might you do differently this time around?

Findings from interviews (n=8)

Importance of Personal Connections

- Personal connections and recommendations were critical for obtaining internships. All students interviewed who participated in an internship (n=5) obtained their internships through their network and personal connections.
- Mentors simplified and removed barriers for students applying to internships. Mentors would connect students without the students submitting a formal portfolio.
- Students with mentors connecting them to internships did not apply to other internships.
- Professional mentors were the most likely connection for internship placement.

Confidence through Internship Experience

- Initially applying for internships was overwhelming and intimidating.
- Having internships improved students' confidence and they were more comfortable submitting their portfolios to other internships or professional positions if they are graduating.
- Students who did not participate in an internship felt less confident than their peers with internships, even if they were not able to participate due to costs or other issues, not because they did not have the same skill sets as their peers who were able to participate in internships.

Value of Internship Experience

- Internships are highly valued even if they aren't found to be valuable, students reported that they thought having an internship on their resume was critical in their ability to find full time employment after graduation even if they reported that the internship was not beneficial to their education or prepared them for the profession.
- Female identifying students found the internship experience less relevant to their success as a student or as their success in the future.
- Students feel unsupported when not assigned a manager, or when their assigned manager is often unavailable.
- Students reflected that they wanted to feel like they fit into the workplace and culture, specifically women wanted to work with other women.

Discussion

Internships play a pivotal role in supporting students' success in entering the ID workforce. This research reflects inequity for women in ID, specifically the experiences that women are having in finding and then during their internships are not the same as their male counterparts. Male students who had internships were also personally referred to positions 42% of the time, while 30% of our female internship participants were personally referred. Although no statistically significant differences arose from our survey data, trends emerged.

These trends, including male students benefiting from a strong network, with more men participating in internships overall and male students finding the internship experience more beneficial to their education and to their future careers in the field of industrial design, were reiterated during qualitative interviews. The authors believe this discrepancy contributes to women's difficulty entering the field of industrial design at the same rate as their male peers.

Since this research shows the importance of a personal network, specifically mentorship, and how male students are benefiting at a greater rate than our female students it would be beneficial to assess how to expand the networking opportunities for female students. Female students are needing and looking for mentorship and guidance from professional female designers. Making female mentors available for female industrial design students would contribute to building confidence and give them a connection to an employer who values gender diversity. To make changes needed we believe it is not only the responsibility of faculty and students, but also employers can have an impact. This research shows that providing opportunities for their female designers to mentor and represent the design team to students will be beneficial in attracting and recruiting a gender balanced design team.

We found that students felt like they needed more support during the internship experience. There was a difference in women and men's perspectives on the value of the internship. Women saw the internship as an important checkbox for their resume while men seemed to find more value from the actual internship experience, reflecting that it was beneficial to their education and their future. This difference would be worth investigating further in a future study.

Conclusion

This study showed that there is a gender-based disparity in students' experiences with internships. This includes how many students receive internships and how students obtain their internships, with men having more internship experience overall and being much more likely to have more than one internship.

With these results, this indicates a need for further investigation into how to better provide support for students and their search for internships. There is also a need to investigate the disparity in perceived value of students' internships. All of these variables in finding and experiences during internships contribute to inequity which leads to the under representation of women in the workforce.

There is merit in continuing this investigation in:

- Exploring why demographics for interns is more inclusive than hiring full time industrial designers into the profession
- Investigating how educational institutions define industrial design internships
- Expanding to other geographic areas, collecting data from other academic institutions and industrial design firms
- Assessing portfolios submitted to open positions
- Interviewing industrial design hiring managers and assessing what the demographics are of new hires vs. interns

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Everyday objects as the tools of trauma therapy - Examination of the material culture of young refugees in Hungary for trauma processing

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Abstract

Objects integrate, socialise and teach us, mirror our past and self. They also represent our home, as we can take them with us when moving. What happens to our objects when this move is accompanied by trauma and compulsion? The aim of this research is to understand the significance of the object, the smallest physical unit of the home, in the recovery processes of forced migrants. In parallel with theoretical and field research, interviews were conducted with forced migrants with the main question of "To what everyday objects can forced migrants be attached to and what do those objects mean to them?". The paper first presents the literature review of the ongoing interaction between people and objects, highlighting aspects of forced migration and trauma processing. After it introduces the results of the interviews. The coping strategy of the interviewees is associated with activity and social connections: the individual memories of their past are replaced by the collective actions of their future. By collective actions it is possible to gain the two main goals of trauma processing: the individual is not only restoring the lost control of its life but also the individual does it among a community. Therefore the result of literature review and in-depth interviews proves that objects can play an important role in processing trauma at all three stages of recovery (creating security, restoring memories and grieving loss, reconnecting to everyday life). It becomes clear that refugees have much less emotional expectation of their objects than a place called "home", which means objects can become a neutral tool for a painless methodology for processing trauma. From the results of this research, a design therapy toolkit will be created, which can initiate therapeutic, learning and community-building processes by developing place and object attachment: it can provide a creative tool for professionals, educators and therapists working with those who have lost their homes.

Author keywords

loss of space; boundary objects; object attachment; forced migration; design therapy.

Introduction

Forced migration is a traumatising event (Silove et al., 1997). The traumatic reaction occurs when the self-defence system is overloaded and stops functioning: the individual can neither fight nor escape (Herman, 2015). The traumatic events of forced migration are, on one hand, the push factors (war, persecution, disaster), the experience of multiple losses (of loved ones, home, possessions and existence) and the inevitable transformation of one's culture upon arriving in a new environment (Hautzinger et al., 2014). The purpose of this study is to understand the importance of the smallest physical unit of the home – our everyday objects – in the recovery processes of the trauma of forced migration. Restoring the self-structure and control of the traumatised person are the primary goal of the recovery process (Abram Kardiner, Martin Symonds, Evan Strak, Anne Flitcraft cited by Herman, 2015), which has to happen through connection with others (Herman, 2015). The three stages of recovery are: the creation of security (1), the restoration of memories and grief of loss (2) and the reconnection to everyday life (3) (Herman, 2015). The importance of attachment to our objects appears in both Hungarian (Dúll, 2009, Wilhelm, 2014) and international literature (Belk, 1992, Csíkszentmihályi & Halton, 2011). In the context of migration, objects have particular importance since they make the home moveable, so they can maintain its sense of continuity (Dúll, 2009). Studies mostly examined the object culture of refugees in refugee camps and in the transitional areas of the borders (Korac, 2009, Dudley, 2010, Guevara González, 2022). In contrast, this study examines a population that already has a residence permit, official education and a permanent job, so their experiences are not framed to the limitations of illegality and refugee camps.

Method

The research process relies on three methods. The first is a review of the relevant literature in order to create the context: the psychology of migration and the nature of trauma, material culture and cultural anthropology, symbolism, psychology and, within that, environmental psychology. The second is in-depth interviews with young adult forced migrants, the third is the author's 10-year fieldwork experience, including creative workshops and projects with refugees, as well as consultations and discussions with professionals working with refugees.

In-depth interviews were conducted with young forced migrants, a population that has been repeatedly traumatised and had to leave its homeland behind. They allow insight into how material culture can become part of their coping strategy in order to create a new home in a foreign country. The central question of the interview was "To what everyday objects can forced migrants be attached to and what do those objects mean to them?" with two main focuses: what old

objects they own from their homeland (1), in case of another journey, what objects they would take with themself (2). The interviews were conducted with 19 people respecting five main conditions to filter the population into a more specific group of individuals who share similar past experiences of displacement. All the interviewees: had to consider themself as forced migrants (1), had to be between the ages of 18 and 40 (2), had to be born outside Europe (3), already lived in Europe for at least two years, including at least one year in Budapest (4), already have a residence permit and/or recognized refugee status (5). During the interviews, an interactive model was followed (Creswell & Creswell, 2018) supported by visual games and tasks. The interviews were conducted mainly in person (and due to the pandemic situation, party through online video calls) and each lasted 1 hour.

The research also relies on the author's 10 years of field experiences. Since January 2013, she has been working with young refugees and asylum seekers as a volunteer of a Hungarian association called Útilapu Hálózat, where she founded the Open Doors working group with her graphic design partner, Ágnes Jekli. She facilitated short (half to one day) creative workshops (textile silk printing, bookbinding, furniture renovation, mural painting), and long (1-12 weeks) projects (designing and renovating community spaces, media training, placemaking camps). The goal is always to involve people in the design and implementation process so they can make their own decisions, gain new competencies, develop their creative problem-solving skills and build community. The experiences were discussed with professionals working with refugees (psychologists, teachers, social workers, project coordinators). The results were documented in the form of photos, videos and diary entries (Sztompka, 2009).

The diverse role of objects in the context of migration

There is a characteristic and extremely stable transaction between the material environment and human behaviour: every material environment typically triggers and maintains persistent patterns of behaviour over a long period of time, even if the given people change in the environment (Dúll, 2009). Because of the ongoing interaction between people and objects, it is relevant to study the combined phenomenon of them together (Wilhelm, 2014, p. 24).

To measure the individual's attachment to objects, the empirical research of Kapitány Ágnes and Gábor (2005, p. 126), can help with its scaling: respondents answered that objects are "important", "only certain objects are important" and "not important" was chosen the least. According to Belk (1992, cited by Dúll, 2009), attachment to property can have a negative effect if it is so strong that it negatively affects the relationship with other people or if the attachment is so extreme that the loss (or damage) of the object puts the self itself in danger.

Objects can symbolise social integration or differentiation (Csíkszentmihályi & Halton, 2011). The object can embody the power and knowledge of its owner, it can make its social affiliation visible. Community can give meaning to express ourselves, but at the same time it can also mean social separation (like a cross or a flag) (Kapitány & Kapitány, 2021). Integration and connection can be strengthened by exchange of objects: it is a general cultural phenomenon to treat gifts differently (Wilhelm, 2014). "Boundary objects" are able to mediate and create a connection between different groups, as they can be related to all members of the group (Wilhelm, 2014). However, they can also be the source of confusion (Hall, 1975, p. 29).

Objects offer the opportunity to learn (Csíkszentmihályi & Halton, 2011). Whether it is about fitting into social norms, our own personal development, or the environment that supports our learning. The presence of our objects create a familiar, supportive and inspiring environment, so the owner's identity can be strengthened again (Csíkszentmihályi & Halton, 2011).

Objects can develop the self (Kapitány & Kapitány, 2021). Sartre (1943, cited by Dúll, 2009, p. 147) states, objects are integrated into our identity through: "craft knowledge (1), the creation of the object (2) getting to know the object (3)." Our own objects ensure control over the environment, strengthen self-concept, increase self-confidence, provide a sense of security, and allow us to present our identity to ourselves and others (Dúll 2009, p. 141). Different objects convey different messages: about our daily life, occupation, values, cultural habits (Kapitány & Kapitány, 2010). With objects, we create our own cultural environment (Csíkszentmihályi & Halton, 2011, p. 159).

Lifeless objects very actively influence personal behaviour connecting to the place called home (Dúll, 2009, p. 139). Without our objects, we would not be able to inhabit our environment, move our home from one place to another and reform our old patterns (Dúll, 2009, p. 142).

Csíkszentmihályi and Halton (2011) examined the difference between active and contemplative objects. Referring to Hannah Arendt, the first (active) cultivates the personality through individual action, while the second (contemplative) through conscious thought and reflection (1958, cited by Csíkszentmihályi & Halton, 2011).

In the case of forced migration, rescued and lost objects, just like objects that help survival need to be examined as well. Schwarz (1996, cited by Dúll, 2009, p. 155) examined flood victims in the USA, where the focus was on saved objects: of sentimental attachment (1), that reflect and shape the owner's self (2), of "invested sweat" (3), with cultural meaning (4), of survival (5). Connected to lost objects, more respondents mentioned losing a piece of their personality (Kapitány & Kapitány, 2005). According to Turner (1969, p. 108), during the rite of passage, the liminal person is the one who has nothing, who is represented practically nakedű, and from this "nothingness" he rebuilds himself with new status and objects.

We can therefore see by the literature review that we should not underestimate the role of objects in processing trauma. By the presence of our well known objects we experience a familiar and safe environment, so the owner's identity can be developed again. Objects materialise our past, our culture and identity, therefore they can help to recall memories. Also attachment to objects can be formed through memory. Objects have a significant role in reconnecting us to life, since they integrate us into new communities, they teach us to the social norms, support our education and boundary objects can represent a bridge between people with different cultural backgrounds. If we start from the assumption that "objects imbued with emotional attachment (i.e. things)" actively contribute not only to the already mentioned teaching, integration and the "personal, social and cultural construction of our self, but also to the creation, maintenance and eventual

restructuring of the experience of continuity" (Dúll, 2009, p. 156), then objects can have significant role in the recovery processes of migrants.

The objects of forced migration

At the intersection of forced migration and material culture, studies mostly examined the material culture of refugees in refugee camps and in the transitional areas. The focus of Dudley's (2010) research is on the material, object and emotional dimensions of being a refugee. Analysing camp life of Karenni refugees, she revealed how they practise their daily routine through their objects and thus create their reinterpreted "home". She mainly focused on textiles, which, according to the results, can form a bridge between the refugees' past, present and future, especially if these clothes are made by refugees themselves after arriving in the refugee camp (Dudley, 2010, p. 126). Maja Korac (2009) examined the integration of refugees settled in Rome and Amsterdam. She examined the residents of an asylum centre, where clothing was a key value as well. Korac also emphasises the importance of clothes: the fact that refugees themselves sew, repair, wash and protect these items is important in addition to the purchase of them (Korac, 2009, p. 344).

Both researchers gave particular importance to textiles from the point of view of the refugees' possessions and attachments. Within the framework of Open Doors, the author was able to experience as well how a canvas bag, which a few hours earlier was impersonal and only a mass product, became a self-representative object. Silk printing workshops are often organised for young refugees and immigrants, where the participants can shape the textiles into their own image. During the workshops, they get to know the techniques of colour mixing and silk printing, they work deeply on their own ideas, they are also inspired by each other, they help each other in the process, and the end result is an object of their own, which they are proud to wear.

In contrast to Dudley's and Korac's study, this research examines a population that already has a residence permit, official education and a permanent job, so their experiences are not framed to the limitations of illegality and refugee camps. The interviewees of this paper live in their own rented room or flat and they manage their own everyday life with their own rules and decisions. The interviews wanted to explore what everyday objects can forced migrants be attached to and what do those objects mean to them? The questions were focused on two main topics: what old belongings they own from their homeland (1) and in case of another big journey, what objects they would take with themself (2). Besides the fact that few significant consensus was found between the individual answers, also three outstanding differences between the objects of the past and objects of the future were recognised.

The most significant consensus was the first reaction of all of them: they do not keep any objects from their homeland, and they would not take anything special with them in case of another journey. The most frequent explanations for the lack of objects from the homeland were sudden decision-making, tragic life situations and practical reasons. But objects of the past are not missing for practical reasons only. In the first half of the study, we clarified that objects have a prominent role in relocating our home (Dúll, 2009). This continuity is interrupted by the fact that refugees hardly keep any objects from their past. Trauma poses a threat to place and object attachment by fundamentally damaging it (Dúll, 2009), so it can result that traumatised people do not necessarily want (or are not yet ready) to recreate their home. Later, when the refugee would be ready, this gap cannot be filled with authentic objects from the homeland, but it can be bridged with creativity. An Afghan member of the Open Doors community represents an example for this creative bridging. He does not have any objects from his past, but today thanks to the progress of his integration and recovery, he facilitates creative workshops regularly: he teaches others how to make and fly an Afghan kite. It means that he reconstructs his cultural heritage and knowledge and passes it on to the new, inclusive culture, while he himself recreates it.

Another important similarity in the answers was that in the progress of the conversation 9 interviewees found objects from their past and all of them realised that they have belongings to bring with themself on a journey. Their objects from the past are family photographs, jewelleries (it preserves the memory of the family), a spoon (it is practical), a book (it preserves the culture), money notes from home (which according to him it means nothing), a tie (more like a memory). The objects for the future are cooking equipment (to share culture), shisha and guitar (to spend time together), sewing machine and a big bed (to help a friend who is in need), study books, professional degrees, portfolios, also pictures and a globe (as memories).

The first outstanding difference between the past and future objects is the quantity of them: 10 interviewees had no belongings from the past while all of them had something for the future. It means that the nakedness of liminal persons (Turner, 1969) is represented by the missing objects from the past. Owning nothing, leaving everything behind: we can only bring our environment to a limited extent, we ourselves are much more mobile and we don't always know and don't always want to take our objects with us (Wilhelm, 2014, p. 25). This nakedness significantly dissolves in the future, but it cannot be ignored that those who have been living in Hungary for more years with recognized status still believe at first: nothing important they would take with themself on another big journey. The nakedness of liminality therefore dissolves only slowly. We can conclude that the interviewed forced migrants are mostly free of close ties to their objects. Based on the empirical research of Kapitány Ágnes and Gábor, in a more detailed statement we can assume that for forced migrants objects are primarily "not important", and secondarily "some objects may be important". There is an important change in this, as the nudity of the past has visibly changed, and the number of the objects has increased over the years.

The second main difference is that the contemplative objects of the past are replaced by active objects of the future. Past objects mostly preserve memories and are only marginally practical, this ratio is reversed in the case of the objects of the future. Among the objects of the past, there are functional objects (a tie, a spoon, slippers), but they are present in the refugees' lives as memories, not as objects of use. The touch of a household object can recall painful memories and by this, they might be removed from their original use, transformed into objects like pieces of a collection (Földessy, 2014). The active objects of the future also serve survival: objects support or symbolise employment and profession. Also the process of building a new identity can be read from these

active objects. Recalling Sartre's grouping, objects become part of the self mainly through masterly control here. Also two of the respondents referred to the creation of the object (portfolios). According to my field experience self-created objects might have the same importance in carrying identity as objects of mastery control in case the individuals have the chance and tools to create and personalise their own objects.

The third significant difference is that the objects of the past connect only the narrow circle of the family, while the objects of the future are largely connected to friends and to an even wider community: to the society. The objects of the past are accompanied with fear, lost and painful memories, in contrast most of the objects of the future are connected and serve the narrower (bed, shisha, cooking equipment, sewing machine, instrument) or wider (degrees of profession, work tools, portfolios) community. Considering that the development of social networks is essential for not only processing trauma (Herman, 2015) but also for new place attachment (Dúll, 2009), boundary objects have particular importance, as they can form a bridge between the foreigner and the native. According to my field experiences, practically anything can become a boundary object: at the Open Doors workshops, I witnessed how a photograph, a pair of shoes, a piece of clothing, a bicycle, a camera or even a ball became boundary objects. From the in-depth interviews, books, cooking equipment, but also objects representing the acquired knowledge, the musical instrument and the shisha, can be considered boundary objects.

Even if it was stated in the method session that this paper only uses the results of the material culture phase of the in-depth interviews, it is still relevant to highlight one important connection to the phase of place called home. According to the interviewees, even years after their arrival to Hungary, they still find it difficult to call their Hungarian accommodation "home". It is important to include this detail here, because according to this, the relationship of refugees to objects compared to the place called home is much less painful and they consider objects much less important. It also means they set much less emotional expectations for their favourite objects, as for a place that can be called "home". Taking advantage of this, we can consider objects as neutral tools in processing trauma: objects can become a tool for a less painful methodology, which does not force the artificial development of a sense of home on the target group.

Conclusions - Collective actions

The intent of this article was to explore how material culture can support recovery from trauma. The literature review proves that objects can play an important role in processing trauma at its all three stages: (1) to support the sense of security, objects create a safe and well known environment, (2) objects can materialise the past and culture, therefore they can help to recall memories and (3) objects have a significant role in reconnecting us to life, since they integrate us into new communities, they teach us to the social norms and also support our education and development. Also according to the interviews, objects can support processing trauma of forced migration, since the coping strategy of the interviewees is associated with activity and social connections. By collective actions it is possible to gain the two main goals of trauma processing: the individual is not only restoring the lost control of its life but also the individual does it among a community. According to the interviews, forced migrants are not attached strongly to their objects because of the trauma of forced migration.

These key findings suggest that objects can become a tool of trauma therapy by creating a neutral, less painful methodology which serves security, memory and reconnection. The results of this research are used to develop the base methodology of "design therapy", which is aiming to involve people who experienced the trauma of losing a place (forced migrants, children in state care, homeless people, prisoners ect.) into the design process.

There are two major limitations in this study that could be addressed in future research. First, the study focused on forced migrants who were born outside of Europe: in the future it would be worth to examine less diverse populations, like interviewees from the Middle East or from specific countries of Africa ect. Second, the interviews had limitations because of the language barriers. It would be worth combining the field research with interviews in a more structured way by developing a series of workshops for a 3-4 month long process, targeting this specific topic. It is necessary to involve different fields (pedagogy, psychology ect) into the research design to be able to develop a new, creative approach for trauma therapy: design therapy. The target group of the design therapy toolkit should be professionals (social workers, therapists, educators, youth workers, NGOs) working with refugees, immigrants or other populations who experienced the loss of place and home.

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The food delivery industry and its lack of care in gender equality: the speculative case of 'GiGi'

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Abstract

This research takes a speculative design-led approach to increase care and safety for the women working in the 'Gig Economy', specifically the food delivery industry.

Past research analysing the employment conditions of the Gig Economy have identified unsafe practices that particularly affect female food delivery drivers operating in large cities. Among others, women have no safe access to wash areas, or no possibility to choose safer routes. More recent research put forward regulations or worker unionisation as possible solutions to address some of these problems. Our strategy, based on 'Research through Design' (RtD), envisions the increase of inclusivity, safety, and care by designing a platform – 'GiGi' (the author's word game of 'Gig Economy Gigs') – that empowers women through training and professional development.

With 'GiGi' we combined technology, service design and business to explore how design practices could increase the level of care for women by developing a 'caring transformation' for the food Gig Economy; through the 'GiGi' physical and digital community hub (self-) employed women can reimagine and redesign their own working conditions beyond its current conditions and limitations. We report on our methods to discuss what implementation a prototype should require to effectively design care through participatory co-creation practices.

Author keywords

Care; Design; Futures; Gig Economy; Research through Design

Introduction

In our research care is intended as the factor driven by "[...] cooperation and emotion" (Tilley, 2015) and should develop earnest feelings of "concern or interest; [...] affection or liking" (Rodgers et al., 2017, p. 1) for something or someone. Care and design share the ambivalence of being both a verb and a noun (Rodgers et al., 2017); hence, they can be understood as a response to issues (of care) and create opportunities for design 'to care more' about someone or something or to 'care less'. Consequently, it follows our working definition of care used in this research:

Care is the provision of attention and beneficiary, participatory or respectful actions towards the well-being, recovery, and future integrity of all participants of ecosystems, including humans, non-human actors, all species, and nature. The provision of these actions also includes to care less about potentially overwhelming, harming or negatively influencing factors.

Key Issues of Care

In recent years the world has been facing major challenges in environmental, political, economic, societal, humanitarian, or medical contexts; furthermore, the recent COVID-19 pandemic has juxtaposed some of these, if looked from the angle of care.

As a response, our ambition was to explore how design could address these issues and develop a methodology that includes care as a strategy to generate possible solutions. We conducted an initial literature review (step 1 - figure 1) covering various contexts of care. We researched what contexts during the pandemic elicited matter of concerns due to an absence of care; these included (a) human careless attitude towards nature (Jax et al., 2018), (b) lack of care towards public healthcare (Yang & Zimmer, 2020), (c) disconnection of social relationships causing loneliness and isolation in elderly, children and adolescents (Loades et al., 2020; Zubatsky et al., 2020), (d) ethics of robot care-givers (Bertolaso & Rocchi, 2022; Leite et al., 2013), (e) growth in the gender pay-gap that disadvantaged women taking more caring responsibilities for family and children; on the latter, for instance, in 2020, women in the Slovakian education sector earned ca. 22 % less than men (Modranský et al., 2020,

p. 302); furthermore, editors of Australian science publications outlined that women in some disciplines published up to 50% less in 2020, compared to a year before, while submissions by men doubled (Nash & Churchill, 2020).

It needs to be noted that issues such as pay gap or caregiver burden already existed before the pandemic (Chatzidakis et al., 2020); however, statistics reported an increased divide when the COVID-19 pandemic hit the global population. Hence our motivation was to develop a scenario capable of shaping more equal futures across society, including culture, economy, politics and environment (Dunne & Raby, 2013), by using design to facilitate the development of new perspectives (Mayer-Johanssen, 2021). Therefore, our work moved to a second phase (step 2 - figure 1) through the question: How do we future care?

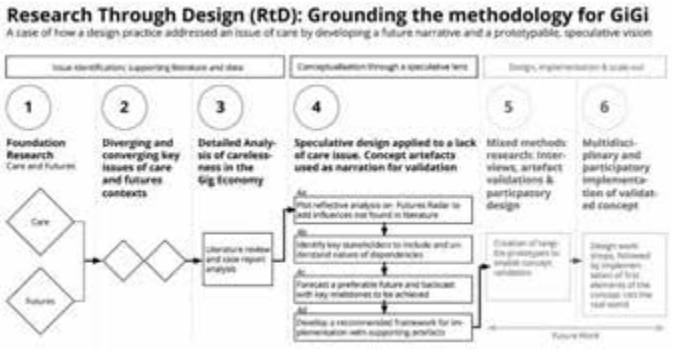

Figure 1. Overview of methodology of 'GiGi', following a Research Through Design (RtD) approach

By visualising different combinations of future societal scenarios in a matrix (adapted from IBM, 2018), we discussed, as a group of design multidisciplinary and multicultural design researchers, how we could draw connections between these and the issues of care, as identified in the literature. The matrix generated a very large pool of future issues in care, and we imagined how design could act upon them to prevent any further development and support future strategies of mitigation. From the literature review we identified that combining issues of gender bias and disadvantage and their related future projection share common factors; for example, the invisibility and inequality of women's work (society), the necessity of empowering women (economy) and gender biases in Artificial Intelligence (AI) technologies. These informed the next steps of the research.

Ways to Future Care and Foster Gender Equality

According to futurists there are three main classes of futures: possible, probable, and preferable (Amara, 1974; Bell, 2017a, 2017b; Heinonen & Ruotsalainen, 2013). We used these by asking *what are some possible, probable, and preferable ways we could design care to create gender equality in a desired future*.

We created the 'Futures Radar' diagram (figure 2) to position existing key issues and those that might become apparent through weak signals (Hiltunen, 2008) in the futures cone of possibilities (Voros, 2017) and plot them on a timeline: 1-3 years (short term), 3-5 years (mid term), 5-20 years (long-term); this helped us understand the likeliness and urgency of challenging issues and ultimately assign a 'lack of safety' index for women working in Gig Economies.

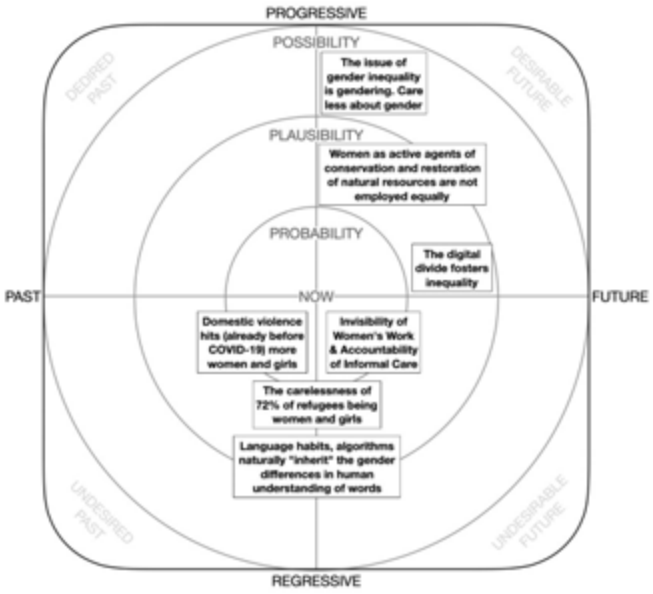

Figure 2. Futures Radar with examples of future issues in gender equality and disadvantage

We focused on the Gig Economy, as its self-employed model where a digital platform "facilitates and manage[s] interaction between buyers and sellers of services" (Goods et al., 2019, p. 505) suffers from the issues identified in the literature. We took the food delivery platforms as a case study, to outline how this industry doesn't "care" enough for its delivery workers, under the terms defined in this research. We used a Research Through Design (RtD) methodology (Zimmerman et al., 2007) to address the lack of safe zones for female food delivery bikers (figure 1). RtD offers a framework that structures foresight driven insights through research activities which are documented in and communicated through design artefacts. It aims to stimulate critical and reflective debates and new perspectives on matters that have been identified as being problematic (Zimmerman & Forlizzi, 2014).

Putting the importance of care and the carelessness in the Gig Economy into context (step 3 - figure 1)

The term 'gig' refers to the loose, irregular venues in the industry, which are also characterised by unstable income streams (Woodcock & Graham, 2020). Despite its instability, the (food) Gig Economy has generated positive aspects, which include flexibility in arranging work hours (Griesbach et al., 2019) or increase of income (Convery et al., 2020). Thus, the promise of a greater "flexibility and freedom" (Griesbach et al., 2019, 2) or "autonomy", as compared to other jobs (Goods et al., 2019, p. 513; Milkman et al., 2021, p. 358) has motivated many in joining these platforms.

The food sector has seen a rise of workforce personnel and revenues in the years leading up to the pandemic, and even more since 2020. In the USA the sector saw a growth in orders by +100% or more (Ecker & Strüver, 2022; Sumagaysay, 2020) and the percentage of female drivers has increased 22% (Delivery Drivers, 2020), which contrasts other regions of the world, e.g., a high number of job losses amongst food delivery drivers in India due to lockdowns during the pandemic (Parwez, 2022). Data from China, the largest food delivery market worldwide (Huang, 2022), suggests a strong increase

in food orders in 2020 with one of the leading platforms processing almost 30 million orders a day (Wu et al., 2022).

With the industry growth more issues surfaced, most likely linked to the interactions between drivers and the digital platform, and often caused by road traffic accidents or harassment. A "surveillance of workers through customer ratings and other performance measures" is reported by Griesbach (2019, 2) and, further, that the platforms' apps direct workers "where to go and what to do" (2019, 3), but leave them uninformed about the destination or to which customer an order must be delivered. As customers rate services according to the expected delivery time, platforms might penalise late arrivals, which leads to more pressure, hence more traffic accidents (Convery et al., 2020; Li et al., 2020). These are all issues caused by the lack of transparency in human-platform interactions. The working conditions do not favour the drivers, as they are unable to estimate the profitability of a gig (Griesbach et al., 2019) and the related exposure to risks (Kilhoffer et al., 2020). The status of self-employment as "independent contractors" (Ecker & Strüver, 2022, p. 6) or "delivery partners" (Parwez, 2022, p. 4) removes employment protection (Kilhoffer et al., 2020). If for some of the workers the engagement with the platforms for short term work is acceptable (Ecker & Strüver, 2022; Goods et al., 2019), others suffer from underpayment (Goods et al., 2019).

Our motivation to investigate this industry from a female safety perspective was led by data suggesting an increase of female workers during the pandemic for the opportunity it offers "to prioritise commitment to their children, families [...]" (Milkman et al., 2021, p. 364). Despite the benefits, the Gig Economies exposed women to different types of risks (Perelman et al., 2020); they are confronted with general discrimination during in job-application and compensation (Som, 2020) as women carry a higher burden of care responsibilities and cannot work in the most profitable evening hours (Atal, 2020; Dokuka et al., 2022). In some cases, women earn less than men, 7% in the case of US based Uber drivers (Cook et al., 2021). Other statistics indicate that women avoid night delivery in unsafe areas or that they are verbally abused (Convery et al., 2020). Hence, care and safety are matters of high concern, as there is a general lack of support by platform providers that is worsened by the absence of a community that could support them through the exchange of information about safety (Perelman et al., 2020).

Administrative bodies, organisations and platform companies have partially responded to these issues; 'Lieferando' with "regular employment contracts" (Ecker & Strüver, 2022, p. 8); Australia (Goods et al., 2019), United Kingdom or India (Parwez, 2022) with regulations for delivery worker safety and social protection; or Austrian food delivery company 'Velofood' through the drivers' self-governance of working schedules and a two-way radio type of app enabling communication between workers (Ecker & Strüver, 2022). Another alternative initiative is "platform cooperativism" which advocates more "democratic ownership models", such as cooperatives, that sets out the use of technology and innovation for the benefit of all (Scholz, 2016, p. 14; also, in Ecker & Strüver, 2022). Despite these, the literature does not indicate solutions that have a more strategic mid- to long term plan for changing the future of the industry by including care as a core component.

Future thinking and a speculative, collaborative lens to design and foster care (step 4 - figure 1)

Following the analysis of the food Gig Economy and the lack of care for (female) bikers, we aimed to "raise awareness" and act "as a catalyst for change" (Dunne & Raby, 2013, p. 33) by designing care through a speculative scenario and "communicating the results" (Frayling, 1994, p. 5) through our Research Through Design (RtD) methodology, see steps 4a-d, figure 1. The design choices must result in a future where (a) women's voices are heard, (b) safe environments for female delivery workers are established, (c) bias due to non-inclusion or disadvantage is avoided and (d) delivery workers co-participate in the development of more inclusive, safer, and caring working environments.

Employing a speculative lens with future foresight rooted in addressing the social issues uncovered through literature review, the strategy of our approach was (a) to identify and understand key stakeholders and the nature of their dependency, to ensure the right approach and target groups for an intervention; we also aimed to (b) forecast a preferable future (ca. 2030) for female delivery bikers that cares more for them, (c) backcast this future back in time to be able set achievable milestones to reach the preferable future and (d) develop a recommended framework for validation and implementation. These objectives have been developed as speculative concepts that prepare the ground for tangible prototypes. Hence 'GiGi', which is a sharable experience that engages key stakeholders and communities of users (Groß & Mandir, 2022) in co-designing a caring response to the unsafe female working conditions in food Gig Economies. With 'GiGi' we initiated a design toolkit with artefacts, such as storyboards that illustrate how empathy can be (co)created (Putnam et al., 2012) through the engagement of a target audience, i.e., the delivery bikers, envision a caring service of the Gig Economy (Reeder, 2005).

Through an extensive stakeholder analysis (Smith, 2000) that was guided by our set goal to avoid self-bias of missing out on all relevant, diverse groups of actors, we identified our key interlocutors: women in the food delivery sector, who act as primary users and beneficiaries of care in food delivery. We chose China as a first focus country due its large market and high number of delivery drivers.

Backcasting from the future

A backcasting map (figure 3) is a planning method that begins with the concept of the desired future and then works backwards to determine policies and programmes connecting the future to the present (Holmberg & Robert, 2000). Through this method we identified two questions: (a) how does (female) food delivery work look like in 2030? and (b) what if in 2030 gender equality has settled in and disadvantages for women in the food delivery industry are a thing of the past? Our backcasting concept framed the achievement of equality when women are empowered to step up from the passive delivery work to an active, managerial role where they can succeed as creative actors and contribute to develop strategies, in our case, for food preparation, delivery and consump-

tion. This concept stems from the United Nations' strategy on achieving "gender mainstreaming" (UNSDG, 2016, p. 7), which regards empowerment as essential for reaching equality. Empowering female delivery drivers means to help them direct their life, professional choices, career development and care responsibilities by providing access to and use of technology (Mackey & Petrucka, 2021).

Figure 3. Backcasting 'GiGi'

'GiGi' envisions the development of a physical and digital community that acts as a hub to empower women in striving beyond the limitations of the current platforms. It offers an alternative to the current dominance of food delivery corporations and provides them with training to elicit more inclusive and caring approaches to the Gig Economy.

The backcasting activity outlined three different horizons: short-, medium- and long-term. In the short term we envision the development of a female delivery driver community to promote a Gig Economy culture based on the values of care. In this community members discourage unethical behaviour (of persons or technology) and define safe spaces for driving. A series of improvements are envisioned to be implementable on short terms. This community will provide training on driver's safety and skill improvement and on-site childcare services which has been proved to be a key support to help women progress their careers (Goryunova et al., 2018; Madsen, 2018). To make software safer and caring we speculated that women could avoid unknown, unsafe, or unwanted areas for delivery (thus safer delivery route planning) or use an alarm functionality for emergencies.

In the mid-term horizon (3-5 years) we envisioned alternative opportunities for employment that enable female drivers to reinvent their professional self through coaching and training, especially by leveraging safe and caring technology as a door opener (Mackey & Petrucka, 2021). As illustrated by previous research in India and (South-) East Asia, consumers are open to food delivery via drones as an innovative and environmentally friendly transportation (Chen et al., 2022; Hwang & Kim, 2019; Mathew et al., 2021). This trend might determine the use of delivery drones, hence pilot training, and certification as upskilling opportunities for our target group. Such a transformation might stimulate more, e.g., that female drivers rethink how food can be produced, prepared, and consumed through more sustainable alternatives, like "urban farming" (Mok et al., 2020, p. 157) and "biodegradable [...] packaging" (Mok et al., 2020, p. 161). 'GiGi' Hub would cater for all this with a respective, physical space (figure 5).

Furthermore, the 'GiGi future of food lab' can engage chefs, futurists, designers and artists in collaborating with these women to raise questions that might even break established "food rituals and cultures" (Burton & Nitta, 2020, p. 29), and transform women to be fore-thinkers and entrepreneurs of the food delivery sector. As a physical and digital self-sustaining ecosystem, 'GiGi' can promote inclusive, caring, and sustainable innovation in the food industry by enabling career progression of women, delivery bikers, and anyone else in the industry. Such an entrepreneurial spirit encourages women in becoming more confident and financially independent (Agrawal et al., 2021).

The short-term nourishing of a culture of care and mid term logistical and technological transformation of the food industry can develop long term impacts in the urban infrastructure. With the introduction of more autonomous systems (Zádor, 2022) that support an entrepreneurial culture to sustainability via the production, preparation, and consumption of food as well as more efficient delivery infrastructure could move the human from passive to active roles.

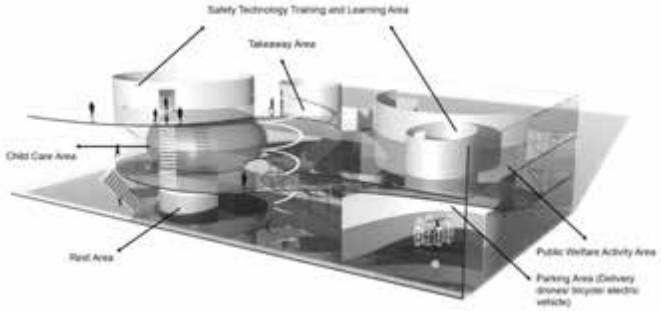

Figure 4. Speculative artefact, a conceptual model of 'GiGi' Hub, visualizing various service areas

Discussion: A Different Approach to Care, Empowerment and Leadership

Through the backcasting strategy we designed a funding map that can lead to the introduction of a business model (figure 5). It would use any of the three stages to create safe spaces for women (care), foster autonomy (empowerment); transform the industry (leadership). To contrast the majority of food delivery services that are managed by tech-companies and have the main purpose of developing profit (Perelman et al., 2020), we developed a platform supporting learning, knowledge exchange and leadership ideas of commoning resources and knowledge (Simonovits & Balázs, 2022). The 'GiGi' Hub is envisioned as a not-for-profit, community-driven, and caring support network.

Figure 5. A not-for-profit model for 'GiGi'

To prepare for validation sessions (step5 - figure 1) we conducted n=4 pilot interviews in China to validate our study protocol and the presentation of the platform. Participants were asked specific questions and shown a storyboard (figure 6) that describes the three temporal stages and key facts through an illustrated narrative and tasked to comment. We used a future scenario to improve the legibility of our proposed solutions during the interview process, and to support our observations and analysis of the participants' responses.

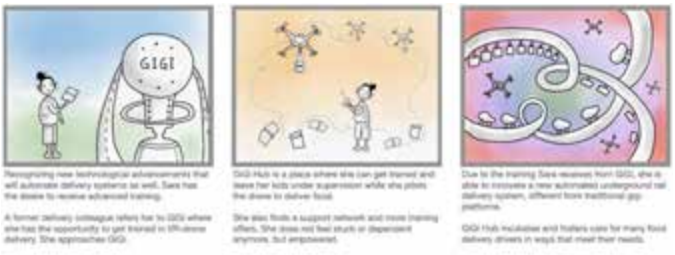

Figure 6. Storyboard (excerpt) to narrate the future vision of 'GiGi' to project stakeholders and future study participants

Here, we report first insights that give indications of the 'GiGi' acceptance rate, while stressing that these were pilot sessions and do not represent a statistically sound sample. We received feedback e.g., regarding our strategy to empower women; all interviewees considered the envisioned efforts as beneficial but challenged whether the model financially sustains as food delivery has very small margins. Another participant suggested improving our strategy of communication, which needs to be attracting more women to join 'GiGi' hub with its training and career development opportunities because many women choose not to opt-in to platforms as those are not offering career development for new female drivers. Confirming both positive aspects and a lack of care in food delivery, two women highlighted how they love the sense of control over her life when driving her scooter but find deliveries to distant locations truly terrifying. One participant also emphasized the issue of pressure by their platform's apps, e.g., when driving in difficult weather conditions and panicking as new orders came in and prior ones running out of time.

It needs to be noted that this is a very early-stage study carrying its different limitations, which include the demography of the sample and the accuracy of the business model.

Limitations and Future Work

Our work has initiated discussion and critique towards the lack of care in the Gig Economy through a speculative Research through Design approach; despite several limitations, our research identifies opportunities for further research.

The speculative case of 'GiGi' needs prototype testing and analytical research to increase the provision of care and safety for female delivery drivers. At this stage we are not able to provide tangible prototypes that could be experienced in the real world. Nonetheless, we are driven to continue developing such research by conducting tests with female delivery drivers across different cities, cultures, and local needs in different social and professional contexts (step 5 - figure 1). Furthermore, we need to combine the speculative approach to a transdisciplinary strategy to further leverage knowledge from designers, architects, city planners, artists, technical experts, and social scientists to prove its technical and economic viability (step 6 - figure 1). Drone technologies, e.g., might face issues of technical feasibility or in terms of security or data privacy. Further studies might include testing with existing food delivery services, which have their own business models and technology needs.

Finally, we are aware that empowering women in existing constructs of care responsibilities and food might not be the truest form of social liberation. The consequences of misogyny aren't yet tackled, and rehabilitation against harm doers was not considered (Manne, 2018). The roles prescribed for men through societal expectations should be equally considered when securing safety for women.

Conclusion

While the Gig Economy and its platform services such as food delivery provides benefits to their customers such as convenience, ease of use or, as observed in the COVID-19 pandemic, a provision of food for persons isolated in their homes, with this study we aimed to design more caring Gig Economies by empowering women and transforming their role in the industry. Our research identified deficiencies in the support and service policies for female delivery workers including gender pay gap, surveillance by and entrapment in digital systems as well as dependency on those for earning money, failures to provide future-proof career development opportunities and job safety or dangers of assault or harassment, isolation, and a lack of cultural solidarity.

Our response to these issues, 'GiGi', envisions a possible three stage future scenario in which female delivery drivers are more cared for and professionally supported. By creating a narrative describing near, mid- to long term futures we presented the value that a Research through Design approach plays in finding alternative solutions that are more aligned with values and people's needs. Employing critical and speculative perspectives on the issue of carelessness had a strong impact on the rigorousness of our research group's approach to analyse the problem space and supported the development of a speculative service solution, 'GiGi'.

Future work into real-world prototyping and validation of the visionary concepts should focus on generating first hand insights of users and stakeholders to go beyond the current phase's stage of narrating a possible future of female delivery bikers in the food delivery industry and start materialising research through detailed design and development (Frayling, 1994).

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Winning at more than a game! A storytelling board game concept to raise awareness about refugees' language barriers

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Abstract

Games are an intermediary medium to attract people and help them spend their leisure time in a pleasant way. However, games are also open to utilisation for different purposes such as educating people, guiding professionals to specialise in their field, changing behaviours, and creating awareness about social issues. Combining social issues that no one wants to talk about with real stories that help engage the players' interest in those issues through games and their mechanics leads players to question the given topics.

This study takes a research through design approach to identify the potential of a storytelling board game concept to raise awareness about societal challenges. The game - called Can You Survive? - uses storytelling as a way to reflect on the experience of the ups and downs of the language barrier refugees deal with and to interactively form an empathic understanding of underrated challenges. To understand the potential and benefit of developing such a board game concept, the first author reviewed literature on storytelling and serious games while also researching examples of existing serious games that illustrate social issues. Based on this, they designed a board game prototype which was then evaluated and developed iteratively through three co-creation workshops. As a result of the research process, the final version of the board game was designed. Research and design of storytelling game concepts tackling serious societal issues are limited. Therefore, this paper offers researchers and practitioners an alternative medium of storytelling combined with a board game to highlight societal issues since it helps engage players, motivates them, and creates empathy towards the people and issue in focus through the use of storytelling and game mechanics. Besides promoting awareness, it also prompts reflections on an individual's own experience and assumptions held around the specific issue. Future work can also examine how might such a storytelling board game be utilised to spur action among individuals and communities.

Author keywords

serious games, social design, storytelling board games, refugees, inclusive design

Introduction

Globally, people are subject to societal problems, although some affected more severely than others. While it may vary across countries, one thing remains constant - few want to speak about them even though the accompanying challenges affect society in various ways. In addition to having a direct impact on many people, social problems also indirectly affect all of us (Glicken, 2011). There has been an increase in the number of people forced to migrate under duress as a result of climate change, long-term conflicts, disease outbreaks, and food shortages in recent years (British Medical Association, 2019). UNHCR (2020) announced that by the end of 2019, the number of people forced to flee their homes due to war, conflict, persecution, human rights abuses, and other disruptions to public order had risen to a record high of 79.5 million, with 26 million of them being refugees. Unfortunately, refugees have mostly become an undecipherable and a neglected topic, even though the directly affected population is enormous. Along with the global increase in the number of refugees and asylum seekers, the worsening wellbeing situation is becoming a far-reaching problem. Depending on where you come to the country as a refugee or the applied strategies of the government regarding refugee issues, a refugee is likely to face various economical and social difficulties on a different level. Moreover, especially language and communication barriers affect a refugee's daily life and one's feelings, leading them to feel lonely and rejected by society. In order to successfully integrate into the society and economy, post-immigration language skills are necessary (Hou and Beiser, (2006, p. 155); van Tubergen and Kalmijn, (2009), as cited in Watkins et al., (2012)). Another study shows that service providers working with immigrants and residents with migrant backgrounds both mentioned language barriers as the most common challenge they faced (Samkange-Zeeb et al., 2020). It is an undeniable fact that lack of ability to speak the local language is preventing the refugees' social well-being boost and contributing to social exclusion. Therefore, it needs to be considered as a big challenge that hampers refugees integration in society. Individuals are mainly unaware or choose to ignore the reality of refugees since they have no idea what it means to have been forced to flee and adapt to another country where they do not know the local language.

Dealing with wicked problems requires competences and knowledge from various scientific domains (Frishammar and Ericson, 2018). Manzini and Coad (2015) indicate that along with NGOs and civil society associations, individuals, families, and communities must be eager and collaborate more for the millions who have left their homes seeking better lives due to several other drivers of migration as well. From a creative competence perspective of society, designers also need to be part of the solution offering innovative alternatives, which might lead to awareness of refugees' obstacles and subsequent redressal of their issues. Therefore, how can we harness design in such a way that it creates empathy and promote awareness?

Storytelling to create empathy

Skaraas and colleagues (2018) state that as a measure of how we handle the world, empathy is probably the most commonly cited. Therefore, as a society, we have to pay attention to refugees' feelings and the problems they deal with in their living conditions. The difficulties encountered and the constant situational changes give rise to several compelling stories. Mar and Oatley (2008, as cited in Dillon, 2021) mention that stories may play a significant role by reducing bias against outgroup members. Storytelling serves as a moral guidepost as well as a quick and vivid way to share information, sell lifestyles, spark change, or inspire others (Huber, 2018). Storytelling is a way to convey a message and ensure that everyone pays attention to it. Therefore, crafting stories based on the social challenges visible or telling those stories helps reach many people and create awareness about the given topic. On the other hand, narratives are a diverse and numerous form of expression, ranging from oral histories, literature, films, and even games (Kampa et al., 2016). Furthermore, making storytelling more interactive and creating more engagement might help to create more impact on society. As for making storytelling interactive and creating a medium where to engage with others, games would be one of the first things that come to mind.

Serious Games, Storytelling and Awareness

Games are an intermediary medium to attract people and help them spend their leisure time in a pleasant way. Apart from their playful function, games also offer a way to explore and explain complex social issues in a less intimidating way (Gomes et al., 2021). There have been numerous attempts in recent years to apply games and game-like methods to serious issues and discussions (Castronova and Knowles, 2015). A truly global group of practitioners, civic leaders, health and human rights advocates, educators, gamers, and researchers is increasingly interested in using games to educate, motivate, and change behaviour (Ritterfeld et al., 2009). Moreover, Serious Game research has been growing in the past few years, namely by trying to construct supporting theoretical frameworks and identifying the most effective design, implementation, and validation methodologies and models for each particular area of application and for each particular target group (Vaz de Carvalho et al., 2021).

Storytelling is beneficial to engage with players and embrace the message in the games not only for fun purposes but also with serious content. For example, a case study used the narrative storytelling approach in the game AirXorcist to create awareness among the public about air pollution. The article states that as a result of interweaving air pollution facts into the storyline, games do result in learners learning about air pollution facts while enjoying themselves (Jupit et al., 2021). Kampa and colleagues (2016), also mention that by incorporating narrative elements, game designers can convey a deeper meaning or purpose behind the game, often for educational or training purposes. On the other hand, McDaniel and colleagues (2010), stress that players can feel demotivated by the inconsistency between the game's story and its learning content if they do not feel like they are progressing in the game. In line with that, Naul and Liu (2020) also reflect that creating immersive, motivating, and engaging learning experiences requires storytelling more than just adding story elements to serious games. Therefore, the relationship between the content the designer wants to promote and the way of the implementation should be built attentively while designing the whole game with serious content because the game environment allows the players to experience something while enjoying the game as well. In addition, Schell (2015) suggests that both stories and games can be viewed as machines that create experiences. Suter and colleagues (2021) state that each type of text with its own narrative mechanics is astonishing and excites readers. Serious games are open to engagingly addressing urgent social issues, as well as discussing actions and solutions. When properly encouraged and valued, serious games are proven to be innovative products for tackling social problems and for promoting social innovation (Gomes et al., 2021). However, the use of commercial board games as serious games has not been common; digital games have been preferred by far (Castronova and Knowles, 2015). The use of board games for serious games applications is not usually considered, but there are numerous advantages such as modifying the game dynamics by using pen and paper without needing any coding knowledge, availability for implementation into various topics, providing a small group environment with face to face interaction, and portability of the game (Castronova and Knowles, 2015).

Material and Methods

This paper employs research through design (RtD) approach to create a storytelling board game concept to communicate refugees' language barrier and raise awareness about it. Through iteratively reframing the problematic situation and the preferred state as the desired outcome of the research, RtD is best suited to addressing these problems due to its holistic approach to integrating knowledge and theories from across many disciplines (Zimmerman et al., 2010). Akmal and Coulton (2019) state that a series of iterations of a game consisting of design, playtesting, and feedback is the most common approach used when developing games. In this research case, the board game design process includes several design iterations, game playing, and feedback sessions during co-creation workshops between the versions. The desk research was used to shape the design of the game prototype versions 1.0 and 2.0 (Figure 1) in terms of the insights regarding obstacles refugees deal with, game elements and its mechanics. Utilising the version 2.0 prototype as a workshop material, three workshops were conducted with a total of 11 participants to develop version 3.0 (Figure 1).

Figure 1. From left to right, the version 1.0, 2.0 and 3.0 of the game "Can you survive?"

The participants were chosen based on the criteria of experience of language barrier, familiarity with refugees and frequency of playing board games to attain diversity. The details regarding the workshop participants listed below:

- **Workshop 1 - All international students studying in Sweden**
  All 4 international students mentioned that they have experienced language barrier. There are refugees around two of them. Frequency of playing board game was always, sometimes (2 persons) and rarely for this group.
- **Workshop 2 - All locals living in Sweden**
  All 4 locals except one mentioned that they have experienced language barrier. There are refugees around three of them, one was not familiar with them. Frequency of playing board game was sometimes (3 persons) and rarely for this group.
- **Workshop 3 - Mix of locals living in Sweden (1 person - other participant canceled last minute) and international students studying in Sweden (2 persons)**
  All 3 participants mentioned that they have experienced language barrier. There are refugees around two of them, one was not familiar with them. Frequency of playing board game was always (2 person) and sometimes for this group.

Each co-creation workshop included four parts: ice-breaker, pre-game mini-focus group, game-playing and post-game mini-focus groups.

Ice Breaker

The co-creation workshop started with an ice-breaking session for participants to get to know each other and ease the rest of the process.

Pre-game Mini-Focus Group

The pre-game mini-focus group was conducted to gather opinions about the language barrier that refugees struggle with during their integration into society. The discussion questions are listed below:

1. Have you ever been in a situation where you experienced a language barrier? If yes, how was the situation? How did you feel?
2. How would you describe social issues from an immigrant's perspective?
3. What do you think is the hardest challenge for those who have migrated with the language barrier?
4. What do you think about the attitude of society towards refugees?
5. Have you ever played a board game that stresses societal issues?

Game-Playing Session

The game-playing session (Figure 2) was based on playing the board game prototype to test it. The participants started by randomly choosing their characters and playing the game based on the rules.

Figure 2. From left to right, captures from game playing session from workshops 1, 2 and 3

Post-game Mini-Focus Group

Another mini-focus group followed the game-playing session to collect insights about the board game itself, game dynamics, the impact of the board game, and feedback to make it more impactful. The prepared questions are listed below:

1. You have just experienced the game. What would you say about the game and the theme? How does it meet the purpose of the game?
2. How did you feel while playing the game from the first moment and the last minute? Could you mention it specifically?
3. What do you know now about the experience of the ups and downs of the language barrier that refugees deal with that you did not know before? How does this impact your view of refugees?
4. What would you say about the strength and weaknesses of the game?
5. What needs improvement to make it more impactful?
6. Suppose you were in charge and could make one change to improve the game. What would you do?

After these co-creation sessions, the latest version of the game was designed based on the feedback.

"Can You Survive?" - A Storytelling board game concept

Objective of the game: The player with the highest positive mood points, which means happiest on the final point of the play, wins!

Game Materials: The game material is composed of several elements listed below.

- A game board: The board is designed to exhibit the language and communication challenges, enriched with stories of the characters, and illustrate the phases of their journeys. The game board is divided into three levels where one progresses from being a stranger to becoming a local in the society.
- A deck of cards: The cards include the elements representing the challenges with different shades of the colour orange, and special ones help the players during the challenges. Each level has its own challenges inspired by real life. Translation challenge entails that the player needs to translate the phrases in various languages. Charade challenge requires that the player

use body language to describe the daily life situations such as bug invasion in your kitchen. The last challenge is explaining the word or phrase using the language everyone understands. Neighbour support and translator help cards are special cards.

- Four character cards and their corresponding story cards: The character cards includes the backstory of a representative with several skills regarding language and communication. The story cards bear stories customised for each character placed on the board supporting the story and engaging with the players.
- Other materials: character tokens, instructions, mastersheet, mood point chart, badges, D3 or D6 dice, and 60 second sand timer.

Gameplay: Each gameplay starts with four players equipped with selected character tokens and rolling the D3 dice. It is a mechanism to move the player on the board with the blocks where some statements are written. These statements have different consequences that might change based on the story of the player's character. Some of them are equally valid for all participants. Challenges and the game dynamics are kept realistic, inspired by real challenges, and interpreted from a game perspective. According to the game perspective, games normally start with easy challenges and become harder depending on the level. Contrary to game perspectives, life and the challenges that refugees face become more manageable when the language is learned and integrated into society to some extent. Until that time, the journey has already been challenging for them. For example, the players face the hardest challenge at the beginning which is the translation challenge, followed by the easier one, the charade challenge in the second level, and explaining the word using the language every player understands in the last level. Each challenge needs to be completed in 1 minute. Every move and challenge results with earning or losing mood points. At the end of the last block, the player with the highest positive mood points wins!

Storytelling: Storytelling is one of the elements in the game, which while conveying the message and creating a game experience, supports the understanding towards the marginalised group via board game mechanics. All game mechanics support storytelling as an element and the whole game itself is a story. As Aristotle explains, the story is composed of three parts: a beginning, a middle, and an end (Dahlström, 2020). During the game, each participant starts a journey with their characters from the starting point "Welcome to the country!". The journey continues through several adverse challenges and positive experiences customised for the represented character with the subsequent consequences. The challenges end with the last block, which gives the player an ending with a strong message saying their characters survived the real journey, which is full of ups and downs. Furthermore, this journey ends with a message for all players questioning the whole journey through the game's final question - 'Do you think you can survive?'. In the board game context, the text is a vital storytelling element since the emotions may be conveyed through texts and help capture reality. In addition, the text customises the language and context using a personal perspective. For example, "I tried to find anyone who speaks my native language in my neighbourhood" instead of "you tried to find anyone who speaks your native language in your neighbourhood."

Research Findings

The data collected from the three co-creation workshops is analysed using thematic analysis. Thematic analysis is a method used to analyse qualitative data such as interviews and transcripts by grouping based on similar patterns (Maguire and Delahunt, 2017). The following section describes the research insights.

Assumptions vs Reality

The participants have some assumptions regarding the hardships of the language barrier that a refugee can face, but their familiarities regarding the given topic are limited. Their experience is based on communication level such as lack of proper communication or misunderstanding, which causes feelings of frustration, stupidity, stress, and embarrassment. However, almost all participants have no interaction with refugees in their daily life context except on few occasions.

Promoting Awareness

Participants thought the game itself shows the real experiences regarding language barriers. The game helped some participants realise the challenges based on the given topic and develop different viewpoints.

"I understand how difficult it was, like language barriers. Because we take everything for granted, like we understand everything here in Sweden. But like if you come here and everything's in Swedish, like I can understand why it's so difficult to integrate sometimes."
- Local 4 from W2

"... Maybe trying to be more understanding if someone doesn't speak English. Because I feel like for us that's very likely in Europe, it's a very normal thing. But in other regions of the world, it's not. So maybe you are trying to be a bit more understanding and not being like why can't you! But being okay, how can I react better in the situation?"
- International student 3 from W1

Unlike understanding the challenge, one of the local people mentioned that he did not learn very much because of his previous experience with international students. On the other hand, there was another comment regarding a long-term perspective that he does not know how the game will impact his acts. Some of the participants realised the patterns and reflected on the correlations between the game dynamics and real life. Creating game mechanics based on real-life activities helped the players understand reality better.

"Yeah, I guess just realising that you are the neighbour's support for them."
- International Student 4 from W1

Eliciting Empathic Emotions

During the game-playing session, the players experienced different feelings such as fun, desperation, excitement, and relaxation after the players moved their characters on the specific experiences represented on the board. The fluctuation of emotions made the game more fun and engaging emotionally. In addition, the players experienced daily life challenges in fun ways like charades. However, after they failed several times, they started feeling different emotions.

While having fun during the game, the following hardships consistently made the people feel disappointed and frustrated, which further led to them to feeling demotivated. For example, a local participant was stuck with taking several steps back consistently in the game, and it made him feel unmotivated since the others were moving forward very quickly. Therefore, the game mechanics should be well thought of from every perspective.

"... It's still making the story and message for a very good game. And it's, it was engaging, we were having fun all the time, actually, which is very rare for some games. In some cases, it gets very dull, very, very quickly ..."
- Local 1 from W2

While conveying the message itself works well, some limitations prevent the participants from engaging. The first limitations were game rules and game dynamics. The participants think the rules need to be more precise, and some more rules are needed. The participants also mentioned that the stories were essential in engaging with the game itself. However, it needs to be improved considering the relationship with the other story elements. The story-related quotes need to be more engaging, so the participants can read and feel the situation. The participants quickly read the story-related blocks after a while. While discussing the game's improvements or impact, some participants bring the possibility of the actions to the table.

"... Honestly speaking, it's like, maybe this is gonna sound way harsher than what I wanted to say. It's like, but what can I do? Because it's like everyday life, it's not like I'm interacting with refugees or not in some sort of organisation, or charity or something that can help them. So I understand the struggle that... I do not understand, obviously, fully the struggle that they're facing, I understand that they face challenges, now I'm aware of it. But what can I do about it?..."
- International student 1 from W1

Conclusion

This research aimed to identify possibilities for promoting awareness of refugees' language barrier by adopting a storytelling board game concept and developing the game prototype with various co-creation workshops. It is really hard to understand the language barrier through simple explanations since it has to be experienced or explained in such a way that might have an impact. Mar and Oatley (2008, as cited in Dillon, 2021) advocate that stories may play a significant role by reducing bias against outgroup members. Based on the analysis of the co-creation workshops, it can be concluded that the storytelling game concept is likely to be used with the purpose of raising awareness of social issues since the players agreed that the board game prototype reflects the content very well with the challenges of the game. The board game is also a promising medium to convey serious content with several advantages such as being able to iterate without spending extreme efforts, feasible to interact with the other players in person, and learning from each other. Besides raising awareness for the given topic, the players acknowledged that another potential of the game is to consider the individual actions and solutions because there are limited familiarities with the refugees and limited experience of language barriers affecting their daily lives. Through the use of real stories, the participants realised the correlations between the game dynamics and real-life interpretation that made them empathise and engage with the characters to some extent. The results indicate that storytelling and game dynamics play an essential role in engaging with the players while conveying the message. The relationship between storytelling and game dynamics such as characters, plot, and texts need to be designed attentively. The board game might have limited visual or audio support, but the text-based stories and journey integrated with fun game dynamics also help the board game convey the message and engage with the player. The co-creation workshops provide further comments that advance the game regarding rules, elements, narrative, and impression. In addition, the whole iterative design process of the game demonstrates that iteration improves the game since it leads the designer to see missing parts and provides an opportunity to better shape the game by understanding the target group's perspective. It supports the theory of an iterative approach to game development (Akmal and Coulton, 2019). Even if there are high possibilities to promote social awareness, there might be some barriers, such as language and cultural differences, reaching the target group to make them play it and propagating the game. Further, while players may empathise with characters and their stories, the game possibly falls short of spurring action amongst individuals.

Further Research

Further studies could focus on conducting co-creation sessions with people who work in the public sector, such as teachers, doctors, and social workers since they are the ones who possibly interact more frequently with the refugees. One of the possibilities could be using this prototype as a tool or pioneer to question actions or solutions. Further research is needed to determine the relationship between the games and their possibilities of being social innovation tools and adapting the game as workshop material to generate ideas. In addition, even if the game helps raise awareness of the given topic, one question arises: What happens after the game? Further research could address the success of the game's long-term effectiveness with the potential of leading behaviour changes after playing the game.

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Cities for all: co-design interventions on urban features by using inclusive technology

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Abstract

All residents of the city should have the right to access, occupy, and produce space to their demands and desires. Cities and public spaces are not for a particular group; they are for everyone's use, including people of different ages, genders, races, and abilities. However, participation, mobility, and engagement levels vary among different people. Minorities in particular are challenged by segregation and inhibited from participating in the city. Designers, local governments, non-governmental organizations, and social enterprises are responsible for providing solutions to this problem. This paper introduces a multidisciplinary project, HeyKENT: Inclusive Urban Experience For All, which aims to increase the civic participation and engagement of all citizens with urban features, regardless of citizens' abilities. The project was designed by PinGOin, a social initiative that aims to reduce inequalities in social life. The collaborative project was conducted and monitored by two designers, local volunteers, and two Metropolitan Municipalities in Turkey. The project's primary outcome was a co-design intervention conducted in two cities with existing urban features using inclusive technology. Twelve urban sculptures in the first city center and 15 different tree species in an urban park in the second city center were determined. The project entailed accessible signboards with QR codes next to each urban feature that led to online video modules. The video modules, co-designed with diverse volunteer groups, were intended to be accessible to people of different ages and abilities (e.g., people with visual and audio impairments, children, the elderly, and tourists). Each video includes visuals, general narrations, audio descriptions for blind visitors, and sign language translations for deaf visitors about the urban feature. Thus, this project is a new approach in Turkey in which urban features of the city are equipped with multisensory features so that people of different ages and with diverse abilities can experience them. It is also a new application of inclusive video narrations for diverse users that are presented with accessible signboards. This design application helps to improve the participation and engagement of citizens with diverse abilities, enhances user interaction with urban features, and cultivates public awareness toward different accessibility criteria. It advocates civic participation and leads designers and local governments to consider inclusivity features using collective design intervention in a public space. In the project's next stage, users' engagement levels and the factors influencing their experience will be studied by a post-occupancy evaluation using observation and survey methods. The follow-up research outcomes will provide additional feedback to enhance future interventions' design processes and outcomes.

Keywords

city, co-design, design, inclusive, urban feature

Introduction

People of all ages, genders, ethnicities, and abilities are welcome to use the city and its public places, which are open to everyone (UNESCO, 2016). Everyone has an equal right to participate in city life and social interactions (Arnold, 2007). However, people's levels of inclusion, participation, and engagement in the city differ. Particularly children, the elderly, women, and those with various abilities have challenges participating in the city. The environment should ensure all citizens' participation through inclusive design.

Designing products and/or services that are usable by as many people as possible without special adaption or unique design is known as inclusive design (British Standards Institute, n.d.). An inclusive environment should allow everyday activities to be carried out comfortably, effectively, and safely without restrictions of poor design, maintenance, or management of the environment (Hanson, 2004), including the urban environment. This could be ensured by offering accessible physical, intellectual, and emotional solutions for as many users with diverse abilities as possible. However, it is seen that the inclusivity of the urban environment for all is limited to the physical access of the citizens. The information and service accessibility is not highly focused (Rebernik et al., 2017). Therefore, in this paper, we focus on the inclusivity of urban environments, in terms of information and service accessibility, by using co-design intervention projects with specific urban features that are the natural or built main components of the urban environment in continuous relation with people (such as streets, squares, parks, trees, monuments, sculptures, etc.) in different cities of Turkey.

Participation Right of All to the City

Many studies have discussed the importance of the participation of all citizens in the city. In the urban context, Lefebvre developed the vision of the "right to the city" by asserting that the city is a space that is the center of humanity, not the capital. He portrayed a collective rather than a personal entitlement to the city (Donahue, 2022). First, he highlighted the city's "centrality" and the opportunity to provide a physical space for interpersonal communication and interaction among the citizens. Second, he conceptualized "the right to difference" offering the city to embody everyone who lives in it rather than a homogenization of space (Galič & Schuilenburg, 2020). Third, with "complete usage" he conveyed all citizens' entitlement to appropriate their everyday life. In summary, the form of a city should be flexible and adaptable to the needs and perspectives of everyone (Lynch, 1964), which is possible through the participation of all in the city (Galič & Schuilenburg, 2020).

People with diverse abilities have always been part of urban life. The United Nations Convention on the Rights of People with Disabilities acknowledges the right of people with disabilities to fully participate in society without mistreatment due to their different access criteria (CRPD, 2022). Inclusive design efforts impact the effectiveness and utilization for all users (Repeva & Adjide, 2020). However, the lack of accessibility in an urban environment still makes it challenging to fully include people with diverse abilities (such as people with hearing or a visual impairment, wheelchair users, crutches users, etc.) in all aspects of social life (Gharebaghi et al., 2018). Similarly, children are part of society. This is supported by the United Nations Convention on the Rights of the Child, which argues that children need to be able to participate in their communities' urban, cultural, and artistic life (Mai & Gibson, 2011; Terreni, 2013). Another diverse group to consider is that of older adults. Age-inclusive cities should be sensitive to changes in the bodies and cognitive levels of older people. Their choices, decisions, and ways of life must be regarded in urban environments. Additionally, a city should consider the orientation of older people when integrating technology (Tymkiewicz, 2019). To summarize, when designing an inclusive city, the city's stakeholders (such as designers, local governments, non-governmental organizations, and social enterprises) should consider and include, with a multidisciplinary approach, people with different access criteria.

Inclusive Design Solutions and Smart Cities

In recent decades, a smart city approach has been embraced to create inclusive cities. This is an urban development vision to integrate technology to improve the efficiency of services and allow stakeholders to interact with the community and the city to increase the quality of life for all citizens. The smart city concept is usually contextualized as technology, people, and institutions/governments (Castelnovo, 2015; Ishida, 2000; Mohanty et al., 2016; Nam & Pardo, 2011; Stadler, 2013). Although one of the considerations of smart cities is physical accessibility (i.e., the opportunity for everyone to access and use different parts of the city equally), the environment's design should also consider intellectual and emotional access (O'Neill, 2002). To create inclusive smart cities for all users, the application of co-design processes with different stakeholders and integrating digital dimension has been applied to increase the civic participation of citizens (Rebernik et al., 2017), mainly in open and enclosed public spaces.

Inclusive Interventions in Open & Enclosed Public Spaces

As public spaces, museums are one of the most often visited spaces in the city (Filova & Rollova, 2019). Museums are traditionally designed as venues where objects are displayed relative to different fields. Lately, modern museums also incorporate spaces and functions such as exhibition areas, art workshops, libraries, and recreation areas (Öden, 2020). Since these spaces offer visitors a combination of education and recreation (Filova & Rollova, 2019), designers have incorporated inclusive design solutions. Previous studies have focused extensively on physically accessible design, inclusive services, and information. The use of inclusive design tools and technology within participatory exhibition design, allowing for a multisensory experience that includes touch-based, hands-on exhibitions and storytelling, are among the design features (Chick, 2017; Christidou & Pierrou, 2019; Cullen & Metatla, 2018; Filova & Rollova, 2019; Görel, 2019; Hadley & Rieger, 2021; Ruiz et al., 2022). Recently, in Turkey, a social initiative named Bongo Art Project collaborated with the Anatolian Civilizations Museum and designed a multisensory exhibition area where visitors can touch the 3D-printed touchable replicas of display objects. The inclusivity of the display object is enhanced by audio descriptions and sign language narrations accessible by QR codes, which improve accessibility by means of quick and direct access to information and by eliminating the need to type (Kulturlimited, 2022). Thus, the display objects become accessible, especially for people with visual or hearing impairment, children, and consequently, other museum visitors. Through recent studies and collaborative projects, museums are progressing in their provision of an inclusive environment for diverse visitors.

The urban public space has a rich tangible potential of visual, audio, and spatial data such as streets, trees, sculptures, traffic noise, etc. In this manner, the urban environment is a kind of open-air museum (Lynch, 1964; Saidi, 2012). The characteristics of the urban environment show similarities with the museum regarding providing sensory experience and opportunities for learning and personal growth. They offer visitors a new experience as well as learning and entertainment opportunities through the living and changing structure. However, to some extent, they differ due to their scale and position in the city. As such, visibility across urban routes, security, vandalism, and outdoor conditions should also be considered in inclusive urban design. Experiencing the urban environment to its full potential is possible where significant urban features can be experienced daily as a part of everyday practices. Streets, squares, parks, trees, urban sculptures, etc., can all become a part of this enriched multisensory experience.
Studies reveal that within the urban context, people with diverse abilities face the obstacle of not receiving one or more of the channels of information provided by visual, auditory, or spatial cues due to a lack of inclusive solutions (de Oliveira Neto & Kofuji, 2016; Durhan & Özgüven, 2013; Hanson, 2014; Saidi, 2012). Many studies focus on physical accessibility, highlighting inclusive design guidelines and providing checklists for the urban environment (Plouffe & Kalache, 2010; Setiawan et al., 2022; Van Herzele & Wiedemann, 2003; Offei et

al., 2017). Furthermore, regarding digital accessibility, several studies focus on geographic information systems (GIS), roadmaps, and navigation tools to ensure citizens' movement and wayfinding in the urban environment (Fernández-Díaz et al., 2022; Svennson, 2009).

Despite the potential that cities offer, urban features can only be experienced extensively by some citizens. Hence there is a lack of information, implication, and integration (Salha et al., 2020). In that respect, diverse design solutions to enhance accessible information and services are still needed (Rebernik et al., 2017). This can be provided through a collaborative design approach that includes different stakeholders as well as people with diverse abilities. Here we describe a collaborative co-design intervention designed and conducted with a focus on service and content accessibility of urban space to contribute to the field.

Inclusive Urban Experience for All

HeyKENT: Inclusive Urban Experience for All, facilitated by the PinGOin social enterprise, is a collaborative social awareness project that supports an accessible social life for everyone. In this social enterprise, we work for people with various accessibility criteria, including people with disabilities, children, the elderly, and anyone who may encounter barriers in their social life. Approximately eight million people with disabilities live in Turkey (TUIK, 2011). Including children and the elderly, the number of people with special access criteria in this society is considerable. However, in Turkey, people cannot fully participate in their cities due to physical and behavioral barriers in places and a general lack of social understanding and awareness. We concentrate on areas where individuals with disabilities and different access criteria are not receiving equal opportunities for socialization with a rights-based and collective working understanding. For this, we first aim at *bringing people together*: without any barriers, people with and without disabilities are brought together through the organization of educational events and workshops in inclusive environments. Additionally, the accessibility level of social places (such as parks, museums, and restaurants) is listed and shared with users, through the help of volunteers, on a user-experience-oriented website. Second, we aim at *making it better*: our team consists of interior architects, communication designers, and psychologists who provide inclusive solutions through consultation to improve the accessibility of public spaces. What matters most is creating a connection and improving the communication between users' needs and social places, urban environments, and local governments. As such, the following project was facilitated by our social enterprise.

The Background of the Project

The inclusive city community project, initiated within two years, is a multidisciplinary co-design intervention project funded by international organizations. The project aims to increase the civic participation and engagement of all citizens with urban features, regardless of citizens' abilities. The collaborative project was conducted and monitored by a social enterprise that the first two authors co-founded. Moreover, two local governments in two metropolitan cities in Turkey participated. As a bridge for municipalities to meet and cooperate with civil actors, an international foundation, the National Democratic Institute, funded the project. Within the scope of this program, local volunteers of the social enterprise were included in the co-design process. The project started in Eskişehir (the first metropolitan city), and it was carried out in Adana (the second city) with modifications and improvements the following year.

First Steps

The key to the project was to involve as many local citizens and communities as possible. The first challenge we faced was reaching participants in a metropolitan city where we had not been active or interacted with the community beforehand. Initially, we looked for citizens to volunteer for the project through an open call on social media, with the help of the local government's network. With the support of the institution that sponsors the project, we organized social media advertisements to target people living in specific cities. We created a community with 65 volunteers in each city. In the following stage, participants connected with one another through inclusive events. Social innovation and the significance of accessibility in cities were emphasized at these events. We organized workshops to have the opportunity to listen to participants' visions of accessibility. During the project, participants were asked to report on the accessibility of the public venues they visited in their cities. Additionally, to deepen the process, a focus group formed comprising ten volunteers who wanted to contribute to further stages of the co-designing process regarding the accessibility of city features. The focus group worked on selecting urban features and creating and inspecting the validity of inclusive narrations (Figure 1).

Figure 1. Inclusive City Community Meeting & Workshop

Project in City 1: Eskişehir

The project was initiated in Eskişehir, a metropolitan city in Turkey, in 2021–2022. Initially, weekly meetings were held with the head of the metropolitan municipality's social services department and the youth center team to select urban features. To increase public awareness, city sculptures were chosen as they are the most notable urban feature of the city. These sculptures are primarily located along the river in the city center, where citizens frequently spend their time. In the end, 12 sculptures in the highly visited walking route were selected.

The aim was to provide all visitors with an equal experience of the sculptures. We began the content writing process for the video, which consisted of two parts. In the first part, the content was written to give information about each sculpture as well as its purpose and its message to the citizens. For the second part of the video, we prepared a detailed au-

dio description of the sculptures for visually impaired visitors. These texts were approved to use in the accessible videos by audio description experts, visually impaired participants in our community, and the city's mayor. The content was then delivered to the video editors to be converted into a video containing accessible audio and sign language. The videos were displayed on the social networking tool Youtube.

To increase the videos' visibility and ensure they reached a wider audience, we proposed that QR-coded signboards be placed next to the sculptures. With the approval of the local government, a QR-coded sign board, which contained text in the braille alphabet, was placed next to each sculpture. After this addition, the views of the videos increased considerably, and diverse citizens and tourists were able to interact with the sculptures by reading the QR code next to the sculpture and watching the inclusive videos (Figure 2).

Figure 2. Gossiping Women Sculpture, QR-Coded Signboards, User Interaction

One year after the installation of the signboards, the videos had been watched over 17,000 times. Most viewers (77.2%) are between 25–34 years of age. Also, 51.6% of the viewers were female, and 48.4% were male, and the most-watched video was seen over 5,300 times and the least-watched over 230 times. The initial observations of the changes in viewing rates depended on the sculpture's location and the location of the QR code signboard. However, in-depth studies are required to learn more about user interaction and experience.

Project in City 2: Adana

In 2022, a similar project was conducted in Adana, another metropolitan city in Turkey. New actions were organized to increase civic participation and co-design. Like the first project, we reached participants through an open call, organized events, and workshops, and established a working group. This time, the urban features we used were the trees in an urban park, the city's most central, which included many tree species. To decide which trees to include in the videos, a survey was conducted on the social enterprise and metropolitan municipality's social media sites to gather data from citizens. Based on the answers, 15 different tree species were selected.

To include citizens in the civic participation process, we made another open call for volunteers to be part of the co-design phase of content creation. During this phase, a workshop was held to provide information about the audio descriptions and create an accessible context. In this workshop, audio description rules (such as the correct identification of the image, written language and tenses, and objectivity in narration) were mentioned by an audio description expert working in the local government. After the online workshop, each tree was narrated by different volunteers. This supported the project's co-production goals and strengthened civic participation by providing citizens the opportunity to directly contribute to the accessibility of their cities.

Additionally, the content creation considered the needs of children with visual impairment and aimed to be appealing to all children in the city. The final product included a description of the characteristics of the tree and an audio caption, presented as if the trees were speaking about themselves.

Figure 3. Inclusive City Community Meeting, QR-Coded Signboards, and Video Narration

With the very recent launch of the second project, the degree of user interaction has not yet been observed. It is critical to track the effect of these design interventions on citizens. Therefore, the next step of the study is to conduct a post-occupancy evaluation of the project to understand the engagement levels of users and the factors influencing their experience.

Conclusion

It is a human right to participate in the public spaces of the city in which we live. The city and its activities should embrace human diversity and provide inclusive solutions for citizens' needs (Donahue, 2022; Harvey, 2004; Lefebvre, 1968). This is possible through a participatory approach that promotes a co-design process involving all citizens. Collaborative projects that include different stakeholders with diverse professions, capabilities, and resources enhance the delivery of products and services to a broader range of citizen groups. Using technologically inclusive design tools such as audio description and user interface design may bring many benefits if incorporated wisely, particularly when driven by users' needs (Rebernik et al., 2017). In that respect, our project has contributed to design literature and practice at many levels. First, although there are examples of inclusive experiences in museums or audio descriptions and sign language narrations of city features in written text formats referring to two-dimensional photographs, this new approach in Turkey treated the city as an open-air museum. Thus, the urban features we pass by daily without noticing were brought to the foreground and introduced to establish a connection between citizens with diverse capabilities and characteristics. Using inclusive signboards on-site can also enhance citizens' awareness of diversity and inclusivity. Informative video modules provide additional information about the city's features and, through their format, send the message of the possibility of accessibility to everyone. While the project outcome contributed to increasing public awareness of inclusivity in the city, transforming the project into output was important in terms of the gains of the volunteers and the project partners. Thus the design process advocated civic participation, leading authorities, designers, and local governments to consider the inclusivity of urban public space in a collective design process. This project-based study can be scaled and applied in differ-

ent cities with different stakeholders and urban features. As such, we will continue to increase accessibility in cities and awareness in the field by developing collaborative, inclusive design interventions in Turkey.

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Separating covid from non-covid: spatial adaptations in existing hospital buildings

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Abstract

The early phases of the Covid-19 pandemic challenged healthcare organisations to rethink how to provide care and deal with their infrastructure differently. Hospitals were forced to amend the use and organisation of their buildings at very short notice in order to separate Covid from non-Covid patients. Given the urgency of the situation, healthcare professionals and architects or technical staff collaborated to design and implement infrastructural adaptations, mostly ad-hoc and simultaneously. In this paper we aim to explore how hospital buildings in Flanders, Belgium, were adapted during the early phase of the pandemic. This was investigated based on interviews (in July 2020) with representatives responsible for infrastructural adaptations in six general hospitals in Flanders. Interviewees illustrated changes made with building plans, photos, and other supportive material. The analysis identified five separation strategies: (1) adapting the building program, (2) installing temporary infrastructure, (3) placing new walls and screens, (4) directing flows of people through signage, and (5) installing new rules and instructions regarding building use. Often several strategies were combined. Despite efforts to divide Covid and non-Covid zones, borders between both were crossed by people, materials, and air. In-between zones, like exchange zones, elevators, and air shafts, were challenging, and required combining strategies to guarantee a safe environment. At the same time, interventions in these zones brought existing rules such as fire regulations to a head. Conflicting priorities arose between providing optimal clinical care and caring for patients' and staff's mental well-being. Covid-contagion risks resulted in a new distinction between patients (Covid and non-Covid) but also highlighted a need for spaces to guard and support mental well-being for staff. At the same time, wards for specific groups of patients, such as children or psychiatric patients, demanded adaptations of the rules. Overall, the spatial adaptations made during the Covid-19 pandemic foregrounded how connecting professionals with different backgrounds allowed creatively adapting existing hospital buildings without losing sight of specific needs of certain patient and staff groups despite, at first sight, conflicting situations.

Author keywords

Covid-19; Hospital buildings, Separation strategies, Spatial adaptations

Introduction

The early phases of the Covid-19 pandemic challenged healthcare organisations worldwide not only regarding the provision of care but also regarding the built environment (Mass Design Group, 2020). Whereas, in March 2020, the World Health Organisation (WHO) published recommendations on how to establish and manage severe acute respiratory infections treatment centres from scratch (WHO, 2020), the specificities of existing hospital infrastructure required creativity of all parties involved as they called for tailor-made and ad-hoc interventions. To guarantee Covid-safe circumstances for patients and staff, hospitals were forced to rethink the organisation and use of their buildings and intervene in their infrastructure at short notice.

The Covid-19 pandemic highlighted the need for strong collaborations between clinical and non-medical professionals, such as architects and engineers (Ndayishimiye et al., 2022). Our research during the early phase of the pandemic suggests that at that point interventions in hospital environments focused on separating Covid from non-Covid patients. In contrast with former formal (re)design processes of hospital environments, these interventions were initially often steered by healthcare professionals and only later coordinated by architects or technical staff (Jellema et al., 2021). To facilitate their daily tasks and optimally care for patients, healthcare professionals are constantly adapting the physical environment (Duque et al., 2019), When doing so, they are well aware of the need for infection control – from the emergency department to patient rooms (Cheng et al., 2013) – but not always familiar with design features that enhance safety, efficiency, and healing or a holistic understanding of the physical and mental impact of the built environment on health care (Cesario & Stichler, 2009). Despite healthcare professionals' essential role is making adaptations to the physical environment, architects and technical staff often fail to recognise these adaptations as design intervention. They tend to take spatial adaptations made by healthcare professionals for granted and do not always acknowledge their input as relevant for a (re)building process (Water et al., 2018).

Interviews with representatives from six general hospitals in Flanders (Belgium), all responsible for infrastructural adaptations, showed how ad-hoc adaptations made during the pandemic have affected space and which benefits and conflicting priorities arose during the adaption of hospital infrastructure.

Based on the analysis of these interviews we aim to explore how hospital buildings in Flanders were adapted. Insight into these adaptations to separate Covid from non-Covid patients identified the importance of connecting healthcare and architectural professionals (Jellema et al., 2021). The cross-disciplinary collaborations between them allowed realizing useful, physically safe solutions in a short time span without losing sight of patients' and staff's well-being. Especially when caring for specific groups like children or psychiatric or palliative patients, guaranteeing physically safe and mentally supportive environments sometimes required conflicting measures. At the same time, the measures taken allowed providing additional care for staff under harsh circumstances.

Background

Throughout the pandemic, publications on the role of infrastructure in fighting Covid-19 abound – both practice- and research-initiated and -oriented. In the early phase of the pandemic, large architecture firms and architect organisations (e.g. HKS & ARUP, 2021; Mass Design Group, 2020; AIA, 2020) provided reports with specific recommendations to design Covid-safe environments. These recommendations translate general topics such as versatility, flow, clean air, or isolation into actual solutions on various building levels ranging from the campus, over the building and unit to the room and its equipment (HKS & ARUP, 2021). Some even explicitly mention a checklist covering all aspects to consider when designing a Covid-safe hospital, ranging from how to approach cross-disciplinary collaboration between heathcare and design professionals to how to realise environments that facilitate separation of individuals, clean and contaminated circulation paths, and appropriate cleaning procedures (AIA, 2020).

In the meantime, a scoping review on the associations between the Covid-19 pandemic and hospital infrastructure adaptation and planning has identified 106 articles discussing the topic (Ndayishimiye et al., 2022). The majority of these papers reported on studies conducted in high-income countries and were published in the first year of the pandemic. According to this review the main focus worldwide lay on infrastructure capacity. We also identified studies that discuss hospital building typologies focusing on Polish cases (Łukasik & Porębska , 2022)and interventions based on international case studies (Setola et al., 2022). Overall, the aim is to gain insight into designing resilient hospital buildings for the future. To achieve this goal several design strategies are foregrounded as important with respect to infrastructure and management, such as re-configuring existing healthcare facilities, introducing additional temporary structures and re-purposing non-health-related facilities (Setola et al., 2022) or striving for adaptability, convertibility, and scalability (Łukasik & Porębska, 2022). The actual topics to focus on differ depending on the phase of a project, design, or operation. Whereas the studies that aim to deepen knowledge focus on location, configuration, and functionality, those that discuss building types pay more attention to themes such as patient safety, indoor air quality, and materials and furniture (Capolongo et al., 2020). Within the Belgian context, we could identify one study (a master thesis) on the relation between the Covid-19 pandemic and hospital infrastructure, focusing on hospitals in Brussels (Gaaloul, 2022).

Practicing architects (e.g. AIA, 2020) and researchers (e.g. Łukasik & Porębska, 2022, Ndayishimiye et al., 2022) pointed at the importance of involving healthcare professionals and conducting multidisciplinary research to identify the impact of infrastructure on Covid-safe environments and formulate design recommendations. From an architectural viewpoint such collaboration is sometimes hampered by a limited spatial literacy amongst healthcare professionals (Mass Design Group, 2020). Yet, the Covid-19 pandemic created circumstances under which healthcare professionals had to explicate care processes and take an active role in design processes (Jellema et al., 2021) Studying the outcomes of such collaboration provides insight into what kind of interventions were achieved at short notice when a closer connection is established between people with a background in architecture and healthcare.

Approach

Based on online interviews (in July 2020) with representatives of six general hospitals in Flanders (Belgium) we identified adaptations made during the first months of the pandemic. Interviewees provided architectural plans, photos, and other supportive material to illustrate changes made 'on their watch'. All interviews were audio- and/or video-recorded while the interviewer made detailed notes of the conversation. The hospitals were selected based on convenience such as pre-existing connections between the researchers and the hospital boards. With this small scale and explorative selection, we covered a broad range of hospital types: both urban and suburban, brand-new facilities as well as older ones, both centralized and dispersed organisations. Prior to the interviews participants were sent informed consent forms. Participants completed and returned these forms to the interviewers or gave verbal consent at the start of the interviews.

We analysed the interview notes and recordings according to a grounded-theory based approach (Dierckx de Casterlé et al., 2012).

Spatial adaptations

Based on the conducted interviews we identified five strategies that hospitals adopted to separate Covid from non-Covid patients during the first months of the pandemic (from March until July 2020): (1) adapting the building program, (2) installing temporary infrastructure, (3) placing new walls and screens, (4) directing flows of people through signage, and (5) installing new rules and instructions regarding building use. Often several strategies were combined.

Separation strategies

In light of infection control, especially in the early phase of the pandemic, many hospitals aimed for completely Covid-free building sections. To achieve this, they adapted their building programs and moved entire departments or functions, like secure changing facilities and transit spaces for handing over either clean or dirty supplies. Some initially even aimed to keep (sections of) buildings closed to avoid conflicting situations. Despite the good intentions, these strict separation strategies sometimes rather resulted in such situations. Especially on wards where patients' need for (mental) support exceeded the clinical health benefits of a fully guaranteed Covid-free environment, the taken measures were at least to a certain extent released. On paediatric wards a parent could accompany a child and patients receiving palliative care were often allowed at least one visitor.

New functions, like secure changing facilities and transit spaces on the ward (Table 1) came with new practices for staff.

Nurses needed to don full protective clothing, and logistics, cleaning and technical staff had to be retrained in Covid-safe procedures. In the interest of the mental well-being of staff working on Covid wards, some hospitals installed lounges in adjacent empty rooms.

Especially at entrances of emergency departments, temporary infrastructure was installed to increase capacity and facilitate triage (Figure 1, left). These tents and containers were often ordered and placed overnight without much planning. This sometimes resulted in conflicts in hospitals' internal and external organisation, e.g. illogical spatial connections between emergency department and intensive care unit, or blocked parking spaces and additional traffic in the neighbourhood.

Figure 1. Examples of temporary infrastructure (left) and new walls (right)

To separate Covid from non-Covid zones and introduce transit spaces, new walls were installed, often with building materials readily available (Figure 1, right). The necessity of doors or transparent panels was discussed between healthcare and technical staff in relation to work processes and social effects. While separating spaces, the ad-hoc installation of walls rarely resulted in airtight compartments, possibly giving a false sense of safety. Since regular care was postponed during the first months of the pandemic, the number of people in hospitals was relatively limited, which made it easier to keep a distance. Once the hospitals opened again for non-Covid patients, plexi-glass screens were in high demand, especially at receptions and in consultation rooms to deter aerosol spread.

Flows were directed throughout the hospitals (Figure 2, left). Entrances were dedicated to specific groups, either patients or staff members. Signs, posters, stickers, and fences were introduced to direct people to relevant departments, waiting areas and wards, and indicate additional levels of infection risk at entrances.

Finally, new rules and instructions were implemented regarding building use (Figure 2, right). Especially towards visitors and ambulatory patients, the use of mouth masks and hand gel, and the need to maintain safe distance needed to be explicated. This imposed additional tasks for staff, often delegated to volunteers. In waiting areas, only chairs could be used that were 1,5 m apart and consultations had to be planned with enough time in between to avoid patients meeting each other.

Figure 2. Examples of direction of flows (left) and new rules and instructions (right)

Figure 2. Examples of direction of flows (left) and new rules and instructions (right)

Table 1. Non-exhaustive table illustrating how the five identified strategies were combined to spatially separate Covid from non-Covid patients.

	Installing new rules & instructions (5)	**Directing flows of people with the help of signage (4)**	**Placing new walls & screens (3)**	**Installing temporary infrastructure (2)**
Adapting the building program (1)	Building program could be adapted because (at various lev-els) certain decisions were taken. E.g. regulating who was admitted to the hospital (and interrupting regular care) reduced the number of non-Covid patients, allowing to repurpose empty recovery and pre-operation rooms as ICUs or empty wards as staff lounges.	ICUs and Covid wards need to indicate additional levels of infec-tion risk beyond the Covid/non-Covid division. Patients' rooms were considered high risk com-pared to other spaces on the ward. These zones were marked with stickers on doors, using colour codes to indicate the protective measures required in a space.	Additional walls and doors were required when wards were repur-posed to create dedicated Covid cohorts and facilitate new func-tions on the ward, e.g. secure changing facilities and transit spaces where either clean or dirty supplies could be transferred.	New functions were housed in tents and containers, in spaces under con-struction or ready to be refurbished, or by repurposing empty spaces or build-ings.
Installing temporary infrastructure (2)	Hospitals were imposed to main-tain a separate Covid and non-Covid emergency department and triage. This demanded the use of temporary infrastructure like tents and containers.	Inside temporary infrastruc-ture signage pointed at the need to follow regulations e.g. wearing mouth masks, disinfecting hands, keeping distance.	Additional walls are placed as part of (new) temporary infrastructure e.g. to create multiple spaces in-side tents and containers. Hospi-tals also used tents to separate larger spaces like a garage.	--
Placing new walls and screens (3)	New transit spaces required new use-agreements. Walls (and doors) delineated zones where certain measures were taken, clear instructions had to be formulated where walls are allowed (or not) and how they should be constructed (e.g. for fire safety)	New walls were placed to separate Covid from non-Covid flows (e.g. at the emergency department) or to introduce transit spaces and cohort wards The zoning and associated infection risk was often indicated on the doors between them.	--	--

Connections and conflicts

Despite the efforts to maintain a strict division between Covid and non-Covid zones, the borders between both were crossed by people, materials, and air. Staff entered and left the hospital, waste from Covid wards was processed elsewhere, and airflows were not necessarily interrupted by spatial separations such as doors or walls. In-between zones, like transit spaces, and elevator and air shafts challenged consciously conceived separations, resulting in adapted practices like medical waste not being allowed in certain elevators. Especially in the in-between zones combining strategies was key to guaranteeing a safe environment (Table 1).

At the same time, interventions in these zones brought existing rules such as fire regulations to a head, forcing to balance one type of safety against another. Fire evacuation routes blocked by newly built walls may delay evacuation. As a result, additional doors were placed, which sometimes facilitated unnecessary passage. This illustrates how spatial adaptations challenge and are challenged by building use. Efforts of staff with various backgrounds sometimes collided because they understood the impact of particular measures differently, e.g. medical staff asking to divide a ward in a Covid and non-Covid part, unaware that a single ventilation system served a larger part of the building. A close, cross-disciplinary collaboration between building- and healthcare professionals allowed discussing such issues in due time and create a mutual understanding about what could and could not be realized. How this collaboration took place is discussed elsewhere (Jellema et al., 2021).

Discussion and conclusion

The Covid-19 pandemic confronted hospitals with major infrastructural challenges. To control infection and offer optimal care, the built environment needed to be adapted at short notice. Whereas international research mainly focused in strategies to increase capacity (Ndayishimiye et al., 2022), our research has a slightly different focus namely on strategies followed to separate Covid from non-Covid. It foregrounds what kind of interventions were achieved within a limited time span when healthcare professionals – whether as formal members of a design team, or as everyday designers (Duque et al., 2019) – work together with architects and technical staff.

Our study identified adaptations on various scales, realised ad hoc by healthcare and/or technical staff and planned by the technical department in dialogue with healthcare management. Most of our findings resonate with design recommendations (e.g. regarding flows, air quality and patient isolation cf. HKS & ARUP, 2021; AIA, 2020) and strategies (e.g. re-configuring existing facilities, installing temporary structure and re-purposing existing structures cf. Setola et al., 2022, and Ndayishimiye et al., 2022) put forward by architects and researchers worldwide. In line with these other studies on the impact of Covid-19 on hospital infrastructure, we discussed contradictions, challenges, or conflicts arising when combining different strategies. Additionally, our research conducted during the early phase of the pandemic shows that both the ad-hoc character of the interventions and the difference in background between healthcare professionals and architects and other technical staff sometimes hampered a sustainable solution while at the same time it benefitted the speed and flexibility of certain solutions. Later international studies (Ndayishimiye et al., 2022), stressed how clinical and non-clinical staff worked as an inseparable team, especially to convert non-medical buildings into medical facilities and to build new structures. It is worth noting that neither of these capacity surging strategies emerged in relation to separation strategies. Through the analysis of adaptations to create Covid-safe circumstances for patients and staff we learned various lessons. Firstly, hygiene and infection risk can be reduced through a combination of strategies. Which strategies to opt for depends on specific circumstances. The adaptations made raised awareness amongst a wider public (from healthcare professionals to patients and relatives) regarding hygiene and infection risk as building qualities, but also created a new distinction between patients (Covid and non-Covid). This resulted in additional challenges faced on wards for specific groups of patients, such as children or psychiatric patients. These challenges raised awareness about the necessity to adapt general rules in particular circumstances to provide a careful and inclusive hospital environment. Secondly, the need for additional (hospital) spaces to guard and support mental well-being for staff invites to reconsider the role of the built environment in healthcare professionals' functioning and general well-being. Finally, guaranteeing Covid-safe circumstances for patients and staff requires spatial literacy (Mass Design Group, 2020), which is increased through close collaboration between technical and healthcare professionals, to understand the complex interaction between how the built environment is designed and used and how this impacts on infection control and safe distancing. Overall, the spatial adaptations made during the Covid-19 pandemic foregrounded how connecting professionals with different backgrounds allowed creatively adapting existing hospital buildings without losing sight of specific needs of certain patient and staff groups despite at first sight conflicting situations. While technical staff took care of spatial interventions that allowed separating Covid from non-Covid zones, healthcare professionals had to take care of people while avoiding unnecessary contact with and between them. As such, both technical and healthcare professionals were continuously resolving conflicts between 'taking care of' and 'avoiding contact'.

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Wayfinding is caring

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Abstract

Wayfinding systems are those systems of signs, physical and digital, designed to help people in the process of orientation toward their destination in a predefined environment. They can also serve as informative systems about the place and as a way to enhance the sense of belonging of the user towards that place. According to the literature review, *wayfinding* can mainly be related to the concept of *care* when dealing with the medical sector, both for the environment in which is located (e.g. hospital, healthcare center) or for the kind of user it is designed for (e.g. elderly people or children, people with physical or mental disabilities). The concept of care could also be considered from a broader perspective, far from the medical one, not only towards the people but also towards the inanimate environment, as a way to preserve and fix it. Assuming this perspective, it is possible to see how the three main functions of a wayfinding system, orienting, informing and creating a sense of belonging for the user to the place, can be an act of care towards both the people and their surrounding place. In order for wayfinding to be an act of care, wayfinding designers have to dive into the place, to understand the needs of the users, the stratification of meanings of each place and the various relations occurring among the different entities that populate that space. In particular, two methodologies are useful for wayfinding designers to go in this direction: co-design and ethnosemiotics. The first has already been used in wayfinding-related projects and has proven useful to succeed in designing efficient wayfinding systems. But the ethnosemiotics ability to observe and enhance the correlation and reciprocity occurring among the different actors could be a way for wayfinding designers to better express throughout a wayfinding system a sense of care not only towards the people but also toward the built environment.

Author keywords

Wayfinding; care; communication design; public space.

Introduction

The terms *wayfinding* and *care* are usually related to each other, in scientific writing, mainly when dealing with the medical sector, as will be highlighted through a literature review process. But the term care can have a broader meaning to which the design of wayfinding systems in urban environments could also be linked. If we consider wayfinding, applied to urban public spaces, not only as a manner to help people find their destination in an environment but also as a way to communicate that environment, in all its complexity, not only architectural but also cultural and historical, we will see how wayfinding systems can be seen as an inclusive act of care, for their aim to preserve and communicate both the tangible and the intangible heritage of the place, and, at the same time, to be an expression of all the plural and diverse community living within it.

An overview of the literature

To start dealing with this issue and better framing the state of the art, the first thing that I have done, was a review of the publications linked to the terms *wayfinding* and *care*. I started looking for wayfinding, in general, to then go deeper into its application in urban public spaces, the context of interest for this research.

The research: strategy and first understandings

I started the literature review by limiting the research to three of the most used and updated web repositories, Scopus, Web of Science and Jstor, searching for the terms *wayfinding* and *care* with no specific timeframe. Within the obtained results I went through a review of the titles, the abstracts and, when needed, the entire text to see how most of them were related to the medical concept of care. Going deeper into this analysis, I was able to see how the publications related to these two terms were mostly linked to the medical area, both for the place where the wayfinding system is located or for the user it is designed for. To check the state of the art regarding the possible connection between the term wayfinding and a broader sense of care, I started excluding those articles that explicitly refer to healthcare, for example referring to users with certain kinds of physical or mental disabilities or grouped by their physical features or that make reference to environments related to the healthcare system. Through the exclusion system mentioned, I was able to identify just a few numbers of publications that were not related to the medical concept of care.

Results and findings

This first overview of the state of the art highlights a gap in the literature about the possible relation between *wayfinding* and a concept of *care* that is not related to the medical field. According to the literature, wayfinding is mainly related to the concept of care when it deals with the medical field, both for the environment in which is located (hospital, healthcare center) or for the kind of user it is designed for (elderly people, people with physical or mental disabilities...). Just a few papers have been found that are not related at all to the medical concept of care. We will go through two of them that are of

particular interest for the purpose of this research because they take into consideration care with the same perspective as I do even if with different approaches. The first one, *Material Ordering and the Care of Things* by Denis and Pontille (2015), introduces the concept of care of Puig de la Bellacasa (2017). In particular, they consider the activity of maintenance related to it, applying it to the materials and signs of which a wayfinding system is made of. In this sense, the concept of care is directly applied to a wayfinding system, a perspective that they started to explore in a previous paper specifically concerning the Paris metro wayfinding system (Denis & Pontille, 2014). The second publication related to this topic that I took into consideration is *Ethical Wayfinding* by Linda Knight (2021), a chapter in a book dedicated to the concept of *Inefficient Mapping*, the title of the book itself. In this text Knight cites the same concept of care of Puig de la Bellacasa (2017) referring specifically to the ethics of care for the place, its histories and politics (Knights, 2021). Doing so, situates wayfinding within the ethics of care, putting in relation the wayfinding practice with the act of giving value to the surrounding environment, by the wayfinders themselves. In addition to these two publications, there is one last interesting reference to the concept of care which is the one expressed by Arthur and Passini in their masterpiece *Wayfinding. People, signs and architecture* (Arthur & Passini, 1992), about the importance for us, as designers, to care more about wayfinding. So, all these publications refer to *care* differently: the first one addresses the issue of care towards wayfinding systems; the second lets us see how the wayfinding process of each person can be a manner to add value to the surrounding environment assuming an ethic of care; the third put the designers in the position of caring about the wayfinding process to improve the quality of wayfinding systems. Instead, through this research I will try to explore another connection between these two terms, pointing out how wayfinding systems could be an expression of care themselves towards people and the environment they live in, starting with defining the concept of care and the possible relation to wayfinding in urban public space.

The relation between care and wayfinding in public space

If we consider care not only from a perspective related to the medical field, where this concept has been first developed, but assuming the broader perspective of Joan Tronto who defined care as "everything that we do to maintain, continue and repair our world so that we can live in it as well as possible" (Tronto, 1993) it might also be possible to consider other forms of wayfinding systems in relation to the concept of care, or as an act of care themselves. Moreover, in this concept of care, Tronto extends the idea not only to the human being but also to the surrounding environment, including in it also the inanimate environment and the more-then-human world (Puig de la Bellacasa, 2017). Care in design has been addressed in a variety of shapes but when dealing with public space, we can assume the perspective that Manzini expresses in his book *Livable proximity* (2021) and that deepens its roots in the definitions of care given both by Tronto (1993) and Puig de la Bellacasa (2017). Manzini states that the city of proximity can be seen as the city of care, in which the capacity of care is expressed by an intertwining of people, associations, services, products and places (Manzini, 2021). This intertwinement facilitates a series of social practices that enables and sustains the social, cultural and physical environment that we are part of. This kind of care necessitates proximity to better express itself, both relational and functional (Manzini, 2021), and, as well as planning, one of the tools able to shorten the distance is a proper system of communication on the territory, a proper wayfinding system.

An overview of wayfinding

Going back to the concept of wayfinding it is possible to define it as a spatial problem-solving process that each person put into action when s/he needs to reach a destination in a predefined environment (Arthur & Passini, 1992; Lynch, 1960). While performing this activity, the user could be supported by a system of signs, made of physical and digital elements. A wayfinding system as part of an identity system, sends messages about the environment in which it is located, contributing to the perception of the space itself (Mollerup, 2005). While doing so, wayfinding systems also convey information about that given place, not only about the orientation but also about the meaning of the place itself. Looking at it from a communication design perspective, a wayfinding system can be seen as a communication tool able to mediate the communication process between the user, considered as the receiver, and the environment itself, considered as the sender of the message (Zingale, 2012). When this environment (or sender) is an urban public space (Carmona et al, 2003; Gehl, 2011; Manzini, 2021), this process became more complex, being related to a place that is not only made by its physical and architectural elements but also made by the stories, cultures and backgrounds of its inhabitants and of all the living entities coexisting within that space (Volli, 2008). To give the chance to all these elements to emerge, and not to be summarized in a singularity or represented by the strongest one (Remotti, 1996), wayfinding systems should be the expression of the plurality of subjects living within that place, and of the stratification of meaning that each architectural or physical elements have experienced through the years (Marrone, 2009; Pezzini, 2008). Being informative systems about the place, wayfinding systems can help not only in the process of identification of the place but also in the process of restoring and communicating its meaning. Wayfinding can provide an experience of cognitive and environmental well-being, improving the perception of the space and reducing the sense of unfamiliarity with it (Zingale, 2012) helping the construction of a personal mental image of a space. A good mental image (Golledge, 1999), among its other functions, gives an important feeling of emotional security allowing the person to establish a good relationship with the surrounding world and enhancing the feeling to be home (Lynch, 1960) and the perception of safety and belonging to that place. For the citizens to feel a sense of belonging to the place they live within, is one of the key factors that contribute to the resilience of urban systems (Pasqui, 2020), and recognizing the value of that place goes along with the feeling of well-being (Manzini, 2015).

Wayfinding as caring

As we have seen, the three main functions of wayfinding systems can be summarized as:

- Orienting, see Figure 1;
- Informing, see Figure 2;
- Conveying a sense of belonging to the place.

Figure 1. Examples of wayfinding systems for orientation in the city centers of Milan, Brunico, London (project by Applied), Rome and Venice

Figure 2. Examples of informative wayfinding systems in Milan, Berlin, Brunico and Asinara.

If we link these three features to the concept of care, we can say that wayfinding can be related to it for the following three reasons:

1. Wayfinding could enable proximity within an urban space;
2. Wayfinding can be an act of care towards the cultural and architectural heritage that it gives information about;
3. Wayfinding can be an act of care toward the people conveying a sense of belonging to that place.

Starting from the first reason (1), we can see how the main function of wayfinding systems, orienting people, could be a way to facilitate proximity both in the city and in the neighborhood. Of course, we are not talking just about a kind of wayfinding addressed to tourists, but we are talking also about a wayfinding system that helps the citizens in finding the closer, primary and secondary functions of the urban area (Jacobs, 1961) and that makes them easier to deal with the complexity of the everyday life improving a sense of well-being (Baur, 2013). This kind of wayfinding can also be a facilitator for the interactions among different actors on the territory, making available to everyone the information about the territory itself and enabling the proximity that is a first step towards the city of care (Manzini 2021). This role as an informative system leads us to the next point (2) which sees wayfinding as a way to take care (Tronto, 1993) of the cultural and architectural heritage. While conveying information about the history and the stories of the place, informative signs can be a way to preserve, keep alive and pass from one person to the other the stratification of different meanings of a place overlapped through the years. Moreover, assuming the idea that for a place to keep on existing, there should be someone or something that talks about it (Manzini 2105), it is possible to see how wayfinding systems can be a tool to talk about the place and to express the different meanings stratified in it through time. In this function, wayfinding could be seen both as a place-making activity and as an act of care towards the built and living environment. Both the functions of wayfinding systems that we have seen till now, contribute to building a sense of belonging for the person to the place leading us to the next point (3). A well-designed wayfinding system helps in building the value of a place for the people who live within it, conveying a sense of belonging and a consequent feeling of well-being for the people. This is another way, for the wayfinding system, to take care of the inhabitants of an urban area and so to be an act of care itself.

Methodologies to design a caring wayfinding system

When we talk about wayfinding systems, we usually talk about a set of signs, made of physical and digital elements, behind which there is, of course, a group of people designing them. A multidisciplinary team that tries to convey this sense of care towards things and people, through a wayfinding system. But how can they do that? When dealing with wayfinding, designers usually follow a complex process that we can divide into three main phases: pre-design, design and post-design (Calori & Vanden-Eynden, 2015). While the design phase is the creative one and the post-design phase is the implementation phase (Gibson & Pullman, 2009) the one that most interests us is the pre-design phase. This phase is mainly the research phase made of data collection and analysis of the place. It starts with an analysis of the place that begins off-site to then goes on with a site inspection to verify the knowledge gained through the desk research. This is the part in which the designers gain knowledge about the place they will work on. There are different ways in which it can be carried on, some of them are just informative and some of them are more empathic both to the people and to the territory itself. Through the years, with the rising of the user-centered approach and of the idea of caring about people, the second one started to be more used and to prove more effective for the design of more efficient wayfinding systems. Some methods, such as surveys, interviews and focus groups, were integrated into the research phase. These tools were a first way to start considering the real needs of the users and a first way to start taking care of them. In the last years this direction of placing the people at the center, and with them, their needs towards others and the surrounding environment, gained more and more importance while wayfinding became one of the paths towards place-making. For this reason, some wayfinding designers started to move from surveys to more participatory activities in the direction of a co-design process. This is one of the methodologies that we will explore as relating to the idea of care. If co-design has already been used and proved useful in designing wayfinding systems, the other one that we will see, ethnosemiotics, has still few applications in the wayfinding field, even if it is suitable for it in the perspective of caring.

Co-design

Co-designing is a well know design practice that has taken place among wayfinding designers as well. It is made of participatory activities that aim to involve the community in the design practices and in doing so the user becomes an active and critical component of the design process (Sanders,

2002). A co-design process that properly involves the final users also promotes the well-being of people engaging them (Fumagalli et al., 2020). The co-design and participatory practices are recognized methodologies in the place-making activity (Manzini, 2015) and by extension in wayfinding design since we have seen how much wayfinding can contribute to the construction of the meaning of a place. Looking at the contemporary wayfinding projects in public spaces it is possible to see how much the planning of participatory activities is taking place in the pre-design process. Co-design applied to wayfinding goes in the direction of caring about the people, being a way for the people to feel involved and enhance a sense of belonging (3) while exploring their need to be connected with other actors in the neighborhood (1).

Ethnosemiotics

Ethnosemiotics is a methodology that in the last years has started to be used in the design field as well. As stated by the name, it has its roots deepening in the fields of ethnography and semiotics both disciplines widely used in the design area. If we start looking at one of these fields alone, ethnography, we can say that can be considered a design practice to express cure and empathy (Cortés-López, 2021). For this reason, by extension also ethnosemiotics, can have this role since it applies the semiotic lens to the ethnographic tools (Donatiello & Mazzarino, 2017). Moreover, ethnosemiotics has the ambition not only to observe objects in their natural environment but also to understand how they interact with each other (Galofaro, 2020). This feature could be an essential characteristic for wayfinding designers who need to deal with an urban environment with the aim of taking care both of the built environment and of the living entities that populate it. For this reason, ethnosemiotics could be a good way not only to care about the people but also to care about the surrounding environment and about the relationships that occur among them.

Conclusions

In order for wayfinding to be an act of care, wayfinding designers have to dive into the place, to understand the needs of the users, the stratification of meanings of each place and the various relations occurring among the different entities that populate that space. Participatory design deals very well with them, not only understanding the needs of the users but also using their knowledge in the design process to succeed in designing a wayfinding system that is efficient in all its three main functions. Ethnosemiotics, on the other side, puts at the center not only the users but their relationships with the surrounding environment. This ability to observe and enhance the correlation and reciprocity occurring among the different actors could be a way for wayfinding designers to express throughout a wayfinding system a sense of care not only towards the people but also toward the built environment in a deeper way. One of the things that these two methodologies have in common is that they both focus on working with others not only considering them as the users but involving them. This shared characteristic is the possible common ground to move toward the concept of care when designing wayfinding systems and a reason why I decided to take into account these two methodologies even if further developments of this research could go in the direction of a deeper methodological analysis both adding more methodologies to this study or deepening the ones already presented. Anyway, besides the methodological part, today as in the nineties "the trouble is that we don't care enough about wayfinding" (Romedi & Passini, 1992), but the trouble is also that, still today, we do not understand how much wayfinding care about us and our surrounding environment otherwise we will for sure take more care of it.

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Explore vacant public spaces regeneration to facilitate minor's activities and education under inclusive design principles

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Abstract

Since 2004, when Europe proposed a greater focus on inclusive design in urban public spaces, aiming to create safer, more inclusive cities for all, the promotion of citizen participation and social co-creation of healthier public spaces has been accelerated (Great Britain, 2004). The inclusiveness of urban public spaces is reflected in the attempt to meet all people's needs from the physical, sensory, spiritual and intellectual aspects, breaking the limits of age, gender and ability, to provide easier accessibility and services (Gehl Institute, 2016; Peraboni & Campioli, 2019). An attractive public space that meets different people's needs can attract citizens to participate in the co-creation and maintenance of public spaces, thus forming a good and sustainable urban life ecosystem (Great Britain, 2004; Carmona et al., 2008).

The Slow Cities, 15-minute Living Circle, Resilient Cities, Compact Cities, Child-Friendly Cities and other initiatives targeting urban development can all be seen as reasons to care about urban health and inclusion issues (Brown et al., 2019). Nowadays, the urban population has increased and more children are growing up in cities than ever before. Currently, more than 1 billion children worldwide live in urban areas (UNICEF, 2012). Children, as the hope of the next generation, need healthy and inclusive urban public environments to play, exercise and even participate in urban events to contribute to urban development. However, the needs of children are often overlooked in public policy (Bishop & Corkery, 2017).

During the rapid urban development process, vacant spaces and potential vacant spaces are found in cities, due to either the decline of economic efficiency and obsolescence of past technologies, or the lack of macro-functional considerations to the pre-existing spaces division, resulting in residual, negative spaces (Solà-Morales Rubió et al., 1996). The inclusion issue is often more apparent in this kind of gray space, but there can often become an informal playground that children accidentally enter when they explore freely in cities (Elshater, 2018; Krishnamurthy, 2019). Meanwhile, as potential spaces for urban public activities, urban vacant spaces can be reused progressively as preliminary sites for new public spaces, thus making the configuration of urban public functions flexible and resilient, especially providing services for the children group.

This article will focus on empirical work in Milan, Italy. Firstly, to provide an overview of child-inclusive urban design in terms of children, urban planning, public spaces and inclusivity. Secondly, through observations, interviews and preliminary research, the bottom-up exploration of some vacant spaces and spatial needs of children's activities in Milan are developed into qualitative diagrams. Furthermore, from the designer's perspective, case studies are presented on the renovation of the MAST community center in Rho town, Italy, as well as the renovation design of the activity spaces around "Ezio Franceschini" primary and secondary school and neighborhood environment (Coppetti, 2018). In this way, it discusses the design and renewal strategies of urban vacant spaces under the concept of inclusiveness, with special attention to children, and tries to explore the broader meaning of public spaces on this basis.

Author Keywords:

Vacant Spaces, Inclusive Design, Child-friendly City, Urban Renovation, Activity Spaces

Introduction

Inclusive city

Since the 19th century, inclusive design has gradually transformed from barrier-free design to universal design, but the design language of inclusiveness still needs to be clarified (Bichard & Gheerawo, 2013; Heylighen, 2008). Today, controversial topics such as the participants, forms of participation and the implementation efficiency of inclusive design have become key research topics around the world (Imrie, 2003; Hill, 2003; Imrie, 2012; Boys, 2014; Luck, 2018). Inclusive design aims not only to eliminate inequalities caused by long-standing discrimination in terms of moral consensus, but also to enhance people's psychological security and well-being in urban life on a psychological level (Gardner, 2019).

In recent years, the pandemic crisis has accelerated a rethinking of the changing psychological needs and more humanistic themes of users in the design of urban public spaces, such as care, interaction, adaptability, integration, proximity and planning time, which are increasingly concerned with their potential impact on the creation of inclusive public spaces (Peraboni & Campioli, 2022).

Children, as one of the target populations for testing the health and inclusiveness of a city, can be studied and observed as an independent object, while also forming a valuable entry point into urban design themes due to their interrelationships with other social groups (Brown et al., 2019). The literatures

show that in recent years children have not been isolated and protected as greenhouse flowers, but have been involved in social activities in public environments through well-guided interactions with adults and public society (Elshater, 2018). For example, usually commercial and semi-private areas are not attractive enough for families with children because of the current prevalence of commercial spaces that are not conducive to the interests of minors (e.g. pubs, cafés). However, the Stadstuin de Bergen (A city park) in Eindhoven, Netherlands, is emerging as a child-friendly environment for public space projects that break down the boundaries between adults and children, promoting interaction between residents, children and civic organizations and providing inclusive services to a wider range of users (Krishnamurthy, 2019). In this way, the role of child-friendly cities for healthier and more inclusive social development is noteworthy.

Child-friendly cities

Research on child-friendly cities can be traced back to the 1970s, with themes extending from health and activity to the urban environment (Sipe et al., 2006). The United Nations (2022) estimates that by 2025, 60% of children in the world will be living in cities. Urban children face many health risks, such as crime, restricted spaces, air pollution, traffic dangers and disconnection from nature (UNICEF, 2012). While children's health needs are often narrowly categorized into children's exclusive services and education, in fact, the urban environment is a decisive factor in children's healthy development. Because urban design that focuses on children's health also meets the needs of the population to a certain extent, so the requirements and the goal of child-friendly cities facilitate the development of cities in a more sustainable, inclusive and equitable direction (Brown et al., 2019). In the early 21st century, the topic of child-friendliness was widely discussed in urban planning, which in turn made the transition to family-friendly cities a new focus of attention in the fields of sociology and urban design (Boterman, 2012). In the 1950s, the increase in private car ownership led to a gradual movement of families to live in the suburbs. Nowadays due to the change in the dominant city sectors and the tendency of higher education professionals to stay in cities have led to an increasing number of young people being drawn to cities to settle their families. Therefore, cities become re-attractive as new centers of employment and consumption (Karsten, 2014).

The theme of urban planning for child-friendly cities is not new, with most research focusing on community reliance on family-friendliness and co-education of children, such as the Playful Cities USA platform created by the non-profit organization KaBOOM. It is based on community engagement and the creation of community spaces and is dedicated to bringing play equally into children's lives (Kaboom, 2017). In addition to the community, public education should also be scaled up within the city to create child-friendly service and caring networks. Karsten (2007) shows in her study how children are conducive to linking areas near their homes, forming a network of mutual support and benefit between communities. These linear or reticulated greenways are the glue that connects the blocks between the school and the living environment. Examples include the "Kindlint" as the safe routes for children in Rotterdam, and the "Streets for Kids" (NACTO, 2019), which encourages children to move independently in their neighborhoods and enhances their mobility between different areas.

Vacant spaces

Elshater (2018) states that the third space as a place for informal activities is an important interactive bridge between school and community, as well as a core place for creating child-friendly cities. The third space, which refers to the relaxing space for leisure activities as distinct from home and places of study and work, is often informal in the urban environment and fulfils its function through the autonomous occupation of the space by its users, this is partly reflects the blurred boundaries and flexible use of the third space. Thus, the value of reusing vacant urban spaces as the potential third spaces is an entry point for the development of new public activity spaces.

A good city is incremental and sustainable (Lynch, 1984), and the ongoing increase of vacant urban spaces is considered to be one of the main symptoms of urban degradation (Trancik, 1991). The study of urban vacant spaces began around the 1960s. Trancik (1991), in his book *Finding Lost Space* published in1986, proposed a study of "leftover, residual, remnant, unused, abandoned, deteriorated" places, which he called "lost spaces". This type of spaces has three characteristics: it is unplanned, has no positive effect on the surrounding environment and has no clear boundaries.

As the study of vacant spaces develops, it emerged a more positive understanding of vacant space definition. SoláMorales et al. (1996) use the description of "Terrain vague" instead of the English term "vacant/ void", with the intention of avoiding negative interpretations of urban vacant spaces, and with a view to their future development in terms of diversity, flexibility and freedom. Nefs (2006) affirms the potential and inevitability of vacant spaces in terms of their economic value, while Maric and Djukic (2018) argue from a historical and cultural perspective, that the regeneration of abandoned spaces should be included in urban development plans. In addition, from a sociological perspective, the re-attraction of people to the city also means that the more crowded city needs to meet the higher demands from people for the public environment.

Children in vacant public spaces

The existence of a large amount of urban vacant spaces not only reduces citizens' sense of identity with their living environment, but also exposes some people to greater inconvenience and safety problems. The number of people living in cities today is growing, and the number of children is quite considerable (UNICEF, 2012; United Nations, 2022). Play is key to children's understanding of the world and their physical and mental exercise (Kemple et al., 2016). Neighborhood spaces around where children live and learn are the main places where they are active. To meet children's need for freely moving around, Arup (2017) proposes the concept of "children's infrastructure", which decentralizes children's activities from playgrounds to a network of multifunctional public spaces such as neighborhoods and streets, providing shared and interactive public spaces for families and communities. Krishnamurthy (2019), through a case study interview, finds that in addition to designated play areas, such as amusement parks and playgrounds, there are a lot of undefined areas where children play. Even though children are not sufficiently aware of the safety hazards of the grey spaces that are spread around the city, because undefined areas give them the possibility to play in a variety of ways, these space still become "playgrounds" for children to explore freely (Elshater, 2018; Krishnamurthy, 2019).

The design of vacant spaces regeneration is a broad topic that covers a wide range of research areas. However, the participation of minors in the event of the renewal and construction of public spaces is still missing, and it is difficult to let them express their needs accurately. In addition to this, the differences in age and gender of minors require more research to determine their needs for activity spaces (Krishnamurthy, 2019; Silva, 2021). For example, Silva (2021), in the PhD study on co-creating communities, demonstrates that teenagers and older people are the participants who have a strong but not fully exploited potential to contribute in projects that promote resident participation in building inclusive and sustainable communities. The participation of teenagers is very important for community development. Perceived as rebellious, with unstable positions and worldviews, they are often less fluid in embracing different cultures and ideas than younger children, and easily suppressed by adults in social discourse, which reflecting that teenagers are a common gap in the practice of building inclusive, sustainable communities. Another difficulty in children participation is that there is no systematic framework of consultation and feedback record for younger children other than adolescents. Therefore, the cooperation of schools and educators is indispensable for designers to ask children questions and guide them to express their most authentic activity needs and preferences that are understood and adopted by designers (Brown et al., 2019).

Regenerate child-friendly places

This chapter shows empirical research case studies located in the metropolitan city of Milan, Italy to demonstrate how the renewal of abandoned and negative spaces can be proposed for the benefit of schools and communities, optimizing learning and activity spaces for minors while enhancing the adaptation and integration of teenagers into the diverse life of the city.

Empirical case: A shared park and urban greenways in the Rho town, Milan

In response to "A Park for everybody" event, many public schools in Milan and the metropolitan area have focused on improving public spaces on campus and coordinating public spaces for all urban residents. In a study on the re-forming open spaces and neighborhood areas in all public schools in Milan, Coppetti (2018) uses the case of the Luigi Cadorna Pre-school and Primary School as an example of a renewal project that proposes to consider teenagers' needs in their rest and recreation time, advocating that the "shared school" model should be popularized. The openness of the school to the public to a certain extent helps revitalize the school's inactive spaces, enriching its after-school activities and integrating them with the services for citizens.

In this case, the "Ezio Franceschini" primary and secondary school in Rho town, Milan, was selected to do an empirical research, which was carried out in the form of a design studio by Polytechnic University of Milan in 2019. Ezio Franceschini Comprehensive Institute is one of the pilot institutes in the "A Shared School: for A Culture of Well-being" project launched by the Ministry of Education and Merit, carried out from 2019 to 2022. The scientific committee includes Catholic University of the Sacred Heart - Center for Studies and Research on Disability and Marginality, Milan Bicocca University - Department of Human Sciences for Education, and Polytechnic University of Milan - Department of Architecture and Urban Studies (*Una scuola condivisa*, 2019).

The primary school covers an area of approximately 9100 m^2 and is located 900 m from the city center, about a 10-minute walk away (see Figure 1). The campus is located between the main roads of Via Mazzo on the south side and Via Terrazzano on the north side, while there are car parks at both the south and north entrances to the school. Due to the school's location in a residential area between the narrow roads, it is always crowded during peak commuting and after-school hours. The eastern side of the school is separated from the residential area by an open public park, which is heavily vegetated and almost obscures the view, creating a barrier of isolation.

Figure 1. The location map of "Ezio Franceschini" primary and secondary school and neighborhood environment in Rho town, Milan

According to the semi-open interviews conducted by the research team with the students, teachers and parents, the students descripts that the formal eastern entrance to the school from the park is poorly identified, and the parents express concerns about the safety of their children walking in the park due to the weak visual connectivity. Walsh (2006) highlights in her study that young children often need close visual observation and support from adults when playing, thus revealing that the heavy shading of vegetation in parks hinders children's safe play and the need for parental supervision (see Figure 2). As urban greenery is interrelated to the theme of child-friendly urban design, and as green parks are important for children's health, the soft surface is retained in the design concept, only enhancing the visibility of the park. In addition, age differences in activity spaces need to be considered, with different scales and openness of activity spaces developed for teenagers' sports activities and younger children's play, and vegetation of appropriate density and height is re-selected to meet the use and safety needs of children's activities at different ages (Walsh, 2006; Krishnamurthy, 2019).

Moreover, since the school buildings are shared for primary and secondary schools, and with the gradual increase in enrolment in recent years, there are very limited learning space within the school. This makes it difficult for children

Figure 2. Current eastern entrance (left) and design proposal (right). Perspective wall, high visibility.

to have a suitable place for self-study and group activities after school, which encourages them to roam around the city, where their safety is further threatened. The school also has difficulty in finding a stable venue for the open days when the school plans to share scientific lectures to the citizens. This set of needs presents an opportunity to upgrade the grey spaces and underused park that exist around the school and the neighborhood. In the design concept, the open park is not only used for student activities, but also serves the multiple functions of a recreation area for the residents and social events (see Figure 3).

Figure 3. A neighborhood shared park concept based on a survey of students' needs for activity spaces

To address the shortage of space for educational classes in school, the "Ezio Franceschini" primary and secondary school attempts to link up with the MAST community center, a half hour walk away, by setting up some of the experimental classes and open courses in this studio out of school. Moreover, Walsh (2006) suggests that focused areas for children's activities in the city, such as schools and small parks, should be connected by child-friendly streets. Therefore, this research proposes to take children's visual perception into account, to create eye-catching urban furniture and architectures along the necessary routes from the school to the community center, thus to enhance the streets' recognition while providing several safe spaces to stop, and this greenway proposal is adapted to the urban scale with narrow roads (see Figure 4, 5).

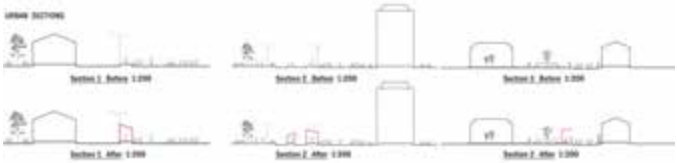

Figure 4. The concept of urban greenways

Figure 5. Iconic urban furniture

Case study: MAST- A community center in the Rho town, Milan

The MAST Space in the south of Rho town is a public-oriented activity center that has been in existence since the 16th century as a village hospital, through changes of ownership, and finally in the 1990s, it transformed from an abandoned urban slaughterhouse to a space dedicated to the community, which provides a multifunctional activity space for young people, students and artists. MAST is a venue for independent musical bands. In addition, the space offers a variety of classes and workshops for all ages, from children to the elderly, such as the experiments in pot plants. In response to the trend in Rho town to serve children's companionship and education, this activity center not only provides part of the open lessons, but also set the place in after-school period for self-study and children activities, thus helping minors strengthen social relationships with their peers (MAST, 2020).

MAST Space is a successful project of reactivating abandoned urban space, providing opportunities for young people to stimulate their potential and invest in their dreams, providing minors with a shelter and an atmosphere of socializing and learning. It is committed to providing community benefits and provides multiple support in the form of space and services for the development of a child-friendly city through its involvement in building shared spaces. It also drives the development of safe urban greenways and promotes the formation of a network of child-friendly streets through its links with interactive activities in schools. Through the flexible and versatile division and use of space as well as the clever arrangement of time slots in a limited space, it meets the basis of caring for children's interests and needs, but also tries to lead the gentle transition of children to grow as adults, promoting their socialization and growth through a harmonious and shared environment.

Discussion

This article shows the design of a child-inclusive renewal of undefined and unsafe activity spaces around a studied school in the Rho town of Milan. It aims to enhance children's safeguarding and activity needs by improving recognition and playability. Since this proposal has not yet been adopted and implemented, the actual benefits of this design are still to be examined. However, this school has now established educational partnerships with social institutions such as MAST and La Fucina, leading to the reuse of inactive urban spaces, while providing minors with more places for education and recreational activities. It demonstrates that this project has the potential to be a pioneering role model in the development of research in the related field and theme.

Conclusion

There is a plenty of research in urban and architectural design that discusses respectively the issues of child inclusion and the renewal of urban vacant spaces. Instead, this article focuses on how to adequately and rationally interpret and present the learning and activity needs of minors in urban public space optimization programs, and translate the demands into a design language for spatial design. Furthermore, this article aims to develop the potential of existing public social resources for the education of minors group, breaking the previous independence of urban design in the planning educational infrastructures, and then involving children's edu-

cation into life scenarios, which makes their life educational and entertaining.

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Human-space relationships as narrative processes for inclusivity

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Abstract

Inclusion is a broader term connected not only to race, origin, religion, and economic status but also to health status, physical and intellectual inequalities, and disabilities of any level. Nowadays, more than ever, it is fundamental to find a way to confront and overcome stigma-related problems, increase well-being and quality of life, and give voices to people living at society's margins. In addressing the human-space relationship as a narrative process, a research question emerges: What is the connection between the experience of space and Storytelling? To reply to this research question, the paper presents two action research projects which explore a narrative-based approach to the experience of spaces in the form of narrative-based processes for promoting inclusion and home-making dynamics. These two cases highlight how Spatial Design can support Storytelling while narrative can considerably benefit architectural understanding and perception of space. In particular, the first research-action explores how home-making processes enable people with dementia (PWD) to create and establish a sense of belonging in their living environment after relocating from their homes. These practices encompass the involvement of material possessions in the form of objects owning an intrinsic emotional value. The memories and emotions embedded in those treasured possessions bring along narratives and habits proper of each older adult, which promote belongingness and trust towards the new living context. Through individual memory and personal narratives, this in-field research aims to understand how PWD have manifested belonging and identity formation in the material and immaterial practices of their new "home" environments and, from this understanding, create a narrative of home-making practices. Similarly, the project *ACTS - A Chance Through Sport* experiments with the transformative power of stories considering the educational purposes of prison facilities and the power of imagination in shaping the function that sports and the space of physical activities can represent. During the project, practical strategies for rethinking stories in practice, in the form of collaborative storytelling activities, were designed to support the construction and reconstruction processes of individual and collective identities. The main aim was to challenge the ordinary representation of penal institutions, overcoming the common belief that sports activity in prison is merely a hobby whose potential is neutralised by the emphasis on crime and punishment. To conclude, these two experiences demonstrate how experimenting with storytelling techniques, world-building practices, and home-making practices can underpin the design of inclusive spaces (physical, digital, virtual, or hybrid). As a result, we can create spaces that support social dialogue and collaboration, foster the reappropriation of places, and create a sense of belonging.

Author keywords

Spatial Design, Human-space relationship, Narrative Spaces, Narrative Change

Introduction

Inclusion is a broader term connected not only to race, origin, religion, and economic status but also to health status, physical and intellectual inequalities, and disabilities of any level. Nowadays, more than ever, it is fundamental to find a way to confront and overcome stigma-related problems, increase well-being and quality of life, and give voices to people living at society's margins. By definition, a stigma is a discrediting or disgraceful mark that distinguishes individuals from others and makes them undesirable, tainted, degraded, or inferior in the eyes of others (Wogen & Restrepo, 2020; Bos et al., 2013). Over time, the term stigma has come to be associated with a discredited state that causes individuals to be isolated from society. Therefore, inclusion also means the re-appropriation of spaces, and taking care not only of those who are excluded, disabled or on the margins of society, but also of the places and human needs that require spaces to be met, benefitting people in terms of their social, physical, and psychological well-being. Yi-Fu Tuan (1977, p.3) wrote: *"Space is abstract. It lacks content; it is broad, open, and empty, inviting the imagination to fill it with substance and illusion. Place, by contrast, is the past and the present, stability and achievement..."Space"and "place" are familiar words denoting common experiences. We live in space ... Place is security, space is freedom: we are attached to the one and long for the other. There is no place like home. What is home? It is the old homestead, the old neighborhood, hometown, or motherland ... Planners would like to evoke "a sense of place." ... Space and place are basic components of the lived world. When we think about them, however, they may assume unexpected meanings".* Place, in fact, is more than just a location; it is a singular entity, a "particular ensemble" (Lukermann,

1964, p. 70), with a background and significance. People's experiences and goals are embodied in a place. Place is a reality that needs to be clarified and understood from the perspectives of the people who have given it meaning, in addition to being a fact that needs to be explained in the context of space as a whole. Moreover, a sense of place or experience consists of emotional bonds, values, meaning, symbols and stories attached to a place. A place is made up of intricate combinations of physical elements, the inhabitants of a location, tangible things, and elements like atmosphere, values, memories, history, and circumstances indicative of the place for the individual (Diener & Hagen, 2022; Breines et al., 2014; Gregory et al., 2011). These components' intricacy results in sentiments and emotions that constitute a person's "sense of place" (Gregory et al., 2011). Accordingly, the experience of places is defined by Yi-Fu Tuan (1977, p. 151) as *"all the modes by which a person knows and constructs reality"*. In light of these premises, by employing narratives to evoke feelings, memories, participation, and action, Storytelling is a technique for conveying ideas, constructing realities and improving conversation among individuals. The portrayal of events is what narrative is, in general. We are also moving toward a situation in which storytelling goes beyond mere entertainment by acknowledging the narrative paradigm and designating humans as *homo narrans* (Fisher, 1989). The design discipline also acknowledges storytelling as having a place in the design process. The relationship between design and storytelling is founded on the capacity of narrative to transcend the functional, problem-solving side of the discipline and provide information that generates new meanings in the ongoing interaction between representation and interpretation. In this sense, designers working in the social space should experiment with storytelling and world-building practices to support social dialogue and collaboration and foster a reappropriation of public space. In addressing the human-space relationship as a narrative process, a research question emerges: What is the connection between the experience of Space and Storytelling?

A narrative-based approach to spaces: two research-action case studies

In order to reply to this research question, the paper presents two in-field research projects which explore a narrative-based approach to the experience of spaces in the form of narrative-based processes for promoting inclusion and home-making dynamics. These two cases highlight how Spatial Design can support Storytelling while narrative can considerably benefit architectural understanding and perception of space, supporting social dialogue, collaboration, and fostering the reappropriation of places.

Case study 1: space as an activator of dialogue and stories for promoting inclusion

The first case presented in this paper is part of a larger study on therapeutic environments for PWD conducted within *GRACE_Lab*, an experimental research laboratory involving designers and researchers from the *Department of Design (Politecnico di Milano)*, as well as therapists and medical professionals from *EQUA Cooperativa*, a Milan-based organisation active in dementia care. The goal of this ongoing research is to determine the aesthetic/functional identity of care environments to improve well-being and sense of belonging. We explored how home-making processes and dynamics enable people with dementia (PWD) and their caregivers to create and establish a sense of belonging and a "sense of home" in their living environment after relocating from their homes. The sense of belonging, intrinsic to every individual, is mined in PWD, when they experience a transition from their home to a care facility, or generally, to a new living environment. Changes in the living environment typically result in bewilderment, irritation, and disorientation. *Piazza Grace*, a Dementia Village (DV) in Milan represented the pilot project: it encompasses 6 apartments, each having space for 2 people and outfitted with a bathroom, and a customizable sleeping area. The 6 units face out onto a communal kitchen and living room, a crucial area for planning social gatherings, and daily common activities. After relocating in the DV, PWD need to re establish their "sense of home". A person's sense of belongingness is strongly correlated with their sense of well-being (*Ref removed*; Cooney, 2012; Falk et al., 2012; Giuliani, 2003), as home is a key location that can offer comfort, safety, and security. Elderly with dementia benefit from feeling at home because it promotes a sense of independence, self-assurance, and social integration (*Ref removed*; Meijering and Lager, 2014; Smith, 2009). When unrelated individuals live in a DV, home-making techniques play an important role to integrate, include and generate relations between the residents and the environment. In particular, home-making practices encompass the involvement of material possessions in the form of objects owning an intrinsic emotional value (Van Hoof et al., 2016). The material possessions brought along by PWD, after relocating to care environments, enable home-making dynamics that evoke memories and emotions. The ways that PWD make their homes, which may involve various material belongings, may reflect various facets of their complex identities, including their sexuality, heritage, families, connections, and spiritual beliefs (Pazhoothundathil & Bailey 2020). In a new care setting, the memories and emotions embedded in those treasured possessions bring along narratives and habits proper of each older adult, which promote a sense of belonging and trust towards the new living context. The ongoing research is focused particularly on the six private apartments and the communal kitchen. The research activities started in 2021, through semi-structured interviews, observations, and focus group activities through storytelling with guests and staff of the DV, in the period between April and October 2021. This project was approved by the ethical committee of the *Department of Design (Politecnico di Milano)*, and the internal ethical committee of *EQUA Cooperativa*. The researchers interviewed 8 elderly people with dementia and 4 people from the staff to collect information about the life histories, life experiences and home-making practices of older adults living in the DV. Participants in the study were questioned on things like: Did you carry any personal items to your new house? What belongings did you bring? What was the purpose of bringing these items with you? What connection do these goods have to you?

In fact, through individual memory and personal narratives, this research aimed to understand how PWD have manifested belonging and identity formation in the material and immaterial practices of their new "home" environments and, from this understanding, create a narrative of home-making practices. Information was also gathered through observation to provide a fuller insight of both the DV and of the inti-

mate and personal places used by older persons. The information revealed in interviews was contextualised with the use of observations of the physical setting of the care facility, the material items utilised by the older individuals, the ways the older adults interacted with various material belongings, and the activities of the older adults. A second phase encompassed focus group activities through storytelling with the participants. Researchers collected individual memories and personal narratives elicited by the material belongings. Most of the residents described their material belongings as cherished or treasured possessions, as they bring along memories, stories, and nostalgic feelings. According to the data gathered, there are 3 categories of cherished possessions: those connected to religion, those connected to past-life experiences, and those connected to memories of family members, including gifts, mementos, and photographs. Each of them elicits narratives, memories, shared habits, and activities. In the focus groups, those material objects were used to foster conversations, retrace shared habits and common cultural backgrounds. The older adults in this study interact with their possessions in various ways. Some of these items are prominently displayed, decorating the spaces. This enables older adults to manage their self-identity, self-esteem, social relations, and past memories reminiscence. Furthermore, personal narratives and memories generated from those possessions, were used to co-design the physical ambiance of the DV spaces, and to create shared daily activities to engage all residents, promoting a sense of belonging, community, and trust towards the new living context, fostering the creation of an inclusive community within the DV. Over time, focus groups have been repeated, every time new residents join the DV, as home-making is a continuous process involving adaptation and modification. As a result, narratives helped to shape and decorate spaces, supporting social dialogue, collaboration, and fostering the reappropriation of places.

Case study 2: a narrative-based approach to support the perception of space

Similarly, the research project *ACTS - A Chance Through Sport*, funded by the *Polisocial Award 2019*, experiments with the transformative power of stories considering the educational purposes of prison facilities (Bezzi & Oggionni, 2021) and the power of imagination in shaping the function that sports and the space of physical activities can represent. The project as a whole intervened in Milan detention institutions to investigate the function of sport in prison as a tool for education, training and social reintegration. Within the research, the theme of sport is addressed and declined according to a multidisciplinary approach, combining design, architecture and engineering skills. *ACTS* is a project in which a system of stakeholders consisting of universities, businesses and creative enterprises has allowed the creation of a virtuous system where different competencies - research, entrepreneurial, productive and creative - have led to the activation of a series of initiatives that are continuing beyond the starting funding. The *Il Casa di Reclusione Milano Bollate* (henceforth Bollate prison) represented the pilot project, which had kick-off during the Covid-2019 outbreak. The consequence was an alternation of activities carried out in blended and in-presence modes (regularly starting in 2021). The first activity was the phase of Listening to identify stakeholders' needs and opportunities through administering questionnaires and interviews conducted with inmates and prison police for 22 hours of dialogue. The second pillar was the design of prison spaces on two levels: quantitative and qualitative. The former concerns the proportion between the number of people incarcerated and the available space. The latter concerns the appropriateness of the places and their uses, which is tackled by the project experimentations. Specifically, it is about the 'prison system' capacity to support the reconstruction of broken ties between offenders and the social body (Di Franco & Bozzuto, 2020). Then, experimental implementations were added in the common interior spaces and walking areas in the form of light and interstitial operations. Thus, concrete interventions were carried out to upgrade the prison spaces through sponsors of materials, innovative instrumentation, and cutting-edge technological products, followed by monitoring the physical activity of a sample of the prison population (inmates and prison officers). The activity tracking was conducted through diaries and wearable devices, allowing the researchers to read a discrepancy between actual and perceived activity performed. The last pillar of the research is Storytelling, in which we experimented with a narrative-based approach to promoting inclusion. During the project, practical strategies for rethinking stories in practice, in the form of collaborative storytelling activities, were designed to support the construction and reconstruction processes of individual and collective identities. The main aim was to challenge the ordinary representation of penal institutions, overcoming the common belief that sports activity in prison is merely a hobby whose potential is neutralised by the emphasis on crime and punishment. On the one hand, we experimented with the synergy between sports-related imagery and actual sports practice; and, on the other, with collaborative storytelling as a practice to support processes of individual identity construction and reappropriation of spaces. In the first phase (October 2020), 55 inmates voluntarily participated in an individual storytelling activity, creating 51 characters using a tool we developed in previous research (Mariani & Ciancia, 2019; Piredda et al., 2015). In the second phase (June 21, 2021-July 8, 2021), 5 inmates from the Third Ward and 7 from the Women's Ward participated in a collaborative storytelling activity to experiment with the integrated use of co-design processes and co-creation of narratives. This was followed (September 2021 - ongoing) by the design, production and multichannel distribution of audiovisual and multimedia content. The outputs of the storytelling activities are two, both presented at the Laboratorio Carcere exhibition, hosted in the *Project Room* of *PAC Milan* from October 9 to November 6, 2022: A documentary on the research project activity in its entirety with the purpose of dissemination of results (supported through a crowdfunding campaign on the *DONA Polimi* platform); A serial podcast with episodes written directly by incarcerated people during collaborative storytelling activities. In the project, the act of telling stories, whether about sports or not, serves as a tool for analysing reality and everyday life (inside and outside prison). It was obtained through an inclusive design process in which worldbuilding practice and narrative-based strategies demonstrate the ability to empower people, including marginalised groups. The space was used as a story idea generator in the first part of the co-design narrative process. In the collaborative storytelling workshop, the second and third meetings focused on creating a shared narrative world that accommodates all the created charac-

ters through storytelling and dialogue. We narrowed the topic to sports to explore the role of space devoted to physical activity in this fictional universe and the feelings connected to playing sports. Starting from the stories and characters written by workshop participants, we decided to co-design a podcast with the following aims: giving a voice to people whose rights have been suspended and providing those living outside of prison with a direct and authentic telling of experiences coming from the outskirt of society. We designed a podcast because listening without prejudice is the only way to understand situations. We wanted humanity and the relationships that emerge from sharing a space to do the talking. Using an audio medium allowed us to convey not only the stories of people, with their fears and hopes, but also an aural narrative of the space that could go beyond the classic genres of prison tales: critique, redemption, and jailbreak. The result is a narrative space where reality and fiction intertwine, offering people the unprecedented possibility of exploring alternative opportunities, roles, and identities to those usual and already given.

Final Discussion

It is possible to observe a strong emphasis on time, while the concept of space is frequently disregarded in discussing narrative from the perspective of its ontological elements.
In this regard, the work of Marie-Laure Ryan, Kenneth Foote, and Maoz Azaryahu, published in 2016, provides intriguing insights into the connection between narrative and space (2016). Their research identifies four typologies of textual space and questions how narrative and space can conflict (Ryan, 2021). These typologies are the spatial form of the text, the space it physically occupies, the spatial context of the text, and the mimetic space or space of the storyworld. The two final spaces are the most intriguing for considering the relationship between narrative and space and reflecting on the human-space relationships as narrative processes for inclusivity.

The text's physical backing is discussed in the third type of textual space, which is also referred to as the text's spatial context. The environment and architectural landscapes are essential in this context. They can provide the narrative experiences in a physical setting and create hooks to increase audience involvement, engagement, and immersion. This typology covers site-specific and location-based narratives that employ space as a medium and can be clustered into three major groups. The first category, referred to as "spatial annotation," includes all the initiatives encouraging individuals to wander the city in search of narrative content and experiences. The second category is mainly represented by location-based games, in which the real world serves as the playing field. In the final category, we can find the mobile narrative experience that emphasises the story rather than the experience itself or the game mechanics. Finally, the mimetic space, or the space of the storyworld, is the fourth type of narrative space. In this type of space, characters act and move in storyworlds inspired by space and architecture (Buchholz & Manfred, 2007). Addressed by several researchers (Dolezel, 2000; Doležel, 2019; Pavel, 1989; Wolf, 2012), fictional worlds are described as collective mental constructs (Ryan, 1991) that have semiotic meaning spheres (Boni, 2017) that viewers can investigate in their parts. According to this, fictional worlds emerge as accurate, maybe eternal and independent construction anchored in interpretive processes. The creation of storyworlds should include hooks or connections to the real world because stories require readers to mentally imitate the actions and movements of characters across the storyworld (Ryan et al., 2016, p. 4) which makes the fictional but shared mental environment seem realistic. In this sense, designers working in the social space should be experimenting with storytelling and world-building practices to support the experience of places (Tuan, 1977), fostering social dialogue, collaboration and the reappropriation of public space. The memory of events that have taken place can help people feel comfortable and diminish non-place feelings (Webber, 1964; Augè, 1995); their cultural and social specificities affect place as a process (Banerjee & Baer, 1984). In this respect, events can be real or fictional, both capable of effectively building a sense of belonging that derives from a familiarity with the stories that are set in the place to develop people's ties and attachment to their places, the so-called "sense of place" or "structure of feeling" (Agnew, 1987). The design of home-making dynamics can support storytelling, such as providing hints in the form of decorative elements, patterns, objects and paraphernalia shapes and decorations. In the same way, stories and memories can support the creation of spaces able to enhance a person's sense of belongingness. Referring to the first case study reported in this paper, the ability of persons with dementia to participate in worthwhile activities and build relationships with others contributes to a sense of home (van Zadelhoff et al., 2011, Norberg et al., 2015; Wada et al., 2020). The design of these activities can be supported by narratives, stories, and memories elicited by those physical elements, or cherished possessions which, for example, are brought by PWD in their living care environment. In contrast, stories can support the understanding of space and architecture, including not only visual, but also aural elements. Moreover, private and public spaces can be designed to support stories, offering in their architectural landscapes elements that may be used to hook story events. In light of such premises, the case studies presented demonstrate how a narrative-based approach can significantly improve and support understanding and perception of space (Case Study 2) while space itself can become an activator of dialogue and stories for promoting inclusion (Case Study 1), constructing knowledge settings that improve interactions, given that people use narratives to form and share their unique experiences (Jenkins, 2006).

To conclude, these two experiences demonstrate how experimenting with storytelling techniques, world-building practices, and home-making practices can underpin the design of inclusive spaces (physical, digital, virtual, or hybrid). As a result, we can create spaces that support social dialogue and collaboration, foster the reappropriation of places, and create a sense of belonging.

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Urban darkness: human experience of atmosphere and fear

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Abstract

The lighting of public outdoor spaces is often associated with the basic assumption that light creates a feeling of safety, while darkness is related to danger. The lighting level thus is often high and uniformly distributed, especially for public urban activities. This can cause an unpleasant atmosphere; because, when lacking a hierarchy of lighting, it is difficult to sense distances, materials and the contours of humans, objects, and buildings. To create inclusive outdoor spaces where people and surroundings can be experienced in a pleasant light, we need both light and darkness. There is a need to design lighting in relation to site-specific qualities, human behavior and to the lighting level in the surrounding context. Where due to the current energy crisis in Europe, lighting levels in public spaces are reduced and, in some spaces, even turned off to save energy, the lowering of lighting levels is often done without assessing site-specific human and spatial conditions.

This paper presents a further analysis of results from a field experiment at an urban tram station in Aarhus, Denmark. Here the experience of space, surroundings and other people was examined through semi-structured go-along interviews and participant-produced photos in two lighting settings, on bright setting and one with a lowered lighting setting. The focus for this paper is directed towards the vocabulary of words to describe experiences of light, developed by the test participants in the field. To examine if the test participants feel exposed or protected in the bright light and to collect reflections, associations and vocabulary related to human experience of increased darkness. The results show that in some cases darkness can provide more visibility than light. When contrasts in lighting levels between two lit zones are removed, a visual contact is created between people in a space and people in the surroundings, which leads to an increased feeling of safety. Urban space becomes more visible, and its site-specific qualities emerge. By considering context, and balancing lighting levels between urban zones, a more calm and friendly visual environment is established.

Keywords

Inclusive urban lighting, darkness, atmosphere, safety, vocabulary

Introduction

There is a fundamental belief that light is associated with safety, and darkness is associated with fear (Dunn, 2020). But less light can also increase visibility and create a more pleasant atmosphere in urban spaces (Hvass et al., 2022). To gain a greater understanding of how urban spaces are experienced, it is important to carry out embodied experiments in the urban context. In lighting research, there is a long tradition in doing laboratory studies; field studies are often regarded as biased because of the many variables which exist when humans move though complex and dynamic urban contexts. But to get an understanding of the role of lighting in Nocturnal Urbanism (Narboni, 2016), there is a need for site-specific field studies, and a need to develop methods of investigation in complex urban scenarios. To get a closer understanding of how lighting influences human experience of site-specific architectural and social values, the importance of balancing urban lighting levels (Hvass et al., 2022), and creating lighting hierarchies (Kelly, 1952) will lead to more inclusive urban environments.

The balance between lighting and darkness

Juhani Pallasmaa states; "Too much light wipes away the sense of space" (Pallasmaa, 2012). The 'wiping away' can occur if lighting levels are too high, the distribution is too uniform and the ability of the lighting to reproduce color is too poor. Both architectural and social qualities of an urban space disappear when shadows disappear. Because of bright and evenly distributed light, it is difficult to see the shapes of objects and nuances of faces. Likewise, when colors disappear, and the visible surfaces are mostly tones of grey and brown, urban spaces lose their visual qualities, and are often not comfortable to move through and stay in.

There is a need to balance lighting and darkness; if lighting levels are only connected to a feeling of safety, urban qualities are lost in the dark hours. Gernot Böhme describes how we need both lighting and darkness to be able to see our surroundings: *"Brightness is what turns sight into a real capability in the first place and enables visible things to be seen in reality...Light is not the only precondition of visibility. Darkness is another. True, light and darkness are asymmetrical. Light is a precondition for seeing at all, whereas darkness (interacting with light) is a precondition for our seeing something"* (Böhme, 2017).

Nick Dunn and Tim Edensor explore the multiple meanings and uses of darkness across time and space (Dunn, 2020). Specifically, they look at how darkness has been laden with negative attributes throughout history, forgetting the positive, aesthetic, and sensory experiences that darkness can create.

They draw attention to this historical tradition of relating lighting to safety and darkness to danger in urban spaces, without considering the aesthetical values of darkness. Lighting and darkness can thus both be linked to the understanding and feeling of a pleasant/ unpleasant atmosphere or a safe/unsafe space. A particular lighting design can never fit all users of a public space; however, a more detailed understanding of the experience of lighting and darkness is needed to challenge biased assumptions about the link between a high lighting level and safety (Dunn, 2020).

Human sensory experience of lighting

To explore architectural qualities of urban contexts, human night vision must be adapted to the experience of fine nuances between light and dark areas in an urban space (Boyce, 2014, 2019). Sound, smell, and touch are also human senses that have an influence on how a place is experienced (Pink, 2015). Pallasmaa touches upon the complexity of evaluating the quality of a space by stating: *"The quality of a space is not merely a visual perceptual quality as it is usually assumed. The judgement of environmental character is a complex multi-sensory fusion of countless factors that are immediately and synthetically grasped as an overall atmosphere, ambience, feeling, or mood"* (Pallasmaa, 2014). Lighting and darkness are part of this multi-sensory experience and should therefore be investigated in the urban context to explore interaction between lighting and site-specific qualities.

To explore the social qualities of lighting there is a need to explore the ties between lighting people and the city and focus on people's emotional, cognitive, and motivational perceptions to achieve more accessible, sociable, and sustainable cities (Casciani, 2020). Daria Casciani highlights the need for a greater understanding of the influence of urban lighting in terms of luminous atmosphere perception, positive social affect, social enhancement, accessibility, and hospitability (Casciani, 2020).

Often, people don't possess a vocabulary for explaining experiences and feelings about lighting and darkness. Sumartojo and Pink describe reasons for this: "presence of light is often taken for granted in everyday experiences; a vocabulary is lacking" (Sumartojo, 2020). In a test situation, "a vocabulary" can be formulated as a pre-defined questionnaire, or through interviews where the test participants use their own words. To try to grasp nuances and get insights into experiences of either a perceived pleasant atmosphere or a perceived danger in the dimmed lighting during the field experiment, semi-structured interviews with participant-produced images were used to collect human experiences.

Inclusive outdoor spaces at night

In the dark hours, the level and distribution of lighting determines which areas are visible and which are not and how spaces and people appear. To fulfill the Sustainable Development Goals 'Leave No One Behind' (UN, 2015) and create inclusive public spaces, lighting must be designed to meet many different needs. Thus, there is a need to focus on the quality lighting can create not only the dangers lighting can prevent.

Research Question

To get a closer understanding of human experience of an urban context in a dimmed lighting setting and their chose of words to express these experiences, the following research question was posed:

How does dimmed lighting levels affect the human sensory experience of atmosphere and fear and how are these experiences described?

Background

The field experiment described in this paper is part of a PhD project on human sensory experience of outdoor lighting with case studies of tram stations in Aarhus, Denmark (Hvass et al., 2022). The PhD project consisted of a total of four studies. Firstly, a literature study where the use of lighting in the theater is compared to the use of lighting in the urban space. Secondly, a field study with the aim of obtaining knowledge about the experience of the lighting at tram stations in Aarhus in different urban contexts. Thirdly, a laboratory experiment where the experience of lighting levels is investigated, and finally, all results are used to design the final field experiment at Nørreport tram station in Aarhus, Denmark. (Hvass et al., 2019, 2020, 2021, 2022)

Figure 1. Nørreport tram station in daylight, transition hour and the dark hours.

A case study was chosen to investigate human experiences of urban lighting in a specific context. According to Bent Flyvbjerg, case studies should be viewed as means to gain knowledge of human experiences in real-life situations. He states: *'One can often generalize on the basis of a single case, and the case study may be central to scientific development via generalization as supplement or alternative to other methods. But formal generalization is overvalued as a source of scientific development, whereas 'the force of example' is underestimated'* (Flyvbjerg, 2006).

Tram stations and the 'real-life situation' of waiting for the tram was chosen as a case because the stations are surrounded by buildings and roads; people stay at the station and go to and from the station every day, as part of their everyday routine in the urban mobile situation (Jensen, 2013). The results from the field experiment at the tram station must therefore be assessed in relation to the specific context of the station, the buildings and the people using it.

Method

To conduct the field experiment, a combination of ethnographic and architectural methods was used, supported by measurements and calculations of lighting conditions at the tram station and in the surrounding urban context.

The field experiment took place in November 2020 at Nørreport tram station in Aarhus, Denmark (Hvass et al., 2022). Two go-along interviews were conducted during the dark hours when people commute to and from work. For one week, the participants experienced the tram station in the existing bright lighting setting and for one week, they experienced the waiting area in an 80% dimmed lighting setting. The existing illuminance level was measured at approx. 165 lux in a sheltered waiting area. On the pavement, by the facades in the surroundings, a level of approx. 1- 6 lux was measured. By dimming the lighting at the station during the second go-along interview, the differences in the lighting levels at the station and in the sur-

roundings were balanced, and the large contrast was thereby minimized.

Ethnographic interviews were conducted as go-along interviews with participant-produced images. The go-along interviews included 10 participants. The interviewer met each participant at the Nørreport tram station twice, in the existing and a dimmed-lighting setting, and took the tram to the next stop, then back again. Each recorded interview lasted approx. 30 minutes. At each interview, the participants were asked to comment on the atmosphere in the waiting area, their experience of the surroundings and their experience of activities at the tram station. During the interviews participant-produced images were used as a probe (Pink, 2021).

The rhythms of daylight, urban light, traffic and people were observed (Edensor, 2012; LeFebvre, 2013) and registered in sketches and photos; likewise, the movements and "the vibe" of the space (Madden, 2017) were registered in time-lapse videos.

Quantitative data about lighting levels were gathered through lux measurements on horizontal ground surfaces and luminance measurements on vertical surfaces at the station and on the surrounding buildings. Furthermore, luminance maps based on high dynamic range (HDR) photos (Inanici, 2006) provided both measurable values plus an overall visual insight into the hierarchy of the lighting levels (Kelly, 1952) in the urban scene, as well as quantifiable luminance levels.

Analysis interviews

The present analysis will describe reflections, associations and vocabulary describing the bright and the dimmed lighting settings with quotes from test participants' experiences of space, atmosphere and fear.

The recorded go-along interviews were transcribed and coded in NVivo12. A deductive sorting of the material was performed to detect and recognize themes; subsequently an inductive coding of the data was performed to introduce new angles and perspectives to the project (Pink, 2015; Madden, 2017). The participant-produced photos were used in the analysing process to get a closer understand of the situations where the photos lead to moments of realization for the test participant (Pink, 2021; Gaver, 1999). Visual ethnography and the use of participant-produced photos proved to be a suitable method for exploring the relationship between lighting levels and the sensory experience of urban context.

Reflections, associations, and vocabulary

At first impression, 80% of the interviewed test participants were positive, while 20% were negative towards the dimmed lighting setting and having less lighting at the station. Test participants used different words and references to describe their positive and negative reflections about the existing high lighting level and a dimmed lighting level.

The existing bright setting

During the first go-along interview (on the existing bright lighting setting), test participants used positive phases like: safe, spacy, practical, security, modern, minimalistic design, enough light for reading. They used negative phases like sharp, clinical, institutional, not cozy, chaotic, sterile, sharp, grey, boring, lack of texture and atmosphere, cold lighting, exposed, glare, stressful, uncomfortable, unpleasant. The negative phases were supplemented by negative references like: it feels like standing on an over-lit island, being prisoner on an island, a gas station, prison yard, an operating room at a hospital, prison yard, the center of a target, being in a light bubble.

The dimmed lighting setting

During the second go-along interview (on the dimmed lighting setting), test participants used positive phases like: less clinical, natural, evening mood, calm, relaxed, comfortable for the eyes, less sterile, the station fits the context, does not take attention, cozier, safe, sophisticated, serious, exclusive, intimate, less extreme, less exposed, more protected, private, not a light bubble anymore. They used negative phases like too dark, scary, unsafe, fatigue, drowsy, irritable, unsafe.

Figure 2. Photos a showing the existing bright lighting setting (left picture) and the dimmed lighting setting (right picture) at the Nørreport tram station, Aarhus.

The surroundings become visible when the lighting level is dimmed. Unfortunately, it was not possible to dim lighting in the commercial advertising screens at the station. The lit screens attract attention when the station is seen from the outside and present another problem concerning high lighting levels in the urban context, which is not described in this paper.

Quotes

The abovementioned reflections and statements are extracted from the interviews. To understand the vocabulary of the test participants, four quotes are mentioned here to explain what influence the two lighting settings have on the experience of the surroundings, and the feeling of either safe, calm atmosphere or one of danger.

Two test participants expressed their view towards the surroundings in the dimmed lighting setting as such:

"I actually think the surroundings are clearer; it's like it's becoming more of a whole [the station and the surroundings]. Before you stood in quite a lot of light, and then the surroundings became secondary. Now it seems more homogeneous" (Female, age 69, dimmed lighting).

"Somehow it seems that the station is better connected to the rest of the city because it is not a light bubble anymore" (Female, 22 years old, dimmed lighting).

The test participants expressed that they could see the surroundings more clearly, that in the dimmed lighting there was harmony between the local and the surrounding spaces and that it had become a cohesive space instead of two spaces.

80% of the test participants preferred the view to the surroundings in the dimmed lighting setting. It came as a surprise to many, and it was difficult for them to express what they saw and why this happened. Most of the test participants did not consider the importance of the surroundings in the existing lighting setting. However, when the lighting had been dimmed, all test participants experienced a regained connection to the surroundings and sensed that the station had become a part of the urban context.

The following two quotes represent opposite views on the dimming of lighting in relation to the feeling of safety.
One positive quote in relation to the dimming of the lighting reads as follows:

"I actually start looking around in a different way because I have a feeling that I can see the surroundings. I'm in harmony with the surroundings now. It feels different from when I was in the very bright light...it is no longer the case that I am a target, exposed, and they can only look at me. Now, we can just look at each other" (Female, 56 years old, dimmed lighting).

A negative quote in relation to dimming reads as follows:

"It's a little scary.... I think it is an advantage to be exhibited in the light because if some strange people come to the station, you can see them" (Male, 56 years old, dimmed lighting).

The two test participants had opposite feelings about the lighting level and safety. One feels safe and calm in the dim light and the other feels unsafe. When dimming the lighting level, most of the test participants saw an advantage in the regained visual contact with the surroundings and linked this regained connection to the surrounding context with a feeling of safety.

Conclusion

The findings from the go-along interviews demonstrated that the human sensory experiences of space and other people in the urban context were affected in the dimmed lighting. The participant-produced images were effective for understanding the participants' immediate thoughts about the experience of the urban context. Photos were taken as a collective probe to provoke responses and unexpected ideas. The photos led to sudden realizations and triggered memories for the participants, and they helped the participants develop their own language about what they saw. It was discovered that issues that were difficult to describe in words could be easier to describe when explaining the content in a picture. Dimming and adjusting the lighting level according to the surrounding lighting level created a relaxed atmosphere at the station for those waiting for the tram. A connectedness to the surroundings and the people there was felt, thus increasing the feeling of perceived safety. This is thus an example of how site-specific experiments with lighting are necessary and how the fundamental belief of light being related to safety can be challenged when lighting is adjusted to site-specific qualities and lighting levels in the surrounding urban context.

Future work

The field experiment was performed during Covid 19; therefore, the number of test participants was limited. It is the intention to conduct more interviews, with test participants with different needs to collect further knowledge on human experience of darkness. Furthermore, to draw on the experiences made during the current energy crisis in Europe where lighting levels have been lowered to save energy.

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Daily social interactions of hawkers as a catalyst to actuating bottom-up spatial justice: experience from Hong Kong

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Abstract

The concept of bottom-up spatial justice is conceptualised as the capacity of streets to offer diverse experiences for street users. The concept advocates for caring the disadvantaged groups and incorporating their needs in design. Based on the premise that informal economic activities in public spaces make cities vibrant, dynamic, and safer for keeping 'more eyes on the streets', street hawking, a representative of such activities, provides alternative public spaces, offers job opportunities and convenient daily services for the vulnerable groups, especially those deprived ones. The everyday lives and social interactions of hawkers resonate with various urban discourses. Yet, hawkers have rarely been placed at the centre of favourable intentional legislation, instead, they are largely disregarded, rarely supported, licensed following a strict manner, often regulated and sometimes aggressively discouraged or even expelled by relevant authorities. There is still a paucity of studies recognising the role street hawkers play as urban informal sectors in facilitating bottom-up spatial justice. A conceptual framework that proactively guides the co-creation of a more inclusive and just street life is lacking. Through the medium of a case study of Sham Shui Po, one of Hong Kong's densest and poorest districts, qualitative methods are adopted in this research as on-site environment audition, unobtrusive observations; photo and video recording and note-taking in streets to expound the street hawkers' temporary appropriation of streets as social spaces, and investigate their daily interactions with the surroundings that facilitate diversity and inclusion. Findings are examined through the critical perspective of spatial justice to highlight the dynamics needed to (re)produce an engaging, informal and inclusive public life. A design guideline that calls for more participation of vulnerable stakeholders, preserving street hawking and maintaining urban informality with care is proposed to advise relevant policy-making and practice.

Keywords

social interaction; street vending; spatial justice; inclusive design; care;

Introduction

Worldwide, countries and regions have long relied on street vendors (also known as hawkers or peddlers) as a vital part of the economy (Bhowmik, 2005). The vending practice is a popular informal activity and can be opted as a medium of livelihood and job opportunity for people who are relatively low-skill (Adama, 2020). There are an estimated billion street vendors offering goods or services at an affordable price in public spaces, accounting for a significant share of informal non-agriculture employment in Asian cities (Sekhani et al., 2019). This predominantly own-account or self-employed group is under constant scrutiny as a mediator to untangle 'informality' (Tucker & Devlin, 2019). Researchers have argued that the close observation of those 'informal workers' businesses reveals a connected, coexistent, and complex relationship between the 'formal' and 'informal' aspects of commercial exchanges (Sekhani et al., 2019).

Governments around the world have made efforts to regularise street vending (Kinoshita, 2001). Providing hawkers with licenses is a typical approach. However, most studies treat hawkers as a homogeneous group (Lata et al., 2019) and regard them as the antithesis of relevant urban authorities. Hawkers receive limited legal protection in terms of labour rights and working conditions (Sekhani et al., 2019). They, especially unlicensed street hawkers, are seen as the source of urban conflicts (Al-Jundi et al., 2022). Iveson (2013), in response, raised concerns over spatial justice by arguing that both context and spatial justice should be normatively integrated when investigating urban informality, and that, to some extent, corresponds to a 'hands-off' approach (Iveson et al., 2019).

Seeking spatial justice is part of reclaiming public spaces for individuals and the collective. Different groups, regardless of their class and background, should have the right to access and participate in the process of geographical (re)production (Soja, 2013). By negotiating and resisting collectively, hawkers are able to cope with challenging situations (Al-Jundi et al., 2022) and generate a higher degree of certainty with respect to their free use of public spaces (Tucker & Devlin, 2019). The understanding of the positive influence of vendors' social

practices and their patrons on the promotion of spatial justice in public spaces needs to be enriched.

The article unfolds as follows. We begin by presenting street vending as a common global phenomenon and exploring hawkers' acknowledged daily situations. We ground our findings in critical theories of spatial justice in public space. Next is a presentation of the major findings, notably the social dynamics of street vending in Sham Shui Po, Hong Kong. We conclude by arguing that understanding how street vending in densely-populated cities provides shelters and refugees for socially and economically marginalised groups is a precondition for intervening to construct spatial justice in public spaces.

Literature Review

Street vendors in public spaces

Researchers regard street vending as a bridge connecting the informal with the formal economy (Siu, 2007). Besides food, street vendors purchase a substantial number of goods produced by small factory workshops in the informal sector and sell them to economically disadvantaged groups at lower prices. They are also popular among middle-income individuals for offering essential and affordable services that may not be easily found in municipalities or larger retail stores (Bhowmik, 2005). People patronise street vending for the accessible and convenient service provided, with necessary goods being fairly priced. They feel grounded and willing to support the hawkers (Igudia et al., 2022).

It is common for hawkers to be stationary, occupying space on the pavements or other public or private spaces. Itinerant vendors who move from one place to another by carrying their goods on push carts are not unusual at the same time (Bhowmik, 2005). These features make vendors often show up on sidewalks, parks, intersections, leftover spaces and privately owned spaces such as outdoor shopping malls (Cupers, 2015). In this sense, the accessibility of public spaces, streets in particular, is an indispensable resource of income for vendors (Adama, 2020).

However, governments worldwide are, more or less, reluctant to consider street vending as a legal activity (Bhowmik, 2005), not to mention recognising their positive influence on the city. Especially in much of Asia, street vendors are perceived as the opposite side of the ideal clean, beautiful and functioning city image, and therefore, are seen as inimical to the interests of the society (Bhowmik, 2005). Many governments have attempted to regulate or prohibit the activities of street vendors (Graaff and Ha, 2015).

Numerous studies showed that street vendors are not provided with adequate physical, policy and social protection (Sekhani et al., 2019). They are claimed to have to constantly confront different forms of uncertainties, including resource limitations (e.g., inadequacies in infrastructure such as running water and toilet), merchandise being confiscated by relevant authorities (Sekhani et al., 2019), threat of eviction (Bhowmik, 2005), and risks posed by policy makers and law enforcement agencies (Jiang & Wang, 2022). As a result, street vendors live in precarious and uncertain lives. On the other hand, choosing to be a street vendor typically corresponds to the person being not well-educated, having less capital to invest, and possessing limited skills to showcase (Sekhani et al., 2019). They are generally in less privileged positions and are more vulnerable than their counterparts, and therefore, deserve more attention.

Some of the recent literature also depicts that, in some cities, street vending is part of people's culture, tradition, way of life or gesture of kinship (Igudia et al., 2022). While previous research focuses more on the locally negotiated relationships that enable vendors to bargain with different stakeholders to ensure temporary security over use of public space (Lata et al., 2019), it is necessary to undertake a similar effort to understand the important role street hawkers play in promoting spatial justice in public spaces during their daily interactions and negotiations. Our effort here is to explore this issue.

Street vending in Hong Kong

Hong Kong, an iconic world city of extreme high density, has a street vending history of more than a century (Kinoshita, 2001). The government, taking into account health, hygiene, safety and traffic, has implemented policies for regulating and protecting street vendors over the years. At the end of 2021, Hong Kong urban areas had 5,051 licensed fixed-pitch hawker and 153 licensed itinerant hawker (Knott, 2022).

Back to 1973, the Hong Kong government devised the Hawker Permitted Area Scheme, allowing hawkers to trade freely within designated areas. The scheme has been revised several times, such as being changed in 1979 to the Hawker Permitted Places (HHP) Scheme. Licensed hawkers currently are allocated modularised fixed-pitch hawker stalls to conduct their daily trade practice. This potentially enables them to keep proper hygiene (Legislative Council Panel, 2014).

From 2019 onwards, influenced by the social unrest and the COVID-19 pandemic, the city's economy stagnated and declined, leading to the relaxation of street vending regulation. A 'more tolerant approach' was taken towards unlicensed hawkers in light of the economic conditions, while the government still maintained about 190 squads of Hawker Control Teams to help regulate hawking activities.

Bottom-up Spatial justice in everyday life

Spatial justice in public spaces is a recent topic that draws attention to putting public spaces at the centre of urban politics and conflict (Jian et al., 2020). The topic examines the physical distribution of public spaces and raises numerous concerns pertaining to who has the right to public spaces and how that right is determined, contested, and claimed by different groups (Jian, Chan, Luo, et al., 2021; Mitchell, 2003; Siu, 2013).

According to Jian et. al (2020), spatial justice in public spaces encompasses five aspects under three dimensions, namely access and management; sociability and diversity; demand and provision; social stratum and information, and social inclusion. While 'diversity has long been used as a conceptual tool to assess planning outcomes with spatial justice considerations, the ability of public space to facilitate social interaction is also an essential indicator that helps examine whether a space is inclusive for diverse users (Jian, Chan, Xu, et al., 2021). As claimed, to seek spatial justice is to create more public places with more diversity for different people, instead of creating the same space without acknowledging heterogeneity (Jian et al., 2020).

Spatial justice in public spaces, together with the right to work in the city (Lefebvre, 1996; Adama, 2020), is of particular importance to this research issue since it raises the ques-

tion of the vendors using different kinds of available public spaces to carry out daily activities (Lefebvre, 2014; Mitchell, 2003; Soja, 2013). Crucially, this argument points to the important phenomenon that street vendors are denied crucial indicators of their right to the city that involve their rights of accessing and appropriating public spaces, thus omitting their role in facilitating bottom-up spatial justice (Lata et al., 2019; Siu & Zhu, 2016). This is reinforced by the fact that the available public spaces for street vending are decreasing owing to accelerating commodification and privatisation (Graaff and Ha, 2015).

As a representative urban informal sector, the socio-spatial exclusion faced by hawkers manifests as being under surveillance routinely, risk of being moved out of the space, or even violent encounters with enforcement agents (Adama, 2020). Female hawkers are reported to occupy smaller places. They sell perishable, less popular and less profitable commodities in less strategic spaces, making them easier targets for eviction (Adama, 2020). Well-positioned vendors usually feel more empowered to capitalise on uncertainties (Tucker & Devlin, 2019).

In response, street vendors are adopting a range of spatial, temporal, and relational tactics to maintain their daily business and rights of using public space. These tactics include but not limited to those highlighted by Adama (2020): ready-to-run, move to safer places, depend on informal relations and networks, and function only in specific hours. On the other hand, while street vending is under strict regulation, policy executors sometimes do not insist on eviction. Instead, they are open to, or encourage negotiations (Adama, 2020). This results in a liminal grey space (Lata et al., 2019) that nurtures the inclusiveness of the public spaces and facilitate spatial justice.

Methodology

Sham Shui Po, one of Hong Kong's densest and poorest districts, was selected as a case study owing to the vast number of residents taking advantage of the streets to engage in informal economic activities. Two streets in this district, Apliu Street and the connecting Pei Ho Street, were selected as the observation area, as Apliu Street is one of the representative 'hawker permit' zones officially endorsed by the Hong Kong government. Along the street, licensed hawkers market their goods in uniformed stalls. Furthermore, these two streets were designated as part-time pedestrian streets from 12:00 pm to 9:00 pm every day by the Transportation Department of Hong Kong. Vehicular access is only permitted at other times (Transportation Department, 2017).

Before collecting the data, the two selected streets were visited and mapped to identify the best observation spots. Data on the everyday interaction of street vendors were collected through first-hand observation from June to September 2022, including both working days and weekends, and covering two public holidays, namely Hong Kong Special Administrative Region Establishment Day and the Chinese

Table 1. Observation time

Selection criteria	Observation time periods
Warm weather to carry out outdoor activity	June 2022 to September 2022 Temperature ranged from 33 to 35 degrees Celsius
Public holidays	Hong Kong Special Administrative Region Establishment Day, Chinese Mid-Autumn Festival
A day observation unit represents four sections with street activity.	Morning (9–10 am), Early Afternoon (12–2 pm), Afternoon (4–6 pm), Nighttime (6–10 pm)

Qualitative methods, including on-site environment audits, unobtrusive observations, photo and video recording and note-taking, were adopted to facilitate the data collection process. The collected data were analysed through a categorical coding approach. Themes related to the various forms of street hawkers' temporary appropriation of streets as social spaces, as well as themes concerning the interactions among objects and spaces, are analysed and presented below.

Results

Overall, the observation yields 382 photos and 58 videos. We supplemented this process using random chats with vendors and their patrons. In line with some previous studies, hawkers in Sham Shui Po consist of people of diverse socio-economic situations. They can be easily differentiated with respect to gender, age, ethnicity and types of activities and the spaces they occupy. Males predominate in businesses like electronics and antique vending, while females are more engaged in selling fruits, vegetables, clothes and ornaments. Care can be observed in the interactions between street vendors and their customers, as well as the support and camaraderie that vendors offer each other.

In general, behaviours in public spaces present two forms: *human – human communication* and *human – object interaction*. While the former can be further understood from three aspects, namely social interactions among street vendors, between street vendors and their patrons or family and friends, and among patrons, the latter can, to a large extent, be comprehended from the perspective of solitary behaviour.

People who visit this vending market, besides making essential or random purchases, also tend to spend time commu-

Figure 1. Street vending in Sham Shui Po

Figure 2. People sleeping on the street

Figure 3. Vendors chatting with their patrons

Figure 4. People sitting along the street

Figure 5. open-air dining

nicating with friends or strangers, or just to pass the time by hanging around, 'window shopping'. Notably, the most common type of interactions that occurred along the street is between street vendors and their patrons, as this underpins the primary function of the market. These commercial activities comprise behaviours around shopping, such as bargaining and demonstrating products or services. Care is demonstrated in these interactions, as vendors may offer advice, assistance, or recommendations to their customers. Chatting among street vendors, especially during the evening, was also commonly observed in the markets (Figure 1 to Figure 6 present selected representative behaviours in the vending street). People were observed staying (i.e., eating, sitting, waiting, playing with their phone), working (i.e., selling goods, rag-picking), moving (i.e., walking, cycling), chatting, looking around, purchasing, lying, and even sleeping on the streets. During the process, people encounter, experience and tolerate the differences in the public spaces. The care shown by street vendors to their fellow vendors and customers helps to create a more inclusive and supportive environment within the market.

On the other hand, the study results suggested several types of human – object interactions in the streets. Street vendors utilise objects to claim space to work, occasionally bending regulations to do so. Care can be observed in the way vendors adapt and arrange their objects to make the most of the available space while considering the comfort of their patrons. While people, mainly the street vendors, claim the space through occupying using their odds and ends, in ways of enlarging or extending their pitch, the street also offers people a comfortable vibe to enjoy solitude. People were observed eating alone, playing with cell phones alone, sitting alone (e.g., sitting alone on the handrail; on the stall; on a concrete curb), and using the street as a transit station to wait for others alone. We also found one person sleeping alone on a temporary bed made of bubble chamber and cardboard. Whether he is homeless or not, the street provides him with a safe place to rest (Figure 2).

In fact, most activities happened in the streets with a purpose – commercial operation, while spontaneous communication and interaction rarely occur. Yet, hawkers potentially add to the vibrancy and inclusiveness of the street by directly engaging in the social communication with other people, as well as providing space and a setting for people to start conversations. Street vendors act as a catalyst to creating a safe, active, and lively atmosphere that nurtures spatial justice. They also play a role in offering 'eyes on the streets' (Jacobs, 1961) in this district with poorer social public order. In line with the argument of Adama (2020), while working, street vendors create informal relations and networks to overcome life challenges (Adama, 2020). They make the public spaces inviting and safe during nighttime, transforming traffic corridors into public spaces, thereby extending the use of the streets and facilitating its vitality.

Discussion and Conclusion

Even though street vendors contribute to the production of new kinds of public spaces that broaden the definition of which, governments, unfortunately, seldom acknowledge their significance. As space is a dynamic mix of order and chaos, a more inclusive understanding of street vending – a typical urban informality – is an important precondition for facilitating spatial justice in public spaces. In this context, the present study examines how street vendors in Sham Shui Po, Hong Kong are experiencing and practising their everyday practices through consciously or unconsciously appropriating public spaces, often demonstrating care for their surroundings and the people they serve. By looking into interactions that happened in vending streets, the research reiterated the indispensable roles street vending has played in everyday life of less wealthy people of the territory. We acknowledged the role of vendors in the appropriation and vitalisation of public spaces and argued that street vending confirms the liminality of streets – as space for mobility, for the market, and for social communication and human-object interaction.

Yet, in line with previous claims (Kinoshita, 2001), maintaining proper public hygiene is still a critical issue in the vending street. Care should be taken into consideration to ensure that the vendor's grounding claims to livelihood through favourable or sympathetic policies. Reasonable, supportive, flexible and projective policies towards street vending, as well as the collective efforts by policymakers, law-executors, and urban designers, can bring a more inclusive approach to the operational dynamics of street vending. A follow-up in-depth interview with both the hawkers and the public appeared in the street to understand their needs, motivations and perspectives, could offer new insights to decipher their behaviour, so as to better integrate the notion of care into urban design and relevant policy-making.

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The city of care through walkability and proximity. Researching on and with Generation Alpha on urban walkability assessment

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Abstract

The concept of the 15-minute city is a promising model to transform modern cities towards sustainability and resilience. However, the possibilities and accessibility to walking in the urban neighborhood depend on various factors. The average citizen could not be considered a reference to planning and making our cities. If cities are for all, different perspectives and opinions should be included, especially those who are less capable or have limited access to them. One of the under-considered groups for city-making is the children.

This paper presents a pilot research project that aims to engage children in urban exploration to assess the level of walkability to identify opportunities for developing more inclusive urban scenarios and environments. Based on the literature review on proximity and walkability and the relation between children and city-making, a class of 21 students (11 y.o.) has been involved to observe and assess the neighborhood's walkability and imagine a preferred one collectively. From the research results, discussions and reflections emerged. Children have their ways of interpreting the different walkability assessment factors, which might be highly linked among them. The research results bring discussions and reflections on emphasizing human perspective and perception of the city's walkability assessment criteria. Besides, the engagement approach and tools for urban observation and investigation are tested as an effective way to activate relationship building among stakeholders, who could collaborate better to care for the city where citizens, especially the children, live in.

Author keywords

Walkability; Proximity; Children and City; Stakeholder Engagement; Strategic Design Research.

Introduction

Urban proximity has been considered a desirable characteristic of future cities (Banister, 2011; Boyko & Cooper, 2011; OECD, 2012) for a long time. In presenting the concept of a 15-minutes city, Moreno et al. (2021) state that residents will enjoy a higher quality of urban life where they can effectively fulfill six essential urban social functions in proximity urban contexts: living, working, commerce, healthcare, education, and entertainment (Moreno et al., 2021). Applying this model requires a careful consideration of the hybrid usage of the spaces to provide the necessary functions and services for the residents and citizens. Moreover, the neighborhood should allow residents to move effectively – on foot or by bicycle – from place to place without problems and difficulties. The relationship between urban form and mobility has been mainly analyzed through three factors: environmental issues, the social significance of walkability, and the use of time in moving and traveling (Marquet & Miralles-Guasch, 2015). Rodrigue et al. (2006) have stated that one of the difficulties in analyzing proximity from the mobility point of view lies in the lack of a linear relationship between space and travel time due to the different speeds of each type of transport. This means that the different ways to study proximity vary according to how people move or travel from one place to another. Since the promotion and application of the concept of proximity have highlighted the importance of moving by foot, the relationship between the urban spaces and the time to travel could be linked and somehow defined by the walking activity. A "walkability" perspective on understanding proximity refers to the physical distance and space in the urban environment as well as the built environment, urban and public facilities, and the presence of necessary services (Blečić et al., 2016); more importantly, the capacity of people to reach a certain place (effort and access), the motivation and objectives, the sentiment and feeling, as well as the "invisible" social and cultural significance (Ewing & Handy, 2009).

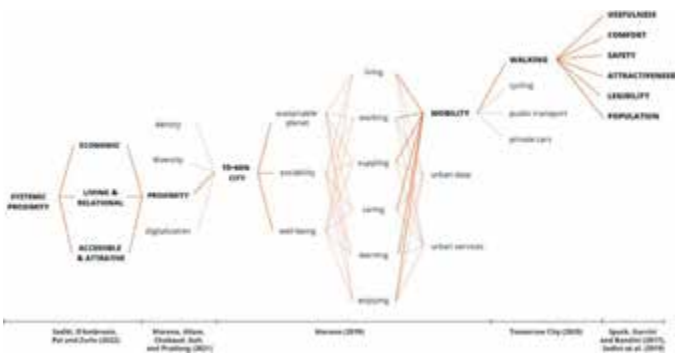

Figure 1. Visualisation of the connections of the factors related to the concepts of proximity and walkability.

The development of a more walkable urban environment is aligned with the notion of proximity. Jane Jacobs (1961) was one of the first urban planners who emphasized the importance of neighborhood proximity and the activism it can generate. She considered cities as dynamic and complex ecosystems, observing them in their infrastructural details and paying attention to sidewalks, parks, urban furniture, etc., as opposed to car-centered design. A first attempt on constructing this intersection between proximity and walkability was made in a paper presented at the RSD2022 conference, where a new concept of Systemic Proximity was introduced not only from the functional and spatial perspectives, but also the relational one, systematizing its domains with Quintuple Helix spheres (Sedini et al., 2022). Speck (2013) has presented the importance of developing the city for pedestrians and walking activity, which requires infrastructure development, network connectivity, a high land-use mix, vitality, and distinction of urban character. He identified four main walkability assessment criteria: *usefulness, comfort, safety*, and *attractiveness* (Speck, 2013). Safety is the key barrier to walking activities that includes issues like crime and traffic (Forsyth, 2015), which is defined not only by the infrastructure and built environment but also by the perceptions of safety. Besides functional factors, Van Cauwenberg et al. (2018) observed a positive association between walkability and aesthetically pleasing scenery with leisure time walking, emphasizing the necessity of considering "attractiveness". The analysis and assessment elements and methods of walkability and proximity have mainly focused on measuring through the use of assessment tools such as GIS analysis, space syntax, observations, sensors, and digital apps (Aerts, 2018, Blecic et al., 2015, Gorrini and Bandini, 2018, & Peyton, 2019) to evaluate the so-called location-based data, mainly related to infrastructural characteristics. While guides and in-depth studies addressing proximity and walkability from the people's (human) perspective (Marquet & Miralles-Guasch, 2015), individual-based data, are still lacking.

Children and walkability

A loud recall for humanity and a higher quality of life for all has been reawakened in every city worldwide (Sedini et al., 2022). Lefebvre (1968) defines the concept of 'the right to the city' as the phenomena that entail the social relations, functions, services, practicability of the urban public space, and its mission to fulfill the instances of all city users (Annunziata & Garau, 2018). It is extensively established that walkability contributes to the physical and mental health (Rundle et al., 2016; Todd et al., 2016; Zuniga-Teran et al., 2016) of people, regardless of age group; it also contributes to the quality of life and social inclusion of citizens that can develop a sense of belonging and ownership (Gorrini, 2021; Speck, 2013). Children's walkability is still not widely explored and consolidated because of their great complexity (as a group) and diversity of needs, especially given the limited available data (Gorrini, 2021).

The ability to walk freely and safely significantly benefits children's healthy and conscious growth as it involves experiences and practices that foster independence and autonomy (Shaw et al., 2015). Play is a fundamental activity of exploration and learning for children, deeply affected by the relationships between young citizens and urban areas (Annunziata & Garau, 2018). Furthermore, children's enjoyment of urban spaces allows them to observe and practice adult behavioral patterns, thus experiencing social constructions and developing interpersonal skills while gradually and individually defining their personas by contributing to society as future adult citizens (Unicef Innocenti Research Centre, 2004). This is where the many strategies and tools for assessing walkability come into play, tending to focus on the spatial dimension (Annunziata & Garau, 1980) and universal design indicators (Steinfeld, 2011). Instead, the perceived level of walkability is greatly influenced by the characteristics of individual walkers (Gorrini, 2021).

The children's engagement in city-making discourses is often guided by organizing co-design and co-creation laboratories within urban regeneration programs. These workshops witness the realization of a child's project, vision, or desire using recycled materials, prototyping, or a two/three-dimensional physical artefact (Pierandrei & Marengoni, 2017). As shown in various national and international projects and initiatives, such as *Walking the city at 95cm high* (2018), *Designing Streets for Kids* (2020), *UrbEX* (2022), a moment of exploration and investigation at the start of the workshop can be conducted, asking and instructing kids to take photographs, sketch, and take notes on what they see, like or dislike, all of which is then used to assist them in creating a concept for the identified purposes.

Research methodology

The main research question we have tried to answer is how young children perceive the concept of walkability in urban contexts. How could the experience of their active participation in the walkability assessment provide potential indications and guides to city development towards proximity?

The pilot experience presented in this paper was conducted during the Sustainability Development Festival 2022. The proposed initiative involved the Alpha generation (born after 2012) - a class of students from the secondary school of the Istituto Comprensivo Giusti d'Assisi. The research was led by a research group of the department of design of Politecnico di Milano in collaboration with the Junior design lab of PACO Design and ADI Design Museum. The team of facilitators and moderators was composed of design researchers and educators. The chosen neighborhood was in the "Sarpi" area, located in Municipality 8 of Milano (Italy). The activity lasted about 4 hours, from the beginning of the school day until lunchtime. It was developed in three macro steps, with three different and specific objectives and locations:

1. At **school**: researchers shared with the class (21 students) the agenda and the key concepts of walkability and proximity. After the first moment of knowledge sharing, awareness raising and ice-breaking, each student was given a booklet, a pen, and a badge. The first task of the booklet was individual and aimed at collecting the personal data about their knowledge on the neighborhood and their mobility habits.
2. In the **neighborhood**: the class left the school and started exploring, observing, and collecting data in the neighborhood and assessing proximity through the walkability factors. The walk was organized along two paths (A and B). Students were divided into two macro groups and then micro-groups of three members to collect data, which explored 6 pitstops distributed along the two routes (starting from the school and ending at the ADI Design Museum).
3. In the **museum**: once at the ADI Design Museum, the class was hosted in the Junior Lab spaces, managed

and curated by PACO Collaborative. This activity was about creating a story using a specific template that allowed the micro-groups to present what they had learned. The story was developed in both text and a collage, using three photos of the various pitstops explored by the micro-groups. The images used for the collage are prepared by researchers to support the creation of the collage. This activity aimed to reflect on what had been explored and share an initial evaluation of the neighborhood's walkability. Finally, a short collective plenary presentation by each group took place.

At the end of the activity, students left with a questionnaire to answer anonymously, which was then collected by the educators and were returned to the research team after a week.

Research tool design and data collection

In addition to presenting six tasks (one for each pitstop to journey A or B), a paper booklet with a special cardboard cover was designed to involve students playing an active and leading role in the research and observation activities (Sander & Sappers, 2008). Each page in the booklet provides specific tasks to guide students' observation activities. Besides, the cover is designed as a frame that works as a photographic frame, which could be used by the students to individually choose what to photograph with the help of the researchers and facilitators (Fig. 2). The frame enables students to show their own points of view and decide what they want to take and collect.

Figure 2. Some sphotos showing the booklet used by students: the cover (left) and examples of specific guides and tasks that students need to carry out (right).

Moreover, the tasks were quantitative and qualitative questions, specially alternated and based on proximity through the walkability factors. The questions, always placed on the right-hand page, were accompanied by a display of the overall map, pitstop reference point, and the walkability factors related to it (Fig. 2). The template used for the stories, on the other hand, was structured to provide space for text and space for collages (Fig. 3). There were to be three collages, using as a background, a realistic photograph of three of the six pitstops explored during the second macro phase of the pilot. The story was to be about a peer's walkability experience and was realized through a co-creation session by each micro group at the ADI Design Museum.

The research team collected all artifacts used and produced by the students for analysis purposes. These artifacts are both analog and digital. The analog data include those from the questionnaires (pre and post-experiment ones), the contents of the observation and evaluation carried out by the students, and the stories at both textual and figurative levels (the collages) in the last phase (Fig. 3). The digital data mainly includes the photos and videos taken to represent the students' points of view. The analog one was then transferred digitally by scanning and using a form to structure a helpful worksheet to triangulate the data analysis and insights that emerged.

Figure 3. Template(left) used for the creation of the neighborhood story in the last phase and an example of the filled tool with photos and stories (right)

Data analysis

The data analysis has been conducted by integrating digital and analog data triangulation. In this paper, we present the first results of data analysis; the authors mainly explored and generated answers to the research questions regarding walkability and civic engagement methodologies. For further investigation, the stories and collages will be analyzed by involving external psychology, education, and GIS experts. Therefore, to answer the research questions stated above, the analysis results thus were clustered into two main categories, the first one deal with the thematic content/topic of the research, children's perception and perspectives on the neighborhood's walkability and proximity, and the second one exam the research methodology itself.

Regarding the former, information extracted from questionnaires and booklets that present the children's perspectives has shown some differences from the literature and practices related to urban planning and regeneration. The walkability factors have often been seen as well-defined, clearly categorized, and distinct from one to another. However, the young children who participated in this pilot showed that the walkability factors (such as usefulness, comfort, safety, attractiveness, legibility, and population) could be correlated and overlapped above all. In other words, the students considered the factors together and not individually, creating relationships and even correlations by citing actions and actors. For example, following this reasoning, it is helpful to quote one of the many answers in response to the question *"what is the most important walkability factor for you?"* which is *"the most important factor of walkability, in my opinion, is usefulness - utility for the simple reason of usefulness = convenience = safety"*. Another peculiarity that emerged concerning the factors of walkability is the correlation and thus the order or rather the systemization of the six different factors. Here we quote another answer to the same question mentioned above: *"because attractiveness makes the population build the need for safety, comfort and work hence usefulness"*. It is worth noting how much the humanistic aspect of these responses related to the walkability assessment factors is present. And all these bottom-up perspectives and humanistic interpretations have been discussed very little in planning and building urban environments. Finally, another element that emerged is the importance of the sensoriality of urban spaces. The 15-minute city is based on the principle of chrono-urbanism, which sees the quality of life based on short and easy spatial-temporal accessibility. From the explorative experience, an emotional and relational dimension to the place could be observed by integrating data collected from the questionnaire and relevant questions in the booklet. This result indicates the potential studies on including a human perspective in the definition of walkability parameters and the assessment factors, and the role citizens could play in proposing different approaches to evaluate walkability.

Regarding the second cluster of results, the one concerning methodology, what emerged, in particular, is the great potential for capacity building and awareness raising that this type of activity can enable and empower. Indeed, answers to the question *"Did you enjoy today's activity? Why?"* such as *"I never notice the important things, so it helps me a lot"*, *"I had much fun [...] I noticed things I would never have seen"* and yet *"because it teaches me useful things in everyday life, and it is also very fun and interesting"*. Civic engagement linked to walkability experiences that consider participants as co-researchers trigger virtuous circles of capacity building and awareness raising that thus contribute to healthy growth as (future) adult citizens. It is, therefore, a question of empowerment, not by chance that it has been verified how answers questionnaire at the beginning of the experience, *"I know the neighborhood"*, at the end of the experience *"it was useful for me to notice things"*. The results of this pilot experience also reveal this kind of citizen engagement actions could set up strategies to articulate the needs of "overlooked" vulnerable targets, who may have diverse preferences and needs regarding amenity accessibility (La Rosa et al., 2018 in Weng et al., 2019).

Discussion

The analysis of research results brings further reflections and indications on how our cities could provide more care:

Firstly, including citizens' perspectives in city-making is more than involving them in co-research, co-creation, and co-design workshops. Participatory design is an effective way to embrace the users' perspectives in the solution-making process, especially for challenges and problems that are complex, ill-defined, and contextualized. However, not everyone has the capacity and knowledge to be able to actively provide their contributions. People have the right to user participation in design only if effective policies make people truly capable of design (Dong, 2008). Especially when facing vulnerable targets, who might have fewer possibilities to participate. From this research activity, we understood that the first phase of warm-up, the presentation on the concept of walkability and proximity, and the guided observation in the neighborhood had played a crucial role in making participants fully prepared for the last co-creation activity. Designers and design researchers should not only work on proving the accesses and occasions to engage participants in the conversations and design actions, but they should not ignore the necessity to equip the citizens with sufficient background knowledge and easy-to-act methods and tools, as well as concrete and unique personal experiences in which they feel comfortable and confident to make their suggestions and proposals. Therefore, we emphasize the co-research activity as important as the co-design/co-creation in the civic citizen engagement area.

Secondly, design and research interventions could activate new ways to collaborate and interact among stakeholders in the urban territory. The proximity concept promotes the mix-use and multi-functionality in the city, which will eventually facilitate new relationships, connections, and interactions that didn't exist before. However, this objective is difficult to reach without the participation and engagement of citizens and residents, who physically move in the neighborhood among different places and locations. For instance, the middle school and ADI design museum are physically quite close to each other; however, before participating in the research project, they have never had the chance to know each other, not even mention to collaborate. Both during and after this research project, we have seen and heard about the interest from both sides to continue the possibilities to collaborate on relevant activities and events. Moreover, middle school students have expressed great interest in coming back to learn better about the design museum and explore interesting events to participate in. The feedback and results demonstrate that the Quintuple Helix (eco)system of relationship (Carayannis & Campbell, 2010) could be activated and initiated by citizens' engagement in city-making and city-researching, at the same time, these actions foster the implementation of 15-minute city concept, which will eventually provide more effective care to citizens and residents.

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Hinges, passages, and comfort

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> "For some, it may seem dim and unilluminated to take the 'mere' comfort of the user as a constituent of architecture. In fact, anyone who is not prepared for that must be accused of an inferior definition of architecture. For, if its intellectual content only existed beyond commonplace purposes, architecture, after all, would be an 'applied,' contaminated art, since commonplace purposes can only rarely be by-passed."
> — Hermann Czech, 2007

Abstract

We all know comfort, yet we also do not know comfort. Arguably tied to physical well-being, a state of ease, and accessible for everyone individually, the conception of comfort was not always as such. Early origins beheld comfort as spiritual, mental consolation endowed by religion and acknowledged it as invigoration of the body's organs. It was a collective endeavour that progressively turned into a subjective matter.
For Cumulus Antwerp 2023, the paper 'Hinges, Passages, and Comfort' examines the concept of architectural comfort and a possible return to its collective dimension through the lens of two ordinary architectural elements: the door hinge and the passage. By this, it will transgress the seminal essays 'Figures, Doors and Passages' by the British architectural historian Robin Evans and 'The House as Path and Place' by the Austrian architect Josef Frank.

The essay will pair historical analysis with future speculations, offering alternative paths to substantially comfortable private and communal living. Both elements door and passage are attuned to the emerging private life since the seventeenth century and, hence, build the base to reverse this trend. The text aims to face contemporary, pressing issues in architecture, such as ever flatter housing standards or repellent public spaces, and to question a century-old one-sided cultivation of comfort.

The door, originally conceived to separate the human from the animal, divides all our experienced realities into private and public spheres, as well as all subtle and gradual distinctions in between. The element of the passage, historically introduced for the servants to access all spaces unnoticed, nowadays facilitates efficient connections. Today, both the door hinge and the passage are degraded to a mode of efficient exchange that comes closer to a rational and economic spatial disposition rather than an open and daring superimposition of social and cultural relations. As the history of comfort is a constant negotiation, so is the door's application and the passage's usage.

In light of the conference Cumulus Antwerp 2023, the essay 'Hinges, Passages, and Comfort' asks for a productive and sustainable architectural comfort to emerge. The chances for care and inclusivity as well as intimate collectivity through the revision of the architectural layout are given – let's seize them.

Author keywords

comfort, door hinges, passageways, carnal architecture, bodily architecture, multilateral spatial relations, social inclusivity, Robin Evans, Josef Frank, Hermann Czech

Introduction

We all know comfort, yet we also do not know comfort. Arguably tied to physical well-being, a state of ease, and accessible for everyone individually, the conception of comfort was not always as such. Early origins beheld comfort as spiritual, mental consolation endowed by religion and acknowledged it as invigoration of the body's organs (Köhler, 2003, p.9). It was a collective endeavour that progressively turned into a subjective matter.

Today's physical understanding of comfort finds its infancy in seventeenth-century France. The French bourgeois cultivated indulgences only accessible for the few. Later on, the eighteenth-century English proletariat emphasised elemental needs, opening the concept of comfort to a broader audience (Crowley, 2001). And as the social ladder in nineteenth-century Europe appeared to level, comfort emerged in relation to a materialistic revolution. The revolution rendered tangible a necessary luxury for the people and elicited concurrently one of the greatest resonances of today's European society: a private life (DeJean, 2009, p.16).

Comfort is inherent in one's personally structured daily life and presently cultivated as a right. Almost all our actions and behaviours are justified by the conception of private well-being (DeJean, 2009, p.1). This essay's effort is the questioning of comfort as an individual affair—paradoxically, by illuminating it. Hinges and passages suggest that our built environment possesses latent potentials to achieve comfort beyond common understandings. The treatise critically reflects on architecture as a formal-spatial practice of socio-cultural breadth through the lens of two seminal texts, 'The House as Path and Place' by the Austrian architect Josef Frank, and 'Figures, Doors and Passages' by the British architectural historian Robin Evans. Its argumentation shall prevent the building practice from ever flatter physical concretisations in housing as well as in the public realm. To enable proper care and inclusivity, spatial arrangements and their thresholds have to be revised.

The Door Hinge

A door splits space into two, imposes partitions, and prevents osmosis. It performs a form of caesura and fosters a duality between the individual and the collective, the private and the public, as well as the domestic and the outside world. In George Perec's words, its trespassing "requests a password, credentials, [and] a talent for communication." (Perec, 1997, p.37)

That this gliding from one space to the other is a feast for the architect daring enough to formulate this transition consciously, is seized only seldomly. In the text, 'The House as Path and Place', 1931, the Austrian architect Josef Frank posits a simple, yet radical position: "The opening of the door is of neglected importance [today]; I have to say that almost all doors are applied wrongly. They open towards the wall and the entrant suddenly stands there, causing unrest." (Frank, 1931, p.323)

By opening the door towards the room's centre, the gesture employs a distinct spatial event of psychological breadth. The door spans a natural space between its leaf and the adjacent wall. The entrant is neither suddenly exposed to multiple gazes nor overwhelmed by his exposition but moves rather protected from one space into the other. The door is as much the element that evokes an abrupt break of continuity as it is the element that attentively orchestrates transitions. A direct penetration comes closer to a Foucauldian conception of power relations, with all its forms of domination and coercion, but in Frank's work, entrances are drawn in length. For spatial comfort to emerge, there are concise decisions to be made. And the door hinge, usually spurned, plays a crucial role.

Already in the nineteenth century, opening the door with its back towards the centre belonged to the norm. If one reads Robert Kerr's The Gentleman's House, 1864, second part, section III, 'The Sleeping-Rooms,' chapter I, 'An Ordinary Bedroom,' it is recognised that the door that opens towards the room's centre was not only widely distributed but heavily demanded: "The primary features of plan in a Bedroom are, first, the door or doors, the fireplace, and the windows; ... The door ... must open with its back towards the fire (the rule for all doors), this position allows it to open with its back also towards the bed (equally a rule)." (Kerr, 1865, p.132) Studying accounts of Kerr and Frank, the door qualifies as a deliberate promoter of a heightened sense of privacy, a sensitivity that stimulates physically and psychologically. Of course, "[o]ne does not want to see if only by the slightest door-gap, the entire bed unfolding in front of one's eyes." (Czech, 2020)

Since the nineteenth century, the private retreat has been established to compensate for the bodily and mental grievances of daily life, liberating from the suffocating social pressures (Kerr, 1865, p.69). And it is well recognised that a change of community and shift in habits have severe repercussions on architectural settings: Floor plans, corridors, as well as doors are all signs of society. Architecture, at that time, went through distinct adaptations: public spaces in the house decreased in size, while private rooms increased in number (DeJean, 2009, p.9). Purpose-specific rooms emerged and a stark sense of individuality fostered (DeJean, 2009, p.16).

As the quest for social privacy is decided precisely at the link of the communal to the personal, it is the door as a spatial element that is crucial for its attainment. Historically used only to separate the human from the animal and the interior from the exterior (Crowley, 2001, p.18), the ever more refined domestic space requested an ever more considerate sequence from public to private. And as much as different shades of privacy became established, the requirements of comfort increased too.

Frank responds to this quest, as at his 'Villa Beer', 1929–31, done in collaboration with Oskar Wlach, the Frankian door is sought twice—at the bedroom's threshold and the hall's entrance. While the former event is linked to a well-known desired privacy of one's place for sleeping, the latter conforms to the sociability of the hall. A human of gentility does not want to be hastily exposed, nor should an entrant irritate too swiftly an already established social integrity (Frank, 1931, p.323). Comfort was not only linked to private feelings but to social habits too. The contrary conditions of both locations render obvious the door's need of being relational to the space in quest, and that the hinge has to consider a larger geographical pattern of domestic and public life.

Corridors

For doors to be of wider communicative relevance, they have to be joined by a "longe Entry through all" (Summerson, 1966). In architecture, the element that has overcome distances and separations evidently is the passage; in our homes duly known as corridor. The closest account of this element as a sign of social integrity—or its opposite—can be read in 'Figures, Doors and Passages', 1978, an essay by the British architect, architectural historian and architectural theorist Robin Evans. By analysing figure-ground relations of fifteenth- and sixteenth-century paintings in Italy, Evans distilled that the social and bodily behaviour of the protagonists possessed reverberations in architectural layouts of said time. Before the middle of the seventeenth century "there is no qualitative distinction between the way through the house and the inhabited spaces within it." (Evans, 1978, p.64) Yet, after this period in time "changes of internal arrangement became very evident." (Evans, 1978, p.70) For Evans, it was of significance that "[e]ntrance hall, grand open stair, passages and back stairs coalesced to form a penetrating network of circulation space which touched every major room in the household." (Evans, 1978, p.70)

Albeit the fact that "thoroughfares were able to draw distant rooms closer," (Evans, 1978, p.79) they first and foremost had to secure that "ordinary servants may never publicly appear in passing to and fro for their occasions there." (Gunther, 1928, p.64) Hence, it can be recognised that the introduction of the corridor at the domestic level, in accordance with the adequately placed door hinge, not only fostered a heightened private life but a deeper division "between the upper and lower ranks of society by maintaining direct sequential access for the privileged family circle while consigning servants to a limited territory always adjacent to, but never within the house proper; where they were always on hand, but never present unless required." (Evans, 1978, p.71) The corridor as much as the door hinge exemplifies the social milieu it is embedded in. It provided efficient exchange and employed alternative realities to both house owners and their servants; one that distinguished between a 'supported, staged life', and a 'rear party'. Since its infancy, the corridor is keeping apart what necessarily is in need of each other.

In the current architectural practice, the increased implementation of unidirectional thoroughfares—apparent in the

Figure 1. Bearwood House, Ground Floor, 1871, in Robert Kerr, The Gentlemen's House

public as much as the private—disengages rooms adjacent to each other. Commonly, the corridor as much as the passage joins spaces far apart at the cost of a bodily matrix of spaces, by repelling physically adjacent localities, and diminishing socially meaningful chance encounters. To bring spaces into a merely functional exchange levels geographically and geometrically distinct locations to numb next-to-each-others. It's neither the arranged proximity within the matrix of rooms, the installing of a heavy door, nor the placement of the household's most offensive activities at the greatest distance—all methods architects such as Alberti heavily relied upon—that brings people together or draws them apart but the strategy of a fully privatised compartmentalisation, coupled with universal accessibility, that provides apparent physical and psychological comfort (Evans, 1978). Occupants of a flat, a house, or an apartment block, citizens on the street, at the mall, and at work, regardless of their social standing, had become nothing but a potential source of disturbance. The corridor "is employed more and more as a preventive measure; an agency for peace, security and segregation which, by its very nature, limits the horizon of experience, reducing daily life to a private shadow-play." (Evans, 1978, p.89)

Facilitated Communication

As the quest for private space in the nineteenth century had advanced to the new social normality, spatially structuring elements became a means of facilitating communication and reducing incidental contact (Evans, 1978, p.79). Both corridor and passage put together a rational and economic spatial disposition rather than an open and daring superimposition of relations. A corridor performs as the vein and artery of the building, invests in its spatial dynamics, and provides a conduit for people's behaviour (Templer, 1992, p.x). Yet, it usually defies the formation of flourishing encounters; prevents moments of halt and social exchange. In current debates, comments on comfort's conception such as Frank's and Evans's are not evaluated according to their sensitivity but to their rationality.

Comfort in the light of the corridor lost much of its previous historical, social, and spatial charge. It is neither psychologically elaborated nor collectively discussed. Frankly, there has to be a conscious negotiation of the user's genuine needs—which inevitably are different for each one of us (Czech, 2016). Architecture should consider once again to achieve also "an accord about—potentially different—access routes." (Czech, 2016) Even during the seventeenth century, the corridor in Italy was not "an exclusive means of access at this time, but was installed parallel to interconnecting rooms." (Evans, 1978, p.71) While the introduction of the corridor had to serve social means, interior spaces stayed connected due to reasons of convenience. The plainly connecting corridor of today's time causes space as an entirety to be forgotten; space becomes the blind spot in a scientifically and politically induced world (de Certeau, 1984, p.95).

It took a decisive shift in the corridor's formulation to arrive at the moment of spatial ailment and it will need an equally decisive shift to leave it again. To implement it spatially, stimulative, and socially, while embracing its functionality, approaches a comfort that considers the corridor and its adjacent hinges not as a means of purpose, but life-participating element.

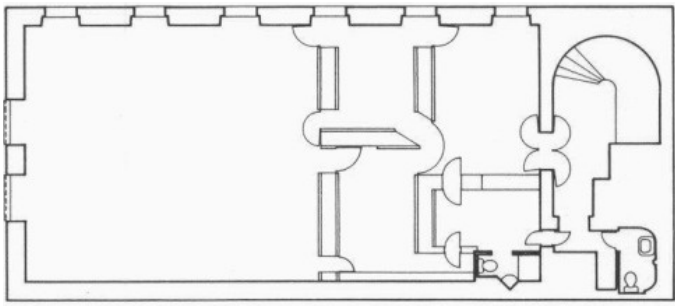

Figure 2. Atelier Singerstrasse, Floor Plan, Hermann Czech, 1989, Courtesy of Hermann Czech

Transgressing Functionality

In another Austrian architect's work, the work by Hermann Czech, also a close follower of Frank, one recognises an additional stimulation on the elements per se. Czech, in his 'Atelier Singerstrasse', 1989, takes the ordinary component of the door and exploits its ambiguous character, fostering a quest that may lead us to the door's latent potential for collective life. Due to its ambivalence, Czech reminds us of Michel de Certeau's door-related logic of ambiguity: "It turns the frontier into a crossing, and the river into a bridge. It recounts inversions and displacements: the door that closes is precisely what may be opened; ... [it] is ambiguous everywhere: it alternately welds together and opposes insularities. It distinguishes them and threatens them. It liberates from enclosure and destroys autonomy. Thus, for example, it occurs as a central and ambivalent character." (de Certeau, 1984, p.128)

Czech's characteristic door is an intervention that points towards the door as a theoretical and practical problem and the possibility in shift from a private to a collective comfort. His ambiguous one-hinge but double jamb leg—analogue to Marcel Duchamp's 'Door, 11 rue Larrey', 1927—explores the dialectic nature of the element. It is neither open nor closed but regularly both and therefore challenges the user mentally as well as bodily. It serves two thresholds and three rooms at once; it is not only functional; it exceeds functionality; it possesses concision and a gesture of economy. The door creates through the act of elimination. Yet its arising ambiguity through the opportunity to close, despite its impossibility to shut, recalls an inexactitude Czech so often refers to. The door at Atelier Singerstrasse achieves this effect by the most traditional of means. It attains through the conventional a rejection of a simple, clean-cut solution and seeks in the door an index of reality (Naegele, 2006, p.6).

Czech's decision is a conscious negotiation that at once serves and challenges a multitude of comforts. In fact, due to the dual nature of the door, the adjacent spaces are either closed chambers or openly connected rooms. The employed gesture generates a dependency between spaces and renders the introduction of a proper corridor fruitless. Although the primary intention is to save space otherwise obstructed, spatial practices of sixteenth-century Italy are latently present. One only has to think of 'Villa Madama' by Raphael and Antonio da Sangallo, or 'Palazzo Antonini' by Andrea Palladio. The interconnected spaces foster a carnal and bodily behaviour, facilitating uncontrolled communication and allowing incidental encounters. The atelier appears as a matrix of connected rooms that "recognizes the body as the person, and in which gregariousness is habitual." (Evans, 1978, p.88) It operates according to a collective understanding of space that since the nineteenth century is considered a fault; mainly because in thoroughfare rooms privacy and retirement—therefore also comfort—are apparently unobtainable (Evans, 1978, p.63). Czech's intervention allows one closed room at every given time while the remaining atelier performs as one big open-plan office (Czech, 2020). It values comfort on terms that prefer the commingling of users to their increasing distancing. Interrelated spaces seek company as much as solitude as a meaningful human condition. Conjoining the advantages of both closed-up spaces and intensely exchanged rooms, the single-hinge but double-frame door aims for an intimacy experienced by a collective.

Collectivising Comfort

If we want to seek a more robust positioning of architecture concerning a caring and inclusive built environment, we have to grasp the ordinary element's potential and understand "architecture's instrumental role in the formation of everyday events." (Evans, 1978, p.89) Does one render our current social proclamations for equality, gender neutrality and openness as impulses for revised architectural layouts yet to come, inclusive spaces might be achieved through the thoughtful and considerate formulation of hinges and passages. Not facing the problematics in plain sight from a spatially concrete point of view, would identify us as moral apostles rather than ethical human beings. Comfort, as much as it is about physical indulgences today, has to be considered as a body and mind in movement always in close relation to our fellow human beings and the immediate environment. Basic architectural elements enable closeness among family members, bonds between roommates, and healthy exchange among neighbours. Their formation leads to a respectable togetherness, meaningful conviviality, and an expanded horizon of experience. Both the hinge as well as the passage demonstrate an opportuneness in reinstating concurrent moments of privacy and security, as well as collectivity and community.

However, as long as the social and ecological aspects of today's architecture are more concerned with the fabrication of buildings than their spatial structures, achieving accordance about a collective comfort will be difficult. In today's practice, moral demands exert pressure on the social justices of architecture's planning but in its realisation "the body had been abandoned to lassitude." (Evans, 1978, p.82) Another drawback of the current architectural practice is that the door and the passageway, combined with today's advent of technology, form an unbearable simultaneity of hyper-connectedness and bold separations. The latest developments towards a private life while being permanently virtually connected magnified "the value of objects and diminish[ed] carnality, till the body appeared as little more than a heavy shadow of the spirit." (Evans, 1978, p.83)

Figure 3. Madonna dell'Impannata, Raphael, 1513, Credit Galleria Palatina, Palazzo Pitti, Florence

Conclusion

The questions stubbornly recurring are: Do we really find comfort in the escape from the pressures of society; seeking retreat in the private instead of the public? Or might there linger such a thing as an architecture propelled by the deep fascination that draws people towards each other again; an architecture that recognises passion, carnality and sociality? Fact is, both the door hinge and the passageway bear latent potential for change. The door is a relational double register, and the corridor a servant of performed life. Comfort is gliding from one place to the other, enhancing the movement from one space to another, strengthening the interhuman relation actively and considering exchange productively. Comfort is as much a matter of movement as it is actively situated within that movement. It employs space in time, as it produces a local condensation in a spatial continuum. Comfort arises if one is bodily and mentally intimate with the spatial practices of daily life. Evoking such spatial intimacy presupposes an architecture that is spatially negotiated rather than theoretically or factually predefined. It valorises the concrete architectural gesture. Our architectural surrounding interlaces physical and emotional realities with economic structures, functional demands, cultural fabrics, and social systems.

Aiming for comfort means seeking general productivity for "future life and its striving, its wooing and desiring." (Loos, 1900) As much as architecture is the fight for space and time, comfort is the endeavour to lend collective life liveability. Dwelling on the simple, clean-cut architectural element aims for both.

For our beloved future, it is clear that comfort emerges if the spatial events produced by the door hinge and the passageway operate consciously in its double register: attuned to a particular privacy, yet, relational to a distinct community.

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Renewal of urban ecological transportation network based on inclusivity design Take Sydney's "Livable Green Network" plan as an example

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Abstract

In recent years, as a means of maximizing ecological and sustainable urban life, the network of pedestrian and bicycle lanes has expanded dramatically in importance as a metric of livable cities. It connects people to the main transportation, hotspots for entertainment, cultural centers, parks, and open areas in the city. City people can travel around the city on foot or by bicycle while simultaneously fulfilling their basic daily needs for food, healthcare, and education thanks to the integration of urban ecological transportation networks. In order to achieve the objectives of reducing pollution and emission, promoting people's wellbeing, and improving the environment and climate, the ecological transportation network has improved the inclusion planning of people and climate compared to the traditional automobile transportation. The "Livable Green Network" design in Sydney is used as an example in this paper. And starting from the three aspects of integrated transportation network, dynamic public space, and pedestrian guidance system, this article analyzes the construction of livable green network in the city with the goal of sustainable Sydney development; investigates the high-quality connected pedestrian environment provided by urban dynamic public space; discusses the role of inclusivity pedestrian guidance system in supporting people's choice of safe travel in the city; and strives to promote the development of livable green network in the city; and aims to explore a more inclusivity urban ecological transportation network update scheme. Building an inclusive urban ecological transportation network can help people live in livable environments, foster social inclusion and trust, and successfully encourage engagement from all city stakeholders in support of urban ecological space governance and sustainable development. This is important given the growing severity of climate issues and the goal of urban sustainable development.

Author keywords

Inclusivity; Eco city; Green transportation network; Public space; Joint participation

Introduction

By 2025, more than 70% of the world's population will reside in cities, according to projections made due to the ongoing urbanization process (United Nations, 2008). The concentration of a high number of people in cities will provide issues in terms of population, transportation, sustainability, energy, and other factors, as well as cause urban designers to sound the alarm. For the purposes of future urban development, "car first" transportation planning is no longer relevant (Register, 2006). Over the past 20 years, the idea of a "inclusive and sustainable city" has grown significantly. Transport and other services play a significant part in the development of an inclusive and sustainable city, and can successfully address the accessibility, safety, and other social inclusion challenges of vulnerable groups.

There are around 1 billion disabled people in the world, or 15% of the total population, according to data from the UN. Nearly half of those aged 60 and older have one or more disabilities, and more than 250 million have moderate or severe disabilities. In addition, the percentage of pregnant women, children, and other vulnerable populations must not be overlooked. The basic principle of the 2030 Agenda for Sustainable Development is "let no one fall behind," underscoring the fact that the solution to inclusive development is not simply a legal matter but also an investment in the future of all people. Their ability to fully participate in society, exercise their right to health, well-being, and public participation, and use urban transportation can all be facilitated by a physically and socially accessible, joyful, and inclusive environment. Planning an inclusive transportation network will help cities become more urban, provide a safe, comfortable, and healthy social environment, raise the temperature of the city, encourage social interaction, and boost public awareness and social cohesiveness.

Walking and cycling are frequently overlooked in traffic thinking when compared to the "City of Cars." However, due to the current economic and environmental issues, many cities are reevaluating their objectives in order to adapt to positive traffic, with the goal of making walking and cycling the norm, particularly for short trips. Sydney made an effort to alter the mode of transportation, which has historically been dominated by automotive traffic, in 2007 by creating a systematized network planning for urban slow traffic and developing a number of bicycle action plans. The 10 strategic goals of Sustainable Sydney 2030 were presented in 2008

as part of a citywide sustainable planning city in Sydney. The planning and construction of bicycle and pedestrian traffic networks as well as the green connectivity of the entire city were highlighted in the seventh, eighth, and ninth items of the particular goal planning.

- TARGET 7: By 2030, at least 10 per cent of City trips will be made by bicycle and 50 percent by pedestrian movement.
- TARGET 8: By 2030, every resident will be within a 10 minute (800m) walk to fresh food markets, childcare, health services and leisure, social, learning and cultural infrastructure.
- TARGET 9: By 2030, every resident in the City of Sydney will be within a three-minute walk (250m) of continuous green links that connect to the Harbor Foreshore, Harbor Parklands, Moore or Centennial or Sydney Parks.

In the context of urban regeneration and sustainable development, the implementation of the "Livable Green Network" plan based on inclusive design would serve to increase the accessibility of disadvantaged groups, ensure the travel safety of pedestrians, and encourage people to deliberately select a more environmentally friendly form of slow traffic as an alternative to automotive transportation. Under the premise of meeting the travel demands of daily life, it will increase the allure of short-distance travel and realize the network interconnection of traffic throughout the city.

This paper describes and examines the inclusivity and sustainability of Sydney's green transport network construction through case study using the "Livable Green Network" plan as an example. Our research intends to address the difficult issue of inclusive planning for urban green transportation networks and investigate a broad framework to enhance the current environment for transportation networks.

Literature Review

Sustainable cities

At the second UN Habitat meeting in 1996, the concept of a "sustainable city" was formally introduced (UN-Habitat, 2001). The concept of a sustainable city is defined as the continuity of the three facets of environment, society, and economy, which calls for the city to be able to keep sustainability use at a sustainable level and to be highly resilient to hazards. This concept first emerged simultaneously from Howard's "Garden City" and Geddes' Eutopia hypothesis. "Ecocity" and "Sustainable urban planning" have gained popularity in the field of urban planning as a result of its concept. Since then, researchers have started looking into novel space forms, transportation planning, land use, and other topics (Jabareen, 2006). The phrase "smart city," which has the meanings of sustainability and inclusivity, first appeared in 2010 with the advancement of science and technology and the passage of time. It is a city concept that combines cutting-edge technology and methods of urban planning to address economic, environmental, and social issues, provide for people, and enhance quality of life. Sustainable cities have become an obvious alternative for people who wish for a better living in the context of coping with climate change. With the continuing advancement of research, they are gradually expanding into urban environment, transportation, social equality, inclusivity, and health-related fields.

Ecological Transportation Network

The concepts of "eco city" and sustainability are currently seen as the ideal city for urban growth, and the development of eco cities is impossible without the construction of transportation. The concept that the ecological transportation network is built on a composite ecosystem, which is made up of three systems: social, economic, and natural, was first advanced by Shijun Ma and Rusong Wang in 1984 (Ma & Wang, 1984). In order to fulfill the goals of fairness and reasonableness, structural optimization, and sustainable development, it uses the flow of people and logistics as its central tenet and includes land, energy, natural ecology, etc. in the scope of planning and management. Prof. Carlos Moreno put up the "15-minute City" planning concept in 2016 (Moreno et al., 2021). In addition, the 20-minute community life circle in Melbourne, the 15-minute community in Ottawa, and the 15-minute community life circle in Shanghai also use travel distance as a gauge of living convenience. Green transport is frequently equated with slow-moving traffic and public transport systems that are mostly made up of walking and cycling routes. Planning for safe, reasonable, fair, and inclusive transportation can improve people's travel options and inspire them to utilize more environmentally friendly transportation.

Inclusivity Design

In an effort to remove the obstacles preventing the elderly from using design products in the context of Britain's aging population, Coleman, a British researcher, established the concept of inclusive design in 1994. It is known as "Design for All" or "Universal Design" in Europe and the US, and it refers to a general design approach that designers use to make sure that their products and services satisfy the demands of as many customers as possible, regardless of the customer's age or ability. A national standard for barrier-free design architecture was created in the United States in the 1950s with the intention of making it simple for disabled troops and other disabled people to enter and exit the structure (Persson et al., 2015). As large-scale urban construction in the United States came to an end in the 1950s and 1970s, professionals started to focus on small-scale planning and design ideas including transportation oriented development (TOD), new urbanism, and universal design. These ideas promote inclusive design by offering accessible public spaces, alternative means of transportation, housing, and housing, as well as a neighborhood that can be reached on foot (Fletcher et al., 2015). From the standpoint of service objects, inclusive design intends to benefit everyone, including the full life cycle of users (Heylighen et al., 2017), in contrast to traditional design, which is less fair, less just, unhealthy, and unsafe. It also aspires to help all people, unlike the early sole focus on the elderly, children, or the disabled.

A Case Study of Sydney's "Livable Green Network" Plan

Overview of "Livable Green Network"

Sydney holds a significant role in the economic, social, cultural, and other spheres as Australia's largest city. Sydney is regarded as one of the world's most livable cities at the same time. However, as a result of the effects of global warming and the ecological issues caused by the city's rapid development, the Sydney Municipal Government has started to rec-

ognize the enormous difficulties that the city's sustainable development would confront in the future. In response to the goal of sustainable Sydney 2030 urban development, Sydney performed a planned assessment and analysis of pedestrian traffic and public space in the city, highlighting the benefits of ecological transportation such as walking and cycling as well as the lack of inclusive facilities, and produced the "Livable Green Network" plan based on this. The "Livable Green Network" is based on slow traffic impediments and pedestrian data from important places collected through Sydney study and renovates the city's pedestrian and cycling networks based on the city's slow-moving traffic lines.

By connecting the city center, village center, public transport, important parks, entertainment facilities, and other destination locations, it is proposed to provide a thorough and clear barrier-free slow traffic network for people and visitors. This will encourage and meet the travel needs of people with disabilities, which will increase the share of walking and cycling in the city and lower greenhouse gas emissions. At the same time, the plan focuses on the needs of inclusive access, sidewalk facilities, road improvement, and composite transportation in order to address the challenges and obstacles that people walking and cycling face. The goal is to construct 10 key Livable Green Network corridors, attractive public area streets and lanes, and a safer and more comfortable inclusive biking and walking environment in the city by the year 2030 in order to connect the sustainable slow-moving traffic network of several regional centers and encourage people to prioritize walking and cycling.

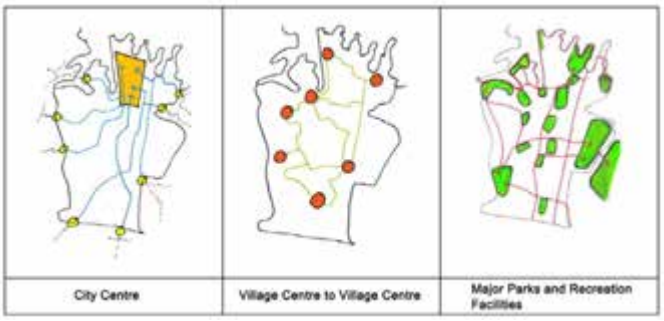

Figure 1. Insert a caption below each figure, and number all figures.

Table 1. An Investigation on the Obstacles of Walking and Cycling in Sydney(2017).

Place	Problem	Obstacle causes
Woolloomooloo	Topography	Steep slopes and cliffs increase traffic difficul-ties
Regent Street Redfern	Traffic speed	Busy trunk roads cross, limiting the frequency of safe passage
Erskineville	Infrastructure barriers	The railway corridor restricts the acces-sibility and direct connection of the destination
Botany Road	Narrow sidewalks and obstacles	Narrow sidewalks re-duce traffic conveni-ence, and improperly placed facilities hinder walking
Kent Street Underpass	Public domain quali-ty/safety	Poor quality urban space makes pedes-trians feel unsafe and hinders walking
Southern Industrial Area	Poor street connectivity	Rough street networks reduce choice and restrict direct connec-tions to destinations
Street	Lack of infrastructure	The construction of toilets, bubblers and rest areas will encoura-ge walking and cycling
Street	Lack of guidance information	Clear information helps increase the experi-ence of walking and cycling

Integrated Transportation Network

Famous urban planner Jan Gehl noted in the research report "Sydney Public Space and Public Life" from 2007 that while Sydney benefited from its stunning coastal environment, expansive parks, and unique terrain, the city's center could not adequately serve pedestrians due to walking obstacles and regulations that made it difficult for pedestrians to easily enjoy slow-moving traffic (Matan & Newman, 2016).

According to the study's findings, the primary factors affecting a network with slow traffic are slow traffic speeds, congested roads, limited pedestrian facilities, uncomfortable walking conditions, weak public space security, and a lack of guidance systems. The elderly, disabled children, and others with disabilities are most affected by these barriers, which to some extent discourage people from preferring to walk or ride. On the basis of this information, Sydney studied and analyzed the city's transportation network, the central transportation network, and the village center transportation network, and advanced the concepts of slow traffic route connection, road alignment, and public domain quality improvement. The prioritizing of transport methods designed to increase spatial efficiency and sustainability while preserving the flow of business and delivery vehicles serves to further support these developments.

Sydney has been gathering data on local walking patterns since 2013 by conducting two walking count surveys each year in the months of March and October. Approximately 100 locations will be chosen for counting and statistics between the hours of 6:00 a.m. and 12:00 a.m. The locations that are involved in building livable networks are based into construction while choosing a location. According to changes in populated regions and new urban project areas, survey locations will be changed. In order to study and analyze the walking data for the entire city, pertinent statistical data are counted in increments of 10 minutes each hour, multiplied by 6, and then divided by 24 to get an approximation of a count for the entire hour. Then increase the statistics of public water fountains and trash cans. The Sydney City Data Center will get universally summarized data from the automatic sensors that have been utilized to count pedestrians in Sydney as of 2020. Sydney now has a clear and focused research base on which to keep promoting the construction of a livable green network thanks to the collection and administration of data. Pedestrian travel will be prioritized throughout the traffic reconstruction and facility setting, and GIS pedestrian penetration analysis will be used to analyze the pedestrian accessi-

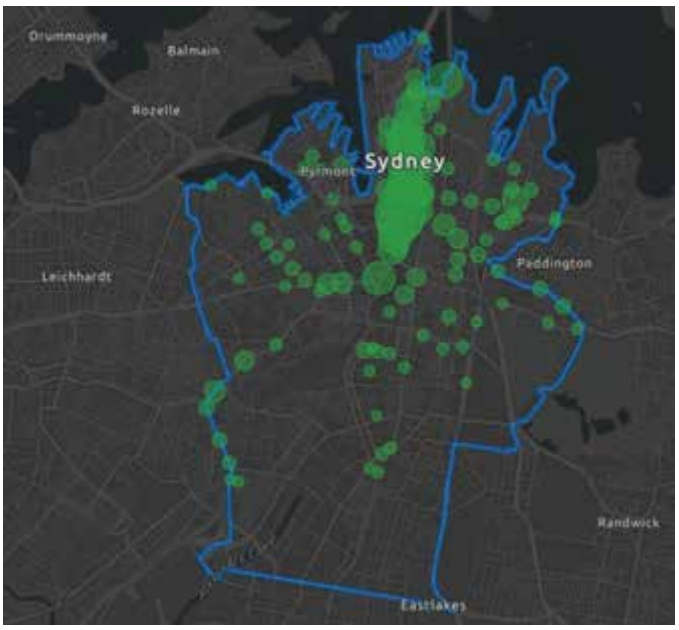

Figure 2. Map of Sydney Walk Count Survey Locations.

bility of activity centers, community facilities, schools, and traffic stations.

Currently, Sydney's traffic problems of road congestion and public transport overcrowding will persist for some time, necessitating the ongoing construction and modernization of a comprehensive urban network to ease traffic issues. A thorough plan has been made for this by the "Livable Green Network." First and foremost, with the overall traffic planning of one main line and three squares, the construction of George Street Central Pedestrian Road will be reserved, connecting the three key sites of Ring Wharf, City Hall, and Central. Second, as the central walkway gradually moves to the south, new streets are added, and public squares are constructed to accommodate increased community traffic. Last but not least, to meet several traffic goals, a clear hierarchy of streets should be developed. The construction of a comprehensive traffic network has redistributed the limited road space, connected the network consisting of main traffic providing bicycle lanes and shared spaces or paths for passengers, and made walking and cycling more pleasant and convenient, such that the primary community amenities are within walking distance. Walking, cycling, and public transport all work together to make a city more sustainable, green, and healthy.

There are currently 392000 bicycle trips among the over 16 million daily trips of less than 10 kilometers in Sydney's downtown. The percentage of people who commute by bicycle has increased by 50%, while the number of people who commute by bicycle has increased from 1.9% to 2.5%. Initial results from the construction of an integrated transportation network have been positive, and its inclusive network design and sustainable transportation planning have successfully boosted the potential of urban slow traffic to some extent.

Dynamic Public Space

The "Livable Green Network" plan will improve urban space's attractiveness in addition to the planning of a comprehensive transportation network by walking an active public space and an open city to encourage people to visit the entire city on foot or by bicycle. The potential of a safer, more desirable, and more appealing space to offer more options for social activities and transform into a hub for cultural interaction is referred to as the vitality of urban public space (Jalaladdini & Oktay, 2012). The plan primarily originates from three issues when it comes to creating dynamic public space. First, there is the resurfacing of lanes. By expanding the small-scale space available on streets and driveways, it offers fine-grained space for the setting of small retail shops to meet the increasingly diverse lifestyle needs of pedestrians, attracting more pedestrian traffic and generating vitality for the area. Second, there is street reconstruction. Streets serve as both a connection between places and significant public places. The public space is the main focus of the main street restoration. The goal of highlighting the unique qualities of the street and extending a sincere invitation to everyone to stop by is to enhance the street's public realm, create a gathering place for the community, and enhance the traditional link and traffic-corridor functions. Thirdly, it is where public art is displayed. The placement of public art in urban public space contributes to the enhancement of space characteristics, the highlighting of urban culture, the attraction of more people to visit and interact, the enhancement of space vitality, and the encouragement of walking tours. While improving the quality of urban life, the inclusivity and public participation of public art can increase recognition of the city's public sphere, generate additional places for communication, relaxation, and recreation, and stimulate the enormous development potential of urban space.

The space of vibrant public space will contribute to the construction of interesting new urban areas and increase the city's appeal to residents, employees, and visitors. The fundamental space of inviting everyone to visit is determined by how public spaces are advertised. As the place where the road connects, a high-quality, vibrant public space may efficiently link the pedestrian street and provide for the basic needs of the community in terms of everyday health care, leisure, socializing, education, and culture. Whether they are elderly, young, or disabled, everyone can enjoy public people and public life in a safe, convenient space, which will substantially increase their level of travel confidence. Therefore, offering a high-quality linked walking environment and significant public space for all people to meet the value of people's social and recreational needs is seen as an important criteria to measure the livability and sustainability of the city.

Inclusive Pedestrian Guidance

A inclusive pedestrian guidance system provides everyone with clear and identifiable information about traffic road guidance and infrastructure along the way as a crucial component of a slow traffic network. The installation of pedestrian priority streets and comprehensive guidance systems in high-traffic sections of the city can offer pedestrians with clear traffic information and boost people's confidence in their ability to navigate the city on foot with ease. The installation of inclusive guide signs was finished in 2015, gradually creating a significant component of Sydney's traffic guidance system. In 2014, Sydney established an installation trial to explore and evaluate the sign kinds of tactile/Braille signs. It offers an inclusive guarantee system for all types of people to pass on the road safely and conveniently on the basis of practical pedestrian use and safe road guidance.

Maintain the importance of physical access issues and ensure that people with disabilities have access to the public domain, including transportation, parking and signage:

- Continue to install and maintain roadside ramps in Sydney.
- Periodic inspection or audit of all access curb ramps.
- Audit the current bus stops to assess whether they meet the requirements of barrier free public transport standards.
- Ensure that the needs of users with disabilities are considered in the following aspects: design, maintenance and layout of facilities and fixtures; The planning process for the development of parks and other outdoor spaces, including the placement of street furniture.
- Develop sidewalk trading policies considering best practice examples and the rights and needs of all pedestrians.

From a sociological standpoint, inclusive design encourages social harmony and satisfies the travel requirements of many groups by creating social cohesiveness and ensuring accessibility of public areas and services (John Clarkson & Coleman, 2015). All kinds of people are able to access the urban traffic network and facilities without any obstacles thanks to inclusive traffic information improvement, which also enhances urban equality. By efficiently addressing the safety needs of pedestrians on the road, increasing accessibility for all kinds of people, and providing clear information on the slow traffic network, clear and accurate inclusive guidance can encourage more pedestrians to move freely, safely, and comfortably around the city. The convenience of eco-friendly transportation is ensured by inclusive pedestrian guidance, which also reflects the temperature of the city.

Discussion

By examining the inclusive design used in the "Livable Green Network" in Sydney, it is discovered that its inclusion extends to everyone rather than just a select few. In the planning and implementation process, social fairness and a safe and comfortable environment are taken into account as they may affect people's travel preferences in addition to the reduction of travel barriers. The concepts of walkability and recyclability can be characterized as the quality of walking and cycling circumstances, including safety (excellent vision, no intentional damage, well-maintained public areas, pedestrians and cyclists have priority over cars), comfort (sidewalks, ramps, rest spots for the elderly or the rehabilitated), convenience (lines of hope, meeting special needs), Connection (round-trip destination, public transportation node), and readability (sign, travel time, distance, danger).

Figure 3. Sydney pedestrian information guide.

This case merits additional attention due to its inclusive planning strategy and positive outlook for the construction of future urban transportation networks, even though it is still in the process of continuous practice and is not at the point of completion. A growing number of academics and urban decision-makers are focusing people and nature in response to the current climatic difficulties and urban issues. Future urban planning will surely center on creating people's cities and ecologically smart cities for the general public. Inclusion and sustainability objectives will be integrated into the construction of ecological transportation networks.

Conclusion

The case of Sydney's "Livable Green Network", which is based on updating an inclusive urban ecological transportation network, is described and discussed in this essay. In order to meet the expanding practical needs of social equity and sustainable development, it aims to develop and implement an inclusive transportation network plan for all people. Through the analysis and discussion of real-world people, it has been discovered that the design of an inclusive traffic network can not only provide high-quality connected traffic environments and remove all travel-related barriers for everyone, but also successfully promote people's walking preferences. This research is light on the inclusive design of urban transportation systems, analyses the construction of future urban ecological transportation systems from the standpoint of inclusive and sustainable development, and places a strong emphasis on creating a safe, just, and comfortable environment with slow traffic for everyone. People are urged to deliberately embrace a green travel lifestyle to actively address the difficulties posed by social equity and climate change.

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How to take care for Alfons Francken's Antwerp modernist social housing? How does it take care of its changing population?

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Abstract

In the 1930s architect Alfons Francken designed two progressive, modernist, well equipped social housing complexes for the Antwerp social housing company *Onze woning* [Our Dwelling]. Both complexes, located in the multi-cultural Antwerp North neighbourhood, are indebted to the Viennese Housing Courtyards and the Existenzminimum defined by CIAM. The housing projects still exist and are renovated in the meantime. However, their population has changed drastically as Antwerp has developed towards a super-diverse city. The original inhabitants were supplemented by people of diverse migration backgrounds, mainly from Morocco.

What is the value of this heritage nowadays? How do people with another dwelling culture appropriate and inhabit these buildings. How do they give shape to their interiors and how do they use the surrounding public space. By means of observations and semi-structured interviews with inhabitants, housing biographies of these buildings are made. This article will show how the inhabitants further develop and build at their house and housing environment. It shows how the Moroccan home culture seems more than the native Flemish one suitable for these social housing complexes. In addition, the article highlights the importance of the use and quality of the (semi-) public courtyard on social control and cohesion and discusses some ways to lead to greater resident participation.

Author keywords

Home culture; housing biographies; modernism; social housing; super-diversity.

Introduction

Much of the social housing in Antwerp was built during the interwar period as a result of the acute housing shortage after the Great War. Those social housing blocks were based on a similar ideology and typology (De Caigny, 2010; van den Broeck et al., 2015). They took their inspiration from the Viennese Housing Courtyards and made their appearance in Antwerp in the 1920s. (Van Herck, 2016a; 2016b). Different modernist architects, like Jan Robert Van Hoenacker, John Van Beurden and Jos Smolderen, Hugo Van Kuyck, Gustave Fierens created social projects. These projects are currently under pressure and in danger of disappearing (Van Herck et al., 2016).

This article sheds light on two social housing projects, designed by Alfons Francken, one built in 1931 situated at the Square Stuivenberg, the other from 1934 at the Place Geelhandplaats (Van Herck, 2016a; 2016b). Both projects, called Stuivenbergplein and Geelhandplaats, were selected for their heritage value and their location in the super-diverse neighbourhood of Antwerp North, which serves as the city's arrival and transit district (Geldof, 2019a; 2019b). The central location and connection to public transport plays a crucial role in attracting newcomers (Geldof 2018; Schillebeeckx, 2019). Furthermore, nearby small ethnic retail stores are important pull factors for residents with a migration background (Komakech & Jackson 2016).

Statistics from the social housing company Woonhaven show that 31.3% have a foreign nationality at Stuivenbergplein and 42.8% at Geelhandplaats (Archive Woonhaven,

Figure 1. (left) Francken, A. 1929. Floor plan, Stuivenbergplein, FelixArchief, Bouwaanvragen, 1929#35527.
Figure 2. (right) Klingner, K. 1937. Social housing: Stuivenbergplein, Antwerp, FelixArchief, SA412027.

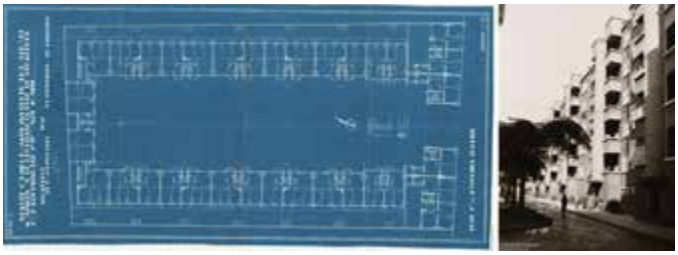

Figure 3. (left) Francken, A. 1931. Floor plan, Geelhandplaats, FelixArchief, Bouwaanvragen, 1929#35527.
Figure 4. (right) Klingner, K. 1937. Social housing: Geelhandplaats, Antwerp, FelixArchief, SA029013.

2022). But since these figures do not provide details of the migration background of residents, we can assume that the ethno-cultural diversity is higher. The Antwerp housing courtyards targeted a white working class, but various forms of migration in the latter part of the 20th century changed the resident community. This article examines the architectural qualities of two modernist social housing projects in Antwerp with Viennese courtyards and whether these are still qualitative in our super-diverse society. Archival research was used to map Francken's original design. Data collection on the residents' current use and meaning of the appartements was done through observations and semi-structured interviews. A total of 19 respondents were surveyed: 14 from Geelhandplaats and 5 from Stuivenbergplein, with 6 men and 13 women, between the ages of 19 until 71. At Geelhandplaats, it was easier to find respondents due to the presence of a collective space, and its greater social cohesion.

Francken's urban apartments

Francken was influenced by the ideas of the Congres Internationaux d'Architecture Moderne (CIAM), an organization where European modernist architects joined forces to respond to architectural, socio-economic, and political questions (De Caigny 2010; Mumford, 2019; Korbi & Migotto, 2019). The second congress in Frankfurt from 1929, on the topic *Die Wohnung für das Existenzminimum*, influenced Francken significantly (Van Herck, 2016a; 2016b). CIAM II laid the basis for European social examples of affordable housing for the masses.

The projects in Antwerp are also indebted to the Viennese Housing Courtyards. In 1921 the Social Democratic Party created an ambitious housing programme for Red Vienna, which was the colloquium name for the socialist municipality (Blau, 1998). Modernist architect Adolf Loos was appointed head of the housing department, with a staff of approximately 190 architects. The majority of architect were private practitioners, with prominent international figures such as, Josef Hoffmann, Josef Frank, Margarete Lihotzky, Rudolf Perco and others. Many of them had trained under Otto Wagner at the Academy of Fine Arts in Vienna (Blau, 1998).

The architecture of Red Vienna consisted of medium-height buildings around green open space. The highly ornamented, large volumes are evocative of Habsburg palaces of the aristocracy. The Viennese hof emphasised on light and ventilation to prevent germs and improve overall living quality. Balconies, loggias and pergolas ensured a connection between interior and exterior (De Smet, 1987). The flats were equipped with central heating and their own toilet. A bathroom and kitchen with running water were hugely innovative for that time. The Viennese Residential Courtyards also housed collective facilities, such as shared laundry rooms, a day-care and library. The street level was filled in for commercial and retail functions (De Smet, 1987; Chaddock, 1932).

Multiple authors point to design similarities between Viennese residential courtyards and Francken's interpretation of them (Van Herck et al., 2016; Elsen, 2016; Copers et al., 2002; Eyckerman, 1989). Antwerp's socialist city government and the release of new land on the edge of the historical city are seen as two similar factors. It is unclear whether Francken actually based himself on the Viennese examples, since they are smaller. In each case the projects arranged themselves in the building block around a courtyard designed as a green zone. Place Geelhandplaats, for instance, contained tall vegetation and a playground, while the courtyard at Stuivenbergplein functioned as a decorative garden (Borstel, 1989; Van Herck, 2016a; 2016b). The interior facades have a monumental design and strong ornamentation based on the Amsterdam School.

At the time, the interiors of both projects were modern equipped with disposal chutes and running water (Van Herck 2016a; 2016b). Francken designed porch flats, with the staircase each providing two apartments. In each case, the entrance hall gave onto a living-kitchen, as the central family room of the apartment (De Caigny & Vanderstede, 2005). The adjacent so-called laundry space included the wet room with a washbasin and a toilet. All two- or three-bedrooms apartments had a balcony overlooking the courtyard, enhancing visual connection between the different units. Shops were located on the ground floor. The Geelhandplaats had a drying meadow, while the Stuivenbergplein roof was set up as a collective roof terrace, but it was because of financial reasons never finalised. Only after the 1979 renovation at Geelhandplaats, the living kitchen and laundry room were replaced by rational kitchen and living area, creating separate functions as envisioned by modernist architects. A modern equipped bathroom and lift were introduced at the expense of a bedroom. The dimensions remained limited and continue to adhere strongly to the principles of the Existenzminimum.

The first renovation works at Stuivenbergplein works only date from 1994, during which the living quarters were thoroughly redesigned; the living-kitchens were replaced by a living room with an adjacent kitchen with serving hatch. Previously, the living-kitchens overlooked the courtyard, but in the redesign, they faced the surrounding streets, consequently departing from the original concept and detrimental to the visual connection between dwellers. The balconies were replaced by an extension towards the courtyard, reducing the size in favour of larger living spaces. In addition, there are currently more variations between the different flat types at Stuivenbergplein. During this renovation, the monumental brick façade was replaced by plaster, partially losing its heritage value (Van Herck, 2019b). After the renovation the original neighbourhood shops were replaced by dwellings. This is unfortunate because small neighbourhood shops can respond to residents' needs, as well as encourage social encounters (Komakech & Jackson, 2016).

Collective spaces provide opportunities for resident initiatives

Circulation is different in both projects, which causes great contract in experience of the two courtyards. While the entrances at square Geelhandplaats open toward the courtyard, encouraging (visual) encounters between inhabitants, the front doors of the Square Stuivenberg exit into the public space, which reduces opportunities for encounters between the inhabitants. The Geelhandplaats courtyard is publicly accessible and owned by the city. As a result, it was repaved in 2010, whereby the green space was replaced by a rubber playground mat. Inhabitants indicate that this new redevelopment is considered detrimental, as it currently lacks soundproofing and privacy. The hard materials of concrete, brick and plaster create a large reverberation. Moreover, the canopy of trees provided discretion towards the upper apartments. The front doors open onto it, promoting social control and valued social cohesion.

Since the late 1990s, one apartment on the Geelhandplaats has been used as a collective meeting place, a so called 'talking flat'. It serves as a space where residents can discuss community concerns at the weekly meeting. It also provides opportunities for resident initiatives and participation. In 2005, language classes for migrants were held (Fransen, 2005). This was followed around 2010 by the organisation of an after-school childcare, which was also accessible to children from the neighbourhood. From this collective apartment and in collaboration with an artists' collective housed there, the former drying meadow was repurposed into a collective garden (*Oase in Den Droog*, 2022). The soil was softened, with some residents currently growing vegetables there. The various initiatives in the 'talking flat' encourage community life among residents. Yet not everyone finds their way to these initiatives. This is because the 'talking flat' is located on the first floor and is barely noticeable. Moreover, the language barrier makes it difficult for non-Dutch speakers to participate.

However, at Stuivenbergplein the social cohesion is remarkably lower. This is because the staircases open into the public space and not into the common courtyard. Moreover, Stuivenberg's courtyard was never publicly accessible. It has also been closed to residents for about three years due to noise pollution. Only Kras youth centre organises after-school childcare there on Wednesdays and Fridays, but this encountered complaints from selected inhabitants. Other collective spaces are missing. The survey shows that inhabitants rely more on the surrounding parks in the area. Nevertheless, inhabitants indicate that there is (too) little accessible public space within the area and it is poorly defined.

As a result of the limited space within social housing, young people, mostly men, seek their own place in public areas. The public domain of Antwerp North is gender-specific and dominated by a predominantly male audience (Potargent, 2020). This research shows that mainly senior residents and mothers with children who live in Geelhandplaats have a negative perception of these 'loitering youths'. Woonhaven uses 'hostile architecture' to keep young people out of the courtyard, such as a rubber light-sloped play mat to prevent footballing, a fence at night and camera surveillance (Potargent, 2020; *Geelhandplaats*, 2010). However, interviews show that young people turn to inhabitants they know, so they use the courtyard even after closing time.

Layout of the private living quarters

The typologies of the Geelhandplaats currently consist of similar, two-bedroom units intended for small households. Statistics from Woonhaven (2022) indicate that mainly singles (59%) and couples (28%) inhabit them, which from observations appear to be mainly senior residents and single-parent families. In contrast to the Geelhandplaats, the Stuivenbergplein has since the 1994 renovation fifteen different types of apartments. These range from one- to three-bedroom apartments and accommodate also larger families. The circulation in both complexes is unsuitable for less mobile people and seniors, as the lift and entrance doors are not wheelchair accessible. Inhabitants of Geelhandplaats report that the house is too compact. The area of the living space is 17.5 m2 which hardly allows for a dining table. Dwellers who do place a dining table, are clearly the exception and lose movement space. According to the current guidelines of the Flemish Society for Social Housing (Vlaamse Maatschappij voor Sociaal Wonen - VMSW), they do not meet contemporary living standards (*Ontwerpleidraad Sociale Woningbouw*, 2021). The living space also lacks flexibility, as there are few free walls against where furniture can be placed. Inhabitants are therefore forced to opt for a corner arrangement. The window height is 0.70 metres, causing residents to place a corner sofa in front of the window and the free wall. The house also lacks privacy, as the night and day areas merge, because the bedroom doors open towards the living room.

However, residents with a Moroccan migration background have an interesting sofa set called the 'sedari' (Habibi, 2020). A sedari or Moroccan sofa consists of a crafted wooden frame with a matching mattress (Fig. 5). Moroccan benches are placed against walls, often in a U arrangement around a *mida*, a round or octagonal table (Barkouch, 2020; Dibbits, 2009). In case of lack of space, only in a corner arrangement. The choice of fabrics is colourful with patterns and cushions. The open woodwork in the Moroccan sedari is called *Moucharabieh* and creates more seating than on the sofas mostly sold in Belgium (*Marokkaanse sedari*, n.d.). This is so because the sedari is a sign of hospitality and provides seating for every guest. Originating in Arab Andalusia, the sedari is said to have spread from the Maghreb to Turkey and Iraq (Barkouch, 2020; Dibbits, 2009). The quality of a sedari lies in the fact that you are seated upright compared to a western model. As a result, it combines eating and sitting function, saving space. After all, a separate dining and sitting area is not needed in this set-up and is therefore an appropriate solution in the minimum dwelling. They also have a third function as they serve as a bed for guests. Interviews with nine residents from Moroccan migrant backgrounds show that first, second and third generations all have a sedari or at least wish for one.

Figure 5. (left) Photograph by the author, 9 February 2022. Geelhandplaats, Sedari in the living room.
Figure 6. (right) Vandevorst, K. 2016. Courtyard Antwerpen Geelhandplaats 19-28. Inventaris Onroerend Erfgoed, https://inventaris.onroerenderfgoed.be/erfgoedobjecten/6751

The living rooms of the units at Stuivenbergplein have changed in size and orientation since the renovation. However, this allows the apartments to be arranged more flexibly, which is shown by multiple seating arrangements. The entrance hall was extended and considered positive by interviewees. It now provides access to the bedrooms, a separate storage room and a toilet, a bathroom, and a living area with an open kitchen. Due to the larger families at Stuivenbergplein, children are required to share a bedroom. This always involves a distinction according to gender. Two of the five families indicate that they eventually would like to move out to give their children more space to move around and a study spot of their own.

The bedrooms at Geelhandplaats are rather spacious compared to those at Stuivenbergplein. Here, the main and children's bedrooms are 12 and 10 m^2 respectively, compared with 10 and 7 m^2. As a result, the Geelhandplaats bedrooms offer more room for appropriation and can more easily change in function. However, Moroccan families want to distinguish between guest area and private rooms, but lack of space makes this impossible in many cases. In two cases, the children's bedroom is converted into a private room, while the living room serves as a guest room, in both cases furnished with a sedari.

At Geelhandplaats, the kitchens are the biggest shortcoming according to its inhabitants. Observations and interviews show that the countertops and kitchen cabinets are saturated with moisture due to the lack of a qualitative ventilation system. Inhabitants use the balcony door as a natural ventilation system to prevent further humidity problems. Furthermore, inhabitants try to renovate the kitchen by themselves, but major renovation work is not allowed by Woonhaven. Residents report that there is neither sufficient counter length nor enough space to install cabinets, resulting in an active need for storage space. The living units do have a basement on the ground floor, but the survey shows that storage space within their own homes is absent. Some dwellers place a fridge in the living room or hallway to overcome this lack of space. Singles or couples occupy the spare bedroom as a storage room or pantry. For most respondents at Geelhandplaats, the balcony is appropriated as a storage space, full of closets. Inhabitants hang a curtain on it to protect these closets from heavy rainfall. It is also a place for rubbish to avoid odour problems indoor.

This research shows that older inhabitants, first-generation migrants with a Moroccan migration background have a negative perception around an open kitchen. Odour nuisance appears to be the main reason. This is in line with the typology of a Moroccan house, where eating and cooking functions are kept separate (Habibi, 2020). Three interviews with Moroccan women (under the age of 30) show that they did favour an open kitchen, which is in line with Flemish housing trends.

After the 1994 renovation, the balconies at Stuivenbergplein were replaced by bedrooms, with currently a private outdoor space missing. In both housing blocks, inhabitants complain about noise between neighbouring flats, which equally affects the liveability factor. The exterior walls of the Geelhandplaats consist of solid walls without cavity layer or insulation, which causes moisture problems. The renovation at Stuivenbergplein improved this issue. However, the poor housing quality not only creates a barrier to receive guests in the house, but respondents also indicated that the low quality of the house encourages moving intentions.

How should we deal with modernist housing projects?

Although Francken envisaged a homogeneous resident community, this is currently no longer the case due to super-diversity. The various home cultures reject a new view on today's social housing heritage. The Antwerp social housing courtyards find connection within a rich European building history. This study demonstrates the architectural qualities of both social housing projects and argues for the preservation of this modernist heritage. In doing so, an update is needed of the residential quality in both complexes. The once-modern housing projects are currently suffering from heat, noise, and humidity problems, necessitating extensive renovation.

Besides, this study shows that the minimum dwelling does not meet the housing demands of its inhabitants. In the case where the minimum apartments were extended, inhabitants have a more positive housing experience, because the units are more easily furnishable. The limited dimensions of the units make it impossible for residents to implement their home culture. The exception to this appears to be the Moroccan community, which can partially implement their home culture. Here, the sedari is a well-chosen piece of furniture, suitable for the minimum apartments, because it facilitates sitting, eating, and even sleeping in one and the same room. In addition, the 'generous' size of the bedrooms provide space for appropriation, but the apartments lack sufficient privacy because day and night area merge. Furthermore, residents point to the necessity of a balcony and storage room within in the home.

The qualitative outdoor spaces are almost as important as the interiors in collective social housing by stimulating encounters between inhabitants. Concentrating all the front doors on a semi-public courtyard creates a visual connecting between inhabitants, thereby beneficial for the social cohesion. The difficulty in this is overcoming the imbalance between age and gender differences. Furthermore, a collective space provides an ideal opportunity for residents' initiatives and participation, enhancing affiliation and a sense of belonging. Thereby, it is important to actively attract non-native speakers to stimulate inclusivity.

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Inclusive innovation: a study of creative furniture design for urban block public space

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Abstract

In high-speed urban construction, people's demand for diversity and functionality of urban space is gradually increasing, and people's practical spatial needs are not fully respected and cared for for the city's prosperity. Many current design practices show that the inclusiveness of design practice activities is more innovative in promoting creative furniture design in urban neighbourhoods and realizing the resilience and sustainability of urban neighbourhood furniture design. From the perspective of sustainable social development, inclusive design is attempted to solve the design problems of the "functional failure" of urban community space and the "misalignment of needs" of residents. Creative furniture design in urban neighbourhoods has become an essential issue in improving the quality of life of community residents.

This paper takes inclusive innovation as the starting point and conducts an experimental study on street furniture design in Fengpu District, Shanghai. The author's team focused on the needs of community residents, especially the needs of children and the elderly, for resting seats in the community space (Li Wenjia, 2021), and organized the "Hundred Chairs for Building Dreams" activity to collect creative proposals from community residents. Designers and residents collaborated to create a four-dimensional framework of "participation in learning - participation in design - participation in construction - participation in maintenance" to explore the role of creative furniture in community renewal and the research path. The participatory creative seating design activity looks at urban space from the perspective of residents' needs, stimulates residents' active participation in innovation, and respects human needs. The creative furniture design activity empowers community deformed space, provides a rich space experience design, and makes residents feel the space expansion from visual, auditory, activity and entertainment perspectives. Solve the severe shortage of urban furniture due to the lack of "no place to sit", "can not sit down", "do not want to sit", or "sit not interesting ", and other problems.

In the new era, there is a need to create a new model for the micro-renewal of sustainable community public spaces through the concept of integrated resilient cities that connect inclusive design activities with community residents. Inclusive and innovative design is one of the core issues in responding to the goals of people's city building, community renewal, and achieving sustainable development. To explore the spatial resources of urban communities and the needs of residents, we must adhere to the concept of "people-centred" urban development and the model of inclusive, innovative development that is tailored to local conditions and needs to guide the humanistic design of urban community spaces and urban space governance from people's construction to people's sharing and to provide a more inclusive, interactive, and entertaining urban community space. It can provide new design ideas for expanding inclusive, interactive, recreational and sustainable functions of urban community space.

Author Keywords

Inclusive Innovation,Sustainable Development,Diversity, People-Oriented, Interactivity, Entertainment

.Introduction

Inclusive cities are an essential direction for urban development and governance in recent years, and the "Changing Our World 2030 Agenda for Sustainable Development" signed by 139 member states of the United Nations (UN) in 2015 established 17 Sustainable Development Goals (SDGs) that the world needs to work together for a more extended period in the future.), of which Goal 11 calls for "building inclusive, safe, disaster-resilient and sustainable cities and human communities" (Hua Ting & Zhao Wenwu, 2019), which shows that the construction of new cities is an essential means to achieve sustainable development. This study is based on the modern urban development process, where urban micro-renewal has become an important way for cities to enter into a refined urban layout. The inclusiveness of urban furniture design improves the quality of life in people's cities. The concepts of "urban living room", "public exhibition hall", "pocket park", "urban oxygen bar", etc. have enriched the current exploration experiments of urban renewal.

This paper takes inclusive innovation as the starting point to study the design of neighbourhood furniture in Fengpu District, Shanghai. The research results show that urban neighbourhood furniture design can be categorized and customized according to the living needs of community residents, from classic to flexible layouts. The practice of urban space

furniture design is an urban renewal activity initiated based on the shift of China's urban development from incremental expansion to sustainable stock resource development. The activity is a microscopic view of urban space that truly focuses on the living needs of community residents. The project aims to help urban neighbourhoods gain better sustainability, comfort and accessibility to public space through creative furniture design's low-intervention strategies for urban space stock so that local governments, residents and designers can link up through a social engagement process. Innovative design furniture design is intended to encourage community residents, urban laypeople, and children and the elderly to contribute a variety of draft models of furniture with creative ideas to urban neighbourhoods to realize the vision of joint participation in community homes. While flexibility is an important consideration in the design, it must also be done in a way that avoids excessive spatial and visual complexity (An Yongfei & Li Yu. , 2019). Based on the essential thinking, designers achieve the inclusiveness and adaptability of community space by intervening in the space with creative furniture design strategies to solve the problem of "no place to sit", "can't sit down", "don't want to sit", or "don't want to sit" in the public space for rest and recreation. "unwilling to sit" or "not interesting to sit" and other fundamental problems. The quality of life of urban community residents has become an important issue in urban space design nowadays.

This is a practical project of an old community group in Fengxian District, Shanghai. The local government attaches great importance to the project, introducing design faculty from Tongji University and jointly promoting the micro-renewal construction of the community group with well-known social enterprises. Due to the housing conditions of the community cluster, old infrastructure, lack of high-quality urban space for recreation and many unused marginal areas, the spatial participation of the whole community cluster is very low. Therefore, the project developed solutions by using urban furniture design as a touch point under the guidance of Professor Zhou, from point to line and line to the surface in progressive steps. Urban furniture designs (artistic sitting furniture, child-friendly activity facilities, public art installations) were placed as exhibits in urban neighbourhood spaces (Jing Lu&Zhao Chenxue,2007). The urban space becomes a "community living room", and the design strategy maximizes the remaining space in the urban space to meet the daily interaction needs of the community residents. The inclusive integration between furniture design and urban space promotes the social participation of residents for effective civic empowerment.

Content

Inclusive design of creative furniture in urban neighborhoods

The concept of inclusive design means that all ages can live conveniently in the community rather than treating certain types of people as special groups (Hu Lingling , 2022). Community design should pay attention to the differences and commonality of all people's spatial needs and emphasize the common use for multiple groups of different ages, different physical and mental functions, and different living conditions (Wu Yan& Dai Zhizhong, 2014), and make it an important part of the construction of "livable cities". The design of urban neighbourhood furniture is not only limited to the barrier-free design to ensure residents' travel and rest but also emphasizes meeting the multi-level needs of residents' life, i.e. from the convenience of life to the emotional demands of social interaction and self-actualization.

Inclusive urban community space construction model of "collaborative governance". On this basis, the basic principles of inclusive urban community space construction are: first, to adhere to the concept of "people-oriented" urban development; second, to adhere to the two-way empowerment of top-level design and grassroots exploration; third, to improve the resilience of inclusion in steady progress; fourth, to comply with the efficiency of open and shared use; and fifth, to adhere to the development of local conditions. (Xiang Pengcheng & Wu Baoting, 2020). Only in this way can urban neighbourhood design be guided to move from people building to people sharing truly.

Design Case

The needs of different groups should be fully respected in creating inclusive and friendly urban neighbourhoods. The way of soliciting creativity for the needs of district residents. Focus on the number of community seating needs and design use style—collaborative co-creation with design seating to care for residents' touch points for community renewal.
This paper takes inclusive innovation as the starting point to study street furniture design in Fengpu District, Shanghai. The author's team focused on the needs of community residents, especially the needs of children and the elderly, for resting seats in community spaces and held a "100 Chairs for Dreams" campaign from October 2021 to February 2022 to collect creative proposals from community residents. The project will explore the role and research path of creative furniture in urban neighbourhood renewal.

Practice path

1). The "Hundred Chairs for Dreams" activity is based on the theme of creative seating series, with designers ranging from professional designers to students, sanitation workers, delivery boys, construction workers and other different groups, using chairs as the entrance to show the charm of art and the temperature of the city in an exciting way. In the first phase, a chair creative design competition was held to collect creative design concept works of public furniture in urban neighbourhoods, which could be a wild design idea or a hand-made DIY model by children. The team collected many street furni-

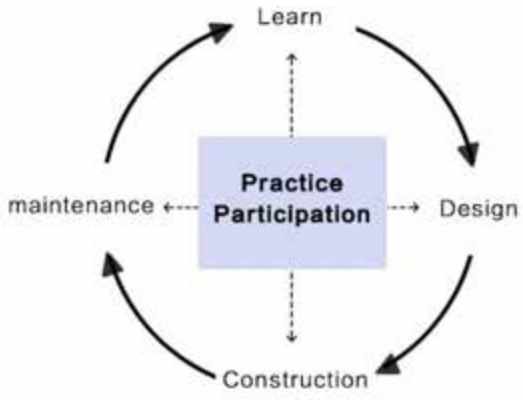

Figure 1. Four-dimensional neighborhood creative design framework model.

Figure 2 and 3. Xu Qiang team of sanitation workers from Shanghai Jiumei Cleaning Co., Ltd. with the design of "Caterpillar Seat", which is rarely seen in the metropolis nowadays. It embodies a kind of nature and ecology, hoping that children can get in touch with nature more and cultivate the concept of environmental protection.

Figure 4. "Pony Chair Seat" designed by Hu Youti, a student of Fengjiuyuan Primary School, hoping that it can bring happiness to the people who ride it like a merry-go-round, and also means a horse to success.

Figure 5. "Smile City" designed by Xi Wangqi, a student of Shanghai Publishing and Printing Higher Specialized College, hoping that the workers on their way home can be accompanied by a happy and relaxing city atmosphere.

ture concepts through the design competition and creative workshops held by the community and schools. In the future, some of the chairs will be integrated into the streets and alleys of Fengpu, community shopping malls and schools to convey the "temperature" of the chairs truly. Among them, 100 pieces of design works, such as "Little Wooden Horse" painted by Hu Youti, a first-grader of Fengjiu Academy, "Caterpillar Seat" by Xu Qiang, a sanitation worker at Shanghai Jiumei Cleaning Co.

2). Based on the community application scene, with the cooperation of schools, government, families and social welfare institutions involved in multiple parties, professional designers collect and classify, evaluate, customize and exhibit the award-winning outstanding creative works, transforming the artistic dreams of children, sanitation workers, construction workers, delivery boys and other types of people from two-dimensional drawings into three community public artworks. From the creative source of the chairs, there are chairs created by children as little community planners participating in community gardens; there are works drawn by students through their understanding and thinking about the city and life; there are ideas developed by citizens of different ages in the process of participating in public art; there are warm seats outlined by city service workers combining with actual needs. Student Hu Youti said, "Because I am a horse, I drew a small wooden horse, and 'horse' also means success." After the wooden horse became a real thing on display in the park, she sat on it for the first time to experience it. Delivery boy Fu Jia Nan said he came to Shanghai as a courier and delivery man for ten years before more traffic safety training and activities, the first time to participate in art design activities, and he was very inspired.

The first phase of "Happy School Road" partly realized some of the ideas, Fengxian children's pride and sense of belonging like never before. The project urgently needs to let more children's creativity land to create their own creative neighbourhood.

Figure 6. The physical object of "Pony Chair Seat" designed by Hu Youti, a student of Feng Education Institute attached primary school.

Figure 7. Xi Wangqi's design of "Smiling City Seat" in kind.

3). After the end of the 100 chairs exhibition, and then the excellent creative seat furniture works for the follow-up funding activities, outstanding innovative seat community drifting activities. At the same time, through the network of crowdfunding, continue to select other suitable children's creative furniture design works successively implanted in different urban neighbourhood public spaces, to explore the path of urban space furniture design.

This collaborative creative seating design activity, which is participatory, takes the perspective of residents' needs to see the renewal of community space, stimulates residents to participate in innovation, and human needs actively are respected. The creative furniture design activity empowers the community freak zero space, provides a rich space experience design, and allows residents to feel the space expansion from the perspective of visual, auditory, activity and entertainment. Solve the serious shortage of urban furniture due to the lack of "no place to sit", "can not sit down", "do not want to sit", or "sit not interesting ", and other real problems.

Inclusive and innovative community design focuses on and addresses the needs of disadvantaged groups in the community as the main content rather than using intelligent technological means to integrate resources to build the community. The inclusive design emphasizes multi-dimensional innovation through concept, system, technology and market to guarantee the innovation-driven development of urban neighbourhood furniture design and the participatory nature of the practice process, aiming to achieve a new urban form with sustainable development and sharing of design achievements. Inclusiveness, resilience, interactivity, entertainment, and sustainability are the core indicators of inclusive urban design (Han Bo , Dai Mingli, 2022).

Results

The collaborative and co-creative participatory design activi-

Figure 8, 9 and 10. The second phase of the exhibition of 100 chairs - creative seat community rafting.

ty looks at community space renewal through the lens of residents' needs, stimulating their active participation in the new, human-centred conditions that are respected. In the process of community renewal in urban neighbourhoods, inclusive and innovative community design activities with seating are a unique perspective and an effective methodological strategy for reshaping the community environment. Empowering urban neighbourhood space through creative furniture design activities provides a rich spatial experience design that allows residents to feel the sense of spatial expansion from the perspectives of vision, hearing, activity and entertainment. Solve the severe shortage of urban furniture due to the lack of "no place to sit", "can not sit down", "do not want to sit", or "sit not interesting ", and other real dilemma problems. In the process of urban old community renewal, children's creative design injected into community micro-renewal, empowering and reshaping the urban neighbourhood space is a new perspective and effective methodological strategy.

Conclusion

Through the study of inclusive innovative design of urban neighborhoods and the case study of inclusive innovative design practice of furniture in the street 100 chair exhibition in Fengpu District, Shanghai. The author's team focuses on the needs of community residents, especially the problem of the practical needs of children and the elderly special groups for furniture seating in urban neighbourhood spaces, solicits creative design solutions from community residents, determines the number of seats and the function of seat design used by the scale of the regional community space, designers and residents collaborate to create, design research to create a new model of inclusive urban neighbourhood furniture creative design, and considers the community The design research creates a new model of inclusive urban neighbourhood furniture design and considers the future direction of community resilience and sustainability. A four-dimensional framework model of creative design for neighbourhoods is constructed: "participation in learning - participation in design - participation in construction - participation in maintenance", and the role and research path of creative furniture in the process of urban neighbourhood renewal is explored.

The practical case shows that it is necessary to create a new model of sustainable community public space micro-renewal by linking inclusive design activities with community residents through the concept of integrated resilient cities. Without increasing the total amount of actual public physical space, the urban neighbourhood space is empowered by inclusive creative furniture to provide a rich spatial experience. In order to explore the resources of urban community and the needs of residents, we must adhere to the concept of "people-oriented" urban development and the inclusive and innovative development model of designing according to local conditions and needs so as to guide the humanized design of urban community space and urban space governance from people's construction to people's sharing, and to provide a more inclusive, interactive and entertaining urban community space. This will provide new design ideas for the expansion of inclusive, interactive, fun and sustainable functions of urban community space.

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Health, care and prosthetics: co-design methodologies in the case of Autofabricantes

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Abstract

"Autofabricantes" is a participatory design collective that started at the Medialab Prado in Madrid in 2015. Its main aim is to co-design assistive devices and limb prostheses for children. Combining different types of experience and knowledge, engineers, designers, occupational therapists, and children have contributed to the creation of open source solutions. The following article analyzes this initiative focusing on how design-based strategies have helped to overcome different interests, types of knowledge and legal frameworks (Lafuente and Corsin, 2010) to create an open archive of different solutions and prostheses that can be replicated globally in fablabs or by local communities. By disentangling the material and technical elements of affective and aesthetic decisions, we will argue that the transformation of children into designers of their own members has contributed to empowering these communities and naturalizing a set of prosthetics (Callon and Rabeharisoa, 2002). These artifacts and methodologies work as an answer to some of the problems that market-driven initiatives have not solved (Simonsen, Scheuer and Hertzum 2015). Until now, the market offers invasive and expensive designs over which the people concerned have no decision-making capacity or say.

The paper will analyze a specific set of workshops, examining the protocols, steps, and strategies developed in order to create an atmosphere that allows for the collective design of complex sociotechnical artifacts (Corsín, 2014). It will also analyze how these workshops have given rise to increasingly imaginative products that challenge conventional ideas about how prosthetics and the body itself work and should look like. By introducing children into the design and production process, we can see the emergence of prototypes that go beyond function. This opens debates on how health, care, well-being and design are intertwined and materialized in specific material products to improve the quality of life and social justice (Constanza-Chock, 2020, Bordeleu, 2020).

Author keywords

Prototyping, prosthesis, co-design, care, health, children.

Introduction

"Autofabricantes" is a participatory design collective which started at the Medialab Prado in Madrid in 2015 whose main aim is to co-design assistive products and limb prostheses for children. Combining different types of experience and knowledge, engineers, designers, occupational therapists and children have contributed to the creation of open source solutions (Abad, 2016). The objective of the following article is to understand the role of the children who participate in these workshops as co-designers of their own prostheses. To do this, we will evaluate the methodology used in a specific workshop, looking at the background, previous steps and established dynamics to facilitate the conversion of what healthcare treats as "patients" or sick people into active subjects in the design of their own prostheses. This type of workshop follows the logic of what has been called "DIY prosthetics" (Knochel, 2016) and is integrated into the logic of what is called "critical making" (Record, Ratto, Ratelle, Ieraci, & Czegledy, 2013), that is, the use of fablabs in spaces of collective design or at the service of social transformation.

Background

The "Autofabricantes" working group originates from a first group called EXando una Mano, located in Seville in 2013. This group has developed a set of tactics and methodologies for creating prostheses where users are at the center of the design process. Users, mainly children, are part of a large group of organized citizens who develop them by contributing their expert, experiential or amateur knowledge (Estalella A., Rocha J. and Lafuente A, 2013). The workshops that we are going to analyze take place in Medialab Prado, a space for public cultural experimentation or citizen laboratory (Corsín, 2014). This space was and is a pioneer in opening of conceptual debates and hybridization of disciplines, areas of interest and democratization of possibilities for innovation and research with and from citizens (Fabian and Rowan, 2016). In a broader scenario in the European context almost two decades have past since the inception and development of communities dedicated to the creation of free and/or self-built hardware, and the appearance of fablabs, makerspaces, etc. This has contributed to many changes in the ways objects are being designed and produced (Perez de Lama y García, 2018). Recently specific communities have grown around concrete needs and concerns, such is the case of

communities of concern around health issues. This has contributed to blend fablabs and social concerns (García, 2019). Currently there are many collaborative design communities with disparate formats of collaboration, organization and management (Fanio, Jimenez-Martinez, & Cantero, 2020). At the same time, and in the opposite direction, we must acknowledge how the public health system considers that the individual who is missing a limb is a patient who needs to be treated and cured.

For the health system, the individual citizen becomes the responsibility of the State, or of him or herself. By doing so the problem becomes individualized and the subject reduces his or her agency (Stengers, 2005, Bordeleau, 2010). The disease is cataloged and individualized, and treated through a series of standardized and regulated protocols in the search for a maximum care guarantee for the general population. This situation has resulted in a pathologization of a multitude of personal situations that, in part, have social and contextual components (Segura 2018). The theories surrounding functional diversity challenge these standardized assumptions of what health and wellbeing imply (Toboso, 2018). In the context of digital manufacturing workshops, so called patients are transformed into active subjects on the design of their own prostheses.

Over many decades, the health and pharmatheutical sector has responded to this question by providing a wide variety of technical solutions (such as prostheses or ortho-prostheses) that provide disabled users with tools to function "normally". The aim is to make all of the bodies equal, adapting to a capable and normative body (Agulló, 2011). A large catalog of technical assistance devices have been created to which the disabled user should adapt without questioning the specificity of his or her disability in order to fully relate to the world. The person affected is almost never a participant in the functional, aesthetic or formal decisions of their technical assistance: most of the time, it is their bodies that must adapt to them (Cottam 2019; Driedger, Kothari, Morrison, Sawada, Crighton, & Graham, 2007). In recent years, many collaborative project initiatives of different modalities, durations, and depths have emerged to provide concrete responses to this lack of adaptation, debate, and/or care models in the orthopedic and prosthetic market.

Case study

Within the trajectory of Autofabricantes, in the period that goes from 2015 to 2020, the collective operated as an open research group with about 20 permanent members and another 30-40 volunteers that took part on an occasional basis. These members contributed with their specific knowledge in some part of the development of different prosthetics (electronics, industrial design, programming, occupational therapy, manufacturing, physiotherapy, etc.). Citizens from different backgrounds were organized following thematic subgroups and met weekly in person at Medialab Prado. These sessions included families and children with missing limbs, and previous experience in the use of market produced prostheses. The technical documentation derived by these workshops can be found in Github's own repositories[1] or on the Medialab's site[2]. Based on this work and creation system, a string of different projects have been developed. All stem from proposals put forward by the children to the working group. This made it easier to address questions that the children themselves asked, such as "Why should a hand look like a hand? or why should a prosthetic tool respond to a specific need and not to the complexity of a common hand. In the following paper we will address the creation of a specific prototype named "SuperGiz", a prosthetic glove that can be adapted and modified to a variety of bodies and playful needs.

Methodology

In the following paper we will focus on the analysis of a workshop that helps to develop the SuperGiz prototype. The workshop took place between March 7 and May 5, 2022, and it is the last in a series of workshops that took place during more than 4 years. We chose to focus on this specific workshop because it is the most recent and the first to take place after two years of the pandemic. This is also the first workshop to include improvement of life quality protocols. These protocols were approved by the ethics committee of the VIC University.

We will focus in these specific points:

- What are the important elements that affect the degree of participation of children in the design of their own prosthesis.
- Which are the tools or means used in these workshops.
- How the participant children blend and are able to collaborate with their working group.
- What is the degree of satisfaction and frequency of use of the prototypes the users designed.

In order to carry out this research, we proceeded as follows:

- Description of a research protocol, ethical code, data collection code based on WHO regulations, national and European data protection law and data collection notebook guidelines (Braun, Clarke 2006).
- Approval of the protocol by the University of VIC with a defense and rectification of improvements by the evaluating committee.
- Review of the internal evaluation reports generator by Autofabricantes and proposal for improvements.
- Implementation of the workshop with improvements already foreseen in the protocols and in the internal evaluation reports.
- Guided observation and description by the researcher of the behaviors of the children, their family and their group based on a data collection notebook with the above objectives, among others (Estalella and Corsín, 2020)
- Brief survey on the degree of participation and group membership.
- Comparative description of the changes introduced into the workshop structure and the consequences they had with respect to previous workshops.

1 https://github.com/autofabricantes. Last accessed 19/01/2023

2 https://www.medialab-matadero.es/actividades/autofabricantes . Last accessed 19/01/2023

With this we hope to disentangle the material and technical elements of affective and aesthetic decisions, showing how this project has helped to transform children which the health system considers to be patients into the designers of their own prosthesis.

Key aspects surveyed

Time

Each workshop takes place over three months of time with three moments of intensive work separated by one month each. A first contact workshop in which a free prototyping of ideas takes place is followed by a second workshop based on testing, redesigning and adaptation of these first prototypes. The third workshop focuses on testing, reviewing and certifying usability. Between each session, the collaborating teams design and 3D print each model that is tested in the workshops. The interval of three or four weeks between each workshop is adequate for the development of the designs and on the other hand the links between participants are not diluted. The communication between members of the workshop does not stop during this time and details, questions and progress reviews get shared.

The sessions always take place on Saturday mornings to facilitate travel (many families and children come from other parts of Spain). In the workshop we surveyed, the second session was on a Friday afternoon due to the Medialab agenda. We observed that they were visibly more tired, more focused on resolving the design challenges and less time spent on conversations or social interactions after the workshop. A regular session lasts about two hours (from 11 a.m. to 1 p.m.) and in more than 80% of cases it is extended by another hour due to dialogue among participants. Friday's session barely lasted 1 hour and 30 minutes (from 5:00 p.m. to 6:30 p.m.) and there were even families that arrived late or left before the scheduled time, the collective time was barely 50% of that scheduled.

Preparation

Participants need to contact the organization and request to take part in the workshops. They are sent information regarding health and safety protocols and information on ethics and data management in order to comply with the ethical research standards. In the internal evaluations of the workshops, we detected that some children arrived with a high level of suspicion and without a clear idea on the nature of the workshops they were going to attend. Therefore, the transmission of information from parents to their children was not effective. From that moment on, families are provided with informative videos and guides that they can show their children. In this way they do not generate false expectations, they know the environment, possibilities and limitations of the workshops, what kind of people they will meet, etc. Their role as active agents in the work process is also explained to them. With this their adaptation to the team is faster.

Managing expectations is a key element throughout the design process. The children are between 5 and 12 years old and in 70% of the cases (own interviews with 20 cases) they have already used another type of prosthesis that has not worked for them. In the first workshops the expectations were high: they proposed to solve at least 4-5 activities and they did not know that in the first two sessions there would be failures and problems regarding the prototypes designed. Currently they are asked to bring only 2 ideas of activities to design (this can change over the workshops). They are also advised that some of the prototypes may not work or need to be resized or redesigned. It is essential to shift attention to effectiveness at the time of testing to eliminate as much frustration about functionality and gain insight into the process. In the analyzes to improve the quality of life that we carried out, we can see how 18 cases, the result is 3 out of 3 in priority activities and 2-2.5 in non-priority activities. (see table 1)

Table 1. SuperGiz assistive devices: frequency of use and satisfaction throughout the study (n = 18).

	T_1	T_3	T_6	
	Median (Q1-Q3)	Median (Q1-Q3)	Median (Q1-Q3)	p [a]
Activity chosen as priority				
Frequency of use	2 (2-3)	2 (2-3)	2 (2-3)	0.607
Satisfaction level	3 (2-3)	3 (2-3)	3 (2-3)	0.368
Non-priority activities (n = 17)				
Frequency of use	2 (1.25-2.45)	2 (1.12-2.50)	2 (1.37-2.55)	0.513
Satisfaction level	2 (1.75-3)	2.5 (2-3)	2.5 (2-3)	0.165

T1, one month after finishing the SuperGiz collaborative workshops (baseline); T3, three months after baseline.; T6, six months after baseline.; Q1, first quartile; Q3, third quartile. a Friedman´s test.

Spaces

Although it may seem like a less important aspect, we must acknowledge how space shapes and conditions workshops and studio practices (Farias & Wilkie, 2016). It enables conversations and cooperation which are key elements to establish shared aims and objectives. In the workshops we simultaneously found 5 teams of 5-6 people plus the main production team of Autofabricantes and some invited people, a total of about 40 people. It is a non-medical place, with tables, chairs and rapid prototyping tools.

Some of the most relevant aspects and changes introduced in the last workshop were, for example, the introduction to a small space prior to the workshop room. On the first day, children and parents are received by a workshop leader from the Autofabricantes team. This welcome with few people generates a first moment of complicity and trust, out of the sight of many adults. Guided by a small protocol, in 15 minutes they get to know each other, the whole design process is outlined, and the participants get to touch and see examples of other designs done by other children. During the interviews conducted we discovered that part of the frustration, anxiety and generation of false expectations is derived from the conversations between parents and their children (80% want a prosthesis similar to a hand, functional and with full adaptation for their child). In addition, we detected that 50% of the families do not know other families in the same situation. To facilitate interaction between participants breakfast and drinks are provided. This helped to promote informal interactions and conversations that contributed to promote trust among participants. To increase interaction, in the last

workshop the central table of the space was for breakfast. The fact that the Autofabricantes team is not present in this context has led to riskier design decisions and proposals as shown in internal reports.

We must also note that along all the design phases, basic tools are needed to fasten the movement from ideas to prototypes. Colored pencils, cardboard, paper, scissors, plasticine and other basic tools are widely available. In this workshop we noted that all the tools except pencils and paper have been centralized on a table (next to the breakfast) so that children can freely go for what they need. This change has two objectives: to increase proactivity and to help shy children to interact with their peers. All this has been reported by the Autofabricantes team in the last evaluation report after the workshop.

Roles and interaction

From the very beginning each family unit is accompanied by a team of four collaborators composed by someone expert in engineering, industrial design, physiotherapy or occupational therapy. This team is the reference point for the child and the family. For 3 years they have been given specific training on interaction in order to build-up the child's confidence. They propitiate playful interactions, use simple and clear vocabulary, help with prototyping, etc.

A member from the Autofabricantes team is the person of reference for each design unit. Their main task consists in helping to generate bonds of trust amongst participants and children. This person also conducts the workshop, is the timekeeper and keeps in touch with the family after the workshop finishes. This person also provides the general design criteria and helps to define the limits and the possibilities of manufacture, use, etc. Other adults with a missing limb are sometimes invited to meet the children and their families. This idea was first proposed by one of the attending families and we have detected that it is important in order to naturalize different disabilities and have other references to look at.

The workshop itself

Session 1: The initial welcome and introduction to the general workshop dynamics is crucial for the children attending the workshops. Afterwards, they begin to design the possible solutions to the problems posed using quick prototyping options such as paper, plasticine and cardboard. They draw, touch and each participant contributes with ideas or prototypes. Sometimes they can play with objects, attaching them to their arm, or drawing directly onto their bodies. When the definition of the designed solution advances further, a first conversation about materials and technical challenges takes place. Each step, the child is made aware of the possibilities or limits of their design.

Session 2: In this session the team focuses on lowering the child's expectations. On this stage 3D printed prototypes and models to test are available and in more than 50% of cases they do not work for reasons of size or adjustment. The biomechanical conditions here need to be taken into account. The team (including the children) pay more attention to every detail, re-measure and intervene or modify the physical model in situ to test changes or new ideas. Touching the models contributes to arriving at better design solutions to which the whole team can contribute.

Session 3: This last stage is all about testing out the prototypes. If all the designs fit and have validation from the occupational therapists, they can take them home. In evaluations of previous cases, we detected that the parents determine in a clear way the frequency of use of the prosthesis designed by the children. To reinforce the degree of commitment of the children, a card with 4 simple use guidelines is included along the prosthesis. A space was also added with a handwritten message from the work team, thus also reinforcing commitment and affective ties through the group.

Evaluation and conclusions

In order to know the perception of the children about their participation in the design process and their belonging to the working group, a brief questionnaire was introduced into this workshop. It was carried out with the presence of their parents, in the final 30 minutes of the workshop. The children read and answered directly on a scale of 1 to 5 to 6 questions. 5 families took part in the workshop and 4 children answered. The questions and results, in this order, were the following:

Table 2. Children perception about their participation

	Yes	No	1 / little	2 / rather	3 / normal	4 / quite	5 / a lot
Do you like your SuperGiz?	4	0	-	-	-	-	-
Do you like to do things in a group?	-	-	0	0	0	1	3
Have you participated in designing it?	4	0	-	-	-	-	-
How much have you participated?	-	-	0	0	1	1	2
Did you like doing SuperGiz in a group?	-	-	0	0	0	2	2
Do you consider yourself part of the group?	-	-	0	0	0	1	3

Acknowledging that the sample only corresponds to one workshop and only a few children replied, we can highlight an adequate response regarding one of the objectives of the workshops, enjoyment and in a minor degree, participation. More research needs to be conducted but after following this project we can conclude that these workshops have contributed to a big degree to transform children into the designers of their own prostheses. Many factors have contributed for this to happen: methods, tools, work rhythms, spaces, materials and conversations. Another key element identified in this process is the creation of trust among participants. Children must increase confidence in their skill and build trust with their group.

We also consider it important to note that in this program any design carried out must be thought from a particular need but must serve many more people, this implies rethinking versatility, changing parameters and including other

families and groups in the design process. Children go from designing only for themselves to design for others. Knowing that disabled children can prototype almost anything relatively quickly allows them to imagine more possibilities and re-think completely how a prosthetic limb should work and look like.

The introduction of celebrations after each important design milestone helps to build the child's confidence in their skills as a designer. Building networks of trust along different generations, persons with different skills and knowledge is key for these workshops to function. Definitely this project has developed interesting strategies to promote collaborative and participative ways of designing and empowering the children that attend and are the central agents of these workshops.

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See the unseen: a co-creation design process for children with incarcerated parents

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Abstract

Children are the future, but we often ignore their opinions and ideas with the excuse that they are too young to understand the world. Especially in the process of caretaking, adults often disregard the importance of the child's agency. This is even more the case for children with an incarcerated parent, who innocently carry the consequences of their parent's crime. As a result, children of incarcerated parents feel powerless; they are stuck in a situation created by adults and have no control over their future perspectives.

If designers successfully want to design for children with incarcerated parents, they need to collaborate with them. This paper describes the importance of and the methods for involving vulnerable children in the design process. As part of an 8-month lasting master thesis project, methods are explored for co-creation with children. During this process, children took on the role of design partners, they were the experts of their experiences while the designer was the facilitator. Co-creation with children was essential for a successful design process, yet this came with a variety of challenges and risks. Co-creation removed the powerlessness of children of prisoners by giving them control over the design process through consultation and participation. By providing information, input, artifacts, methods, and tools the involved children were able to understand and place questions and assignments better, it took away their uncertainty, misunderstanding, and confusion. Further, as a designer, it was necessary to call on the expertise of child therapists and caregivers, who can prepare designers for dialogue with vulnerable children.

Author keywords

co-creation, children, personal agency, participatory design, design methods

Introduction

The context of the issue

Since 2012, children of prisoners have been included under the definition of vulnerable children used by both UNICEF and the European Commission (COPE, 2014). Children in general are very dependent on adults, but this is even more true for children of incarcerated parents (Druin, 2002; M. A. Gielen, 2008). These children feel powerless and unheard in a world controlled by adults; they languish in the shadow of their incarcerated parents. They are three times more likely than other children to develop mental health problems later in life, in addition, they are five times more likely to become incarcerated themselves (COPE, 2014). The world of children with a detained parent is turned upside down after the detention of the parent. A variety of adults make decisions that directly and indirectly impact the child. However, rarely do the children receive an explanation, nor are they given guidance and support afterward to deal with the consequences of these decisions. Co-designing with children challenges this unbalanced relationship. This method chooses to view children as social actors and skilled communicators, able to express themselves in many ways. They influence and actively contribute to the surrounding world. It is crucial to involve children in decisions about their own way of life, they are the experts of their experiences (Hansen, n.d.). The purpose of this co-creation is not only to include children but also to give them control over the end result and the entire process leading up to this result. By delegating control during the process, we empower the participating children to create self-esteem and develop new skills (Druin, 2002; Gielen, 2008; Visser et al., 2005). Besides, the goal of the end result is to give children more personal agency over their home situation and provide them with the tools and abilities to shape their future.

The importance of co-creation

Parental imprisonment is a complex problem in a delicate context. Since the designer is not familiar with this context, a close collaboration with the different stakeholders is essential to gain an understanding of the different perspectives and the issue at hand (Bijl-Brouwer & Malcolm, 2020). Therefore co-creation is approached as a way to let all relevant parties work together to understand the root of a problem and use their various resources and expertise to find a solution together. This process empowers participants to take initiative and participate in finding solutions and generating new knowledge. When co-creation involves children, it requires viewing children as equal co-creators, rather than simply recipients of adult guidance. This challenges the traditional roles between children and adults, which stimulates communication, learning, creativity, and critical thinking (CoC. Playful Minds, 2019; Iivari & Kinnula, 2018; Kouprie & Visser, 2009).

In 2002, Druin described four roles that children can play in the design process: user, tester, informant, and design partner. Later, Iversen et al. (2017) added a fifth role, the child as the protagonist. Although Druin mainly focuses on the role of children in the development of new technologies, this model

is also applicable to the design process in general (Hansen, n.d.). During this case study, children take on the role of design partner, where they attain a voice in all steps of the design process. The researcher and the child are partners who design together with a common goal (Druin, 2002). The decision to become design partners was based on literature research, observations, and interviews within the context of children of prisoners. As mentioned before, these children suffer from powerlessness and incomprehension as a result of parental incarceration. These feelings arise from a lack of information and involvement towards children, which can be overcome by introducing these children as design partners (COPE, 2014; Gielen, 2008). By giving vulnerable children control over the design process they start to feel empowered and dare to give full input, but this learning journey applies only to the children participating in the co-creation process and not the entire target group.

Adults are used to being in charge while children are accustomed to taking orders. When children become design partners those traditional roles do not apply anymore. Finding a new power dynamic between the child and the designer is therefore a challenge that the designer needs to be willing to engage in (Druin, 2002). Designers should be aware of their own and children's competencies and limits. One of the shortcomings is that adults might see children as vulnerable and incompetent and therefore differentiate children from themselves, which results in a limited contribution of children to the project due to a lack of confidence (Hansen, n.d.; Morrow & Richards, 1996). Morrow (2008) describes four ways how adults understand children: a developing child, a tribal child, an adult child and, a social child. During this case study, the children are seen as the social child, which means that the designer acknowledges and encourages children and adults to have different ways of expressing themselves, with the belief that this is beneficial for the design process (Hansen, n.d.).

By giving the children complete insight into the design process, an equal partner relationship can occur. After all, these children know best what it means to be a child of an inmate. Children take on the role of the expert, while designers get a better idea of the world they have to design for and guide the innovation process. The designer's challenge is to empathize and see the problem from the child's perspective, while also staying focused on the bigger context and the ultimate design goal (Hansen, n.d.; Spiel et al., 2018). Children can help by teaching adults their way of perceiving the world, which is through their hands rather than just their eyes. This concept is known as "the epistemology of the hand" and it reminds adults to use more tactile ways of exploring objects and methods through interacting with children (CoC. Playful Minds, 2019).

Even though the right of children to contribute is the focus of co-creation, children still have the right to remain silent (COPE, 2014, 2018; Council of Europe, 2018; School of Rights, 2019). Managing the ethics of working with children is another critical part that can have a significant impact on the outcome of the project. The designer should ensure that the process is beneficial for all parties involved. Besides the research material and tangible solutions for designers, the children should be empowered to acquire new knowledge and skills (Frauenberger et al., 2015; CoC Playful Minds, 2019; Hansen, n.d.).

Framing

This paper describes the co-creative approach of a case study involving children with an incarcerated parent. The case study was conducted as part of a master thesis project on supporting children with an incarcerated parent. This project led to a product-service system, named KiDO, that strengthens the relationship between the child and the incarcerated parent, builds the child's resilience, and processes the child's trauma. Children and their incarcerated parents are more often separated than together. KiDO captures these moments of loss by connecting children and detained parents up close and from a distance. To successfully reach this outcome a close collaboration with many stakeholders was necessary, such as parents, guardians, family members, the prison warden, correctional officers, judicial welfare workers, and psychologists. However, this paper limits itself to describing the most significant collaboration, between the children and the designer. The remainder of the paper will cover the different methods used and the factors, challenges, risks, and opportunities that co-creation with vulnerable children presents.

Method

The case study expands on the research of children with incarcerated parents within the prison of Hasselt in Belgium. An estimated 30 children were involved during the total research period of 8 months. Further, 8 children between the ages of 6 to 12 collaborated closely with the designer, and 2 of them took on the most significant role of design partner. Through weekly visits and the ability to work together frequently, the decision-making process became efficient, agile, and inclusive. The co-creation methods with children are discussed below. The intended purpose of the methods was dependent on the project phase. The understanding of the system happens through participant observer and context mapping, the brainstorming session explores the solution space, and the user test verifies the result.

Participant observer

Participant observation was used to integrate into the environment. In doing so, the designer experiences what it means to be part of this environment (Fine, 2001). Over a period of eight months, the designer participates weekly in the children's visit at Hasselt prison. This visit is adapted to children and the designer integrates as an intern into this setting by interacting with the families. This creates mutual trust and respect, leading to insights into the needs and wishes of children with incarcerated parents (Johnson et al., 2016). In addition, as an intern, the designer has a unique role of neutrality between the various stakeholders, such as the children, the detainees, the remaining parent or caregiver, health care providers, penitentiary custodial assistants, and gatekeepers. Through immersion in the environment, the observer becomes a personal witness. This approach provides a deeper understanding of the situation in which the children and their parents find themselves. In addition, the participating role removes the limitations of the researcher versus the respondent. This method is conducted over a long period with a total average of 30 children to reduce first impressions, biases, and time sensitivities (Fine, 2001).

Context mapping

With context mapping, participants' thoughts and perspectives were visualized. The research question for this specific study reads as follows: "How does it feel to be a child with a parent in prison and what concerns, feelings and attitudes do they have in daily life?". The method consisted of two parts and six participants, part one was a cultural probes package that the child is allowed to keep for two weeks to complete. Part two was a group session where the children discuss their package and envision the future. For this case study, context mapping was applied to children of prisoners, which causes several challenges. These children often do not have the opportunity to talk openly about their home situation and may be withdrawn as a result. In addition, there are often feelings of insecurity and mistrust that hinder conversation (COPE, 2014). Another aspect to take into account is the short attention span of children (M. A. Gielen, 2008). Gielen's guidelines (2013) are used for successful collaboration with children. Visser et al.'s manual (2007) forms the structure of the research method. The composition of the sensitizing package emerged from the literature on children with an incarcerated parent (COPE, 2014; Jones et al., 2012), Visser et al.'s manual (2007), and Thoring et al.'s (2013) critical approach to cultural probes.

Brainstorm session

The design phase was introduced by a brainstorming session with the two child design partners (Figure 2). As this session was conducted with only two participants, it is important to frame this as an idea-generation method and not a method to obtain hard insights. Children are not skilled designers, so certain tools and techniques were used to approach the brainstorming session. A word - and photo brainstorming tool, LEGO serious play and role play with objects were utilized (LEGO, 2010; Rubino SC et al., 2011; StudioLab, n.d.).

Figure 1. Co-creation session.

User test

A user test is a qualitative research method to verify a concept. The purpose of this user testing is to verify interactions with KiDO on both a psychological and technological level. A user test approaches reality as closely as possible and is therefore accomplished in prison itself over the course of one day. However, the actual user cycle lasts at least one week, depending on the frequency of the visits. Two children, aged 8 years, participated in the test together with their incarcerated parents. A scenario of three test phases was created to guide the facilitator through the user test. In addition, a justice welfare worker was present as an observer to analyze the participants' emotions and actions.

Figure 2. User test in Hasselt prison.

Findings

Influencing factors

By taking on the role of participant observer the designer becomes part of the research context. There are many factors influencing the integration of an outsider, in this case the designer was still a student, this led to both advantages and disadvantages (Johnson et al., 2016). On a positive note, the observer was still a young adult, which created a more natural and relatable relationship with children. Being seen as an intern or student also enabled the observer to ask questions to all the different stakeholders from the perspective of curiosity and studiousness. On the other hand, a student often lacks credibility, and this complicated scheduling and executing meetings with people in certain positions. Other disadvantages of submerging in the research context were subjectivity and bias (Druin, 2002; Johnson et al., 2016; Kouprie & Visser, 2009). Every designer has their own identity and unique experiences and even though we try to stay objective during research our own personality will have an indirect or direct impact on the design process. In this case study, the student differed significantly from the majority of imprisoned fathers and their children on a sociocultural level. Therefore, the designer had to acknowledge the limited knowledge about cultural differences, discriminatory practices, and privileges. It was crucial to approach the design process with an open mind and a willingness to learn and grow.

Challenges

An unexpected challenge was encouraging the children of prisoners to think creatively and express their imagination. During the beginning of the co-creative process, the children held themselves back, not daring to say silly and unrealistic ideas out loud, scared of being judged. There are various reasons for this behavior. One explanation may be the influence of the education system. Schools are both Cartesian and goal-oriented, which respectively means breaking down problems into smaller solvable particles and achieving a goal by providing tasks (CoC. Playful Minds, 2019). These models put pressure on children to achieve, causing creative thinking to subside. Another explanation is the power dynamic between children and adults, which often leaves no room for children's opinions (CoC. Playful Minds, 2019; Druin, 2002; Hansen, n.d.; Spiel et al., 2018). This neglect often turns to oppression for the children of prisoners: they live in the shadow of their parents' crime, they are denied information and they are not allowed to talk openly about their home situation. Usually, this results in reclusive, withdrawn, and distrustful behavior (COPE, 2014). Therefore, a reliable connection between the design

partners within a safe environment is of high importance. Together with child psychologists and based on literature (CoC. Playful Minds, 2019; M. A. Gielen, 2008; Hansen, n.d.; Visser et al., 2005), the following guidelines were identified to create this connection: explain who you are and why you are there, explain why the children are there, talk directly to the children not their parents, be transparent and complete with information, clarify that there are no wrong answers because it is not a test, give the children options, check their body language, provide confidentiality, ... These expert insights are necessary for designers since they are not trained to interact with children. Without the expert perspective dialogues between designers and children will not only be ineffective and useless but also harmful to the children.

Risks

Co-creation means treading uncharted territory. Stepping out of one's comfort zone is often necessary for personal and professional growth, and co-creation can be a particularly effective way to do this. However, the decision to co-create has to be thought through before starting a co-creative process (Kouprie & Visser, 2009). Through this approach, you will explore different contexts, perspectives, and realities which broaden your view, but may also challenge it. Hence, as a designer, your neutrality must withhold, even though you might personally disagree. This neutrality is further compromised when an inevitable relationship develops between the child and the designer. A child may exhibit inappropriate behavior that leaves the researcher unsure of how to handle the situation. Or the child and researcher may become attached which compromises the objectivity of the study (Spiel et al., 2018). Further, this relationship may be harmful to the child, since it is always temporary and the designer will eventually leave the context. Especially for vulnerable children that already struggle with trust issues, a sudden detachment can be traumatic for them. It is important not only to consider the potential for attachment and detachment but also the possibility of disappointment due to a lack of implementation. As designers often work on projects for organizations or companies, they may have no control over whether their design will be implemented. This can lead to disappointment for children who have invested in the process and may have put their trust in the designer, only to be left with the status quo. A separate risk is that engaging children is a time-consuming endeavor since they both must adapt to their new roles, build trust, discuss their approach every step of the way, and get together. In practice, we saw that the child's role often changed between partner, informant, user, and tester, depending on the stage of the project or the availability of resources (Hansen, n.d.; Iivari & Kinnula, 2018). Since the co-creation was part of a master's thesis project executed by a single student with a firm schedule, there were not always opportunities to allow the children to have a say in the project planning and methods or tools used. A more innovative approach in which children not only participate in the design process but also assist in the planning and management of the project would allow children to gain agency and potentially lead to more successful and meaningful outcomes.

Opportunities

If done right, co-creation is a mutual learning journey for both the designer and the child (Druin, 2002). The designer has the opportunity to fully integrate into a context to relate and unravel the underlying causes and explanations for a complex problem. A definite ability to empathize with stakeholders is therefore of high importance (CoC. Playful Minds, 2019; Gielen, 2008; Hansen, n.d.; Iivari & Kinnula, 2018; Johnson et al., 2016; Kouprie & Visser, 2009; Spiel et al., 2018; Walsh et al., 2010). The children obtain agency and a say in the design process, which fosters their personal development and growth (CoC. Playful Minds, 2019; Iivari & Kinnula, 2018; Druin, 2002).

Conclusion

Designers are people with their own unique experiences, which enables us to empathize with our research context. However, we all have an empathic horizon, the limit on a designer's ability to empathize beyond certain characteristics of their group (McDonagh-Philp & Denton, 1999; Ryan, 2014). As designers, we should establish our personal empathic horizon through positionality at the beginning of a project to acknowledge the potential impact of personal experiences and background and strive for a more inclusive, equitable, and successful process (Noel & Paiva, 2021). This process should be approached with sensitivity and care, ensuring that the rights and well-being of the children are protected and that any power imbalances are addressed. This is not a task every designer is willing and able to do. Therefore, designers ought to look before they leap by researching and consulting with sociologists and experts.

Further, designers must recognize responsibility for the temporary entry into the world of vulnerable children. They should plan an exit strategy early on and with a focus on the child to minimize the potential negative impact of detachment (Kouprie & Visser, 2009; Spiel et al., 2018). In this case study, the designer ensured transparent communication and a parting moment. Despite these efforts, the designer still experienced feelings of guilt. Therefore, the temporary but intense relationship between designers and children in co-creative processes and how to navigate this relationship in a way that is sensitive and beneficial to all parties involved should be investigated more. In future projects, it would be beneficial to establish the roles and corresponding boundaries of the children and the designer at the outset of the co-creative process, ensuring that both parties have a shared understanding of the expectations for the process.

Children of incarcerated parents are part of a complex and isolated context that is impossible to grasp from the outside. By involving children in the analysis phase, we learn to understand their world. In the design phase, children add value by including us in their thinking process. We, designers, make decisions according to design-related logic, but children do so from their experiences and desires. It is precisely this close collaboration that is essential for the success of the project because it ensures that the outcome is meaningful and beneficial to the intended audience. Overall, co-creation with vulnerable children is a challenging but valuable and rewarding approach to addressing and affecting complex social issues.

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The Power of photovoice: AI support provides voicing opportunities for children in sex education

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Abstract

In China, the conflict between sexual shame, authoritative family culture and children's desire for self-expression is the major obstacle to implementing sex education. Children's initiative and ability to explore are often excluded from consideration. In this paper, we adopted PARTICIPATORY ACTION RESEARCH (PAR) to investigate family sex education in China. The project involved 12 families participating in a Photovoice workshop to help children visualize abstract life situations and explore the possibilities of children's proactive expression. As a result, Photovoice was found to be an effective way of empowering children to become vocal subjects of sex education, but it cannot rely solely on parents with limited sexual knowledge; it requires the intervention of sex education experts to help children uncover accurate knowledge in their lives. The paper proposes new perspectives on ARTIFICIAL INTELLIGENCE (AI) technology to promote family sex education to accommodate a child-centered focus in various family settings. After that, we conduct a collaborative workshop with families to develop TickTick, an AI-based story-generation application for family sex education. The assessment revealed that AI could empower children to have equal communication with their parents, creating a communication bond for families through self-adaptation to create sex education topics in family settings.

Author keywords

Photovoice; Sex education for children; Artificial intelligence for care; Participatory action research, Participatory design with family.

Introduction

Contradictions

In China, the importance of sex education for children has been recognized due to widespread attention to social problems such as child abuse (Shi et al., 2022; Zhang, 2022). However, parents consider it "embarrassing and awkward" to talk about sex at home and often choose passive education for their lack of proper sexual knowledge. In addition, the authoritarian parenting style is the mainstream education style in China (Kang & Moore, 2011), which means that parents dominate conversations, resulting in a lack of an equal and respectful communication atmosphere in families. This makes children troubled by sexual abuse "lose their voices" out of fear and seldom seek help from their close relatives (Chen et al., 2007; Zhou et al., 2021). Therefore, the key issue for this research is how to empower children to have equal communication so that children can learn proper sexual knowledge in the family.

Photovoice: Establish Collaborative Relationships

The above contradictions led us to explore this complex topic of "parent-children discussion about sex" through the Photovoice of the PAR method. PAR is an approach that integrates education(Gibbs et al., 2018; Groundwater-Smith et al., 2014), investigation and action where children can actively participate in the research process. Photovoice is a collective activity in which participants produce their own images through the creative use of image devices to record themselves and the surrounding communities (Shaw & Robertson, 2008; Wang & Burris, 1997). This method is often used for community engagement and is a powerful tool for transforming people, social relationships and their perceptions of the world (White, 2003).

Discourses of sex and gender exist in the complex life scenarios in which children grow up, shaping their knowledge and perceptions, whereas it is difficult for children to directly describe the sexual issues in their lives (Tong & Chen, 2020). Photovoice is a visual interpretation that can visualize children's abstract life situations and help them proactively voice their stances and opinions. Meanwhile, images give parents insight into their children's thoughts, allowing them to discuss the values involved and build collaborative relationships with children, thus stimulating their willingness for proactive expression.

The powerful influence of Photovoice in sex education has been previously described in many papers (D'Amico et al., 2016; Haynes & Tanner, 2015; Shamrova & Cummings, 2017; Tong & Chen, 2020), but its application in a relatively intimate setting (e.g. in a family) is rare. Therefore, we conducted a Photovoice workshop on family sex education for practical research.

AI Provides a New Perspective on Sex Education

With the extremely unequal resource distribution for sex education in China, experts necessary to conduct PAR can hardly reach every family. Through desk research, we found that AI is a common way to address inequalities in education resources (Zhai et al., 2021). In children's education, AI

is increasingly applied to generate educational content, such as self-adaptive curricula (Chen, 2020) and early education (Coates, 2002; Williams et al., 2019).

AI technology can be tailored to a child-centered focus in all types of family settings, providing a new perspective to promote family sex education. Therefore, we designed and tested the AI application Ticktick by conducting participatory design workshops to validate that AI support can offer children the opportunity to voice their opinion in sex education.

Participatory Action Research Process

TickTick is a PAR program jointly conducted by Hunan University, Qingyou Sex Education Organization, and Changsha Library, aiming to empower Chinese children to actively explore sexual topics. Running from November 2021 to December 2022, the project involved 37 families and 41 children. The project was open to the public for family recruitment and was conducted in a mixed format, both online and offline. The flow of PAR project is shown in Figure 1.

PAR Phase	Methods	Participants
Phase 1: Preliminary Research	Desk research, Focus groups, Expert interviews	Experts: 4, Designers: 7, Families: 20
Phase 2: Photovoice Workshop	Materials, recruitment and training, Action, Reflection	Experts: 1, Designers: 2, Families: 12
Phase 3: Participatory Design	Paper prototypes, User testing	Experts: 1, Designers: 2, Families: 5

Figure 1. PAR research flow, methods in use and participants.

Relevant research materials had been provided to the Academic Ethics Committee of Hunan University for approval prior to the official launch of the project. The research project ensured that children and guardians enrolled in the project were aware of the project content and their basic rights. Given the sensitivity of "sex education for children", we attached importance to protecting children's privacy in terms of their images and descriptions. Approval was obtained for the publication of all photos used for publications.

Photovoice Workshop

Process 1

Prior to the family-oriented Photovoice workshop, we conducted preliminary research through focus groups and expert interviews to determine the workshop format and photography themes and worked with experts to develop a photography guideline. The practice routine of Photovoice includes three parts: recruitment and training, picture-shooting and discussion, and public exhibition (Wang & Burris, 1997). Depending on topics, participants, and the social environment of the research site, the workshop flow, as shown in Figure 2, is flexible for adjustments.

Figure 2. Photovoice flow, including the specific steps and participants involved in each step.

Phase 1. Materials, Recruitment and Training

The research focuses on the development of family sex education for children aged between five and eight. Based on the UNITED NATIONS (UN) guidelines and expert instructions (UNESCO; et al., 2018; UNFPA; & UNESCO;, 2022), we concluded four photography themes and a series of questions (as shown in Figure 3) to facilitate parents to guide the photography process and help children to form in-depth thoughts.

Figure 3. Photovoice guidance: sex education theme and enlightening questions

After completing the recruitment, the team explained the Photovoice method for each family through an online meeting, presented the proposed four photography themes through animations and text descriptions, and provided a photography guide to parents after the meeting. In terms of photography themes, we encouraged parents to guide their children based on the guide; we also asked children to shoot freely according to their own interests and desire for expression.

Phase 2. Participatory Action

After the online session was completed, parents and children worked together on a week-long photo shoot. In the shooting guidelines, we informed parents that they needed to submit 6-8 photographs taken by the children before the workshop starts. During the shooting and submission process, the researcher kept in touch with the families and encouraged parents to fully respect the child's expressed wishes and to cooperate with the child in the picture-shooting.

Phase 3. Participatory Reflection

In this phase, a sex education expert and two designers would take part in the online meetings. Based on children's images, experts and designers would ask questions as guidance. Researchers encouraged children to take the initiative and interpret the pictures they took, while parents acted as listeners, providing necessary complements to children's descriptions when they sought help.

Our enlightening questions for children's descriptions of images followed the SHOWeD approach (Wallerstein & Bernstein, 1988), which seeks answers to the following questions: 1) What do you see here? 2) What is really happening here? 3) How does this relate to Our lives? 4) Why does this condition Exist? 5) What can we Do about it? Then, with proper and systematic knowledge, the expert would explain the images and children's descriptions. The explanation method included storytelling and animation (shown in Figure 4).

Figure 4. The image constitutes screenshots of three out of 12 online meetings, presenting the following scenarios respectively: 1. Experts showed sex education animations to children; 2. Experts discussed with children about photos; and 3. Children shared their daily lives with experts.

Research Finding 1

Images build bridges of equal communication between parents and children

Images are found to be a medium for equal communication between parents and children. Some parents, when participating in online meetings, were more inclined to encourage children to express themselves as time progressed. Parents, children, and sex education experts formed a partnership in the multidimensional interactions, increasing trust between parents and children as well as the children's willingness to express themselves. For example, (as shown in Figure 5) a boy said for the first time to his mother, "I like my tablemate because she sings very well"; and the mother responded, "That's the first time I've ever heard of this, and I am quite curious". The workshop fostered a better understanding between the mother and son, and was also an opportunity for parents to guide children on a proper way to express their "fondness".

The Photovoice approach allows children to take an active lead in activities, empowering them to make decisions on their own. For example, when researchers collected some "ambiguous" images (as shown in Figure 5) and politely asked their parents to confirm whether their children understood the requirements, the mother responded, "this is the girl's opinion upon her understanding of the questions, and I don't know her thoughts, but I'll ask her later". This showed that parents have changed their attitude, choosing to respect their children's expression instead of instilling knowledge.

Photovoice effectively reduces the hindrances of authority and avoidance, but this requires a certain project duration and multiple communications between experts, parents and children involved, so as to achieve a shared and mutually inspiring relationship.

Images as a window into children's lives - Differentiated perceptions of sex education

Children tend to understand and express the same question in a strongly individual manner. For example, when confronted with questions about gender perception, children's photography and interpretations were very different (shown in Figure 5). Children's expressions included, "If it were my best friend (a boy) who liked pink, I would have persuaded him in private to change his color preference," "Boys are not allowed to have long hair and wear dresses, and they are not allowed to like pink," "Blue is the lucky color for boys", the list goes on. Through the window of "images," we observed that sex education exists not only at the textual level, but is also embedded in daily lives. Children are individuals with concrete life experiences, autonomous will and the capacity to act. They are equally important forces in shaping the environment of sexuality and gender discussions as well as community and sociocultural ideas. Their distinctive images can serve as triggers and opportunities for communication that point to similar knowledge about sex education.

Figure 5. Photographs taken by children during the workshop.

Ability Gap in Story Construction and Knowledge Conversion

We found that parents lacked the ability to uncover sex education topics from daily situations, whereas sex education experts play a key role in knowledge conversion. For example, when confronted with a picture of a juicer (shown in Figure 5), experts could extend it to topics such as family labor division, gender differences, and parent-child relationships with a dynamic and interactive guide to pass on ideas in communication. But for parents, the juicer may be just a household appliance rather than an opportunity for sex education.

Parents also lacked professional knowledge of sex education. For example, a boy took images of a coloring book, "The Human Body: Lift the Flap and Learn" (shown in Figure 5), that he had read with his parents. As the conversation progressed, he asked, "Why does this pregnant mother have amniotic fluid? What is amniotic fluid? Do boys also have amniotic fluid?" Yet his parents did not answer due to their limited knowledge base.

Based on images, children started to think; they then changed their thoughts and behaviors under the expert's guidance on storytelling. For instance, one girl who took pictures of the "Pink Princess Coloring Book" (shown in Figure 5) changed her mind from "boys can't use pink, and girls don't like blue" to "boys can choose any color" at the end of the workshop.

We discovered that images could bring up topics for sex education at a high frequency. Yet, good sex education requires additional supporting media to help parents uncover topics, build stories, and provide expertise to practice Photovoice in daily life.

Participatory Design Workshop

Process 2

Phase 4. Brainstorming--"AI in Sex Education"

Based on findings from the Photovoice workshop, we found that the day-to-day delivery of sex education in Chinese families cannot rely solely on a handful of sex educators. Rather, it's imperative to empower parents so that sex education can be delivered anytime at home. We brainstormed with experts and combined it with desktop research to reveal AI's ability to facilitate family sex education. Considering the elements involved in Photovoice, we regarded image recognition technology as the key.

Phase 5. Participatory Design Workshop

To explore the effectiveness of AI intervention in sex education, we conducted a workshop with participatory design methods. With five participating families in China, we worked with parents, children, and experts to develop a story-generation application, TickTick, for family sex education. The user testing was conducted following the WIZARD OF OZ (WOZ) approach, in which the design metaphor of "photo book/album" proposed by a participant was included in the app.

The concept of TickTick takes the "picture-shooting", a session of the Photovoice method, as the key (shown in Figure 6). With image recognition technology, the app plays the role of the expert in the workshop. It analyzes images taken by chil-

Figure 6. Ticktick usage flow and page display.

dren, captures keywords in the scenarios, generates various topics for sex education, and provides corresponding stories or communication methods, in a bid to spread the core knowledge of boundaries, body organs, etc.

Finding 2. AI empowering sexual education

We found that children enjoyed the experience of "recording their lives and discussing sex education with their parents". They kept taking new photos because they were curious about what kind of storyline the app could generate. Some children commented, "This is fun! I had no idea that the slide could bring such a story when I took the picture".

In addition, we found that images could induce ambiguity in parents' educational goals. For example, seeing the slides in the amusement park image, they would want to tell their children to "protect their genitals when playing around various facilities". On the other hand, the AI-recognized labels would allow parents to choose a label among "Safety", "Friendship", and others, helping parents to communicate with their children about the most important concerns of the moment.

According to the assessment, Ticktick is effective in engaging children in active thinking about sex and leading to behavioral changes, such as abandoning gender stereotypes. In addition, Ticktick creates opportunities for family discussions, in which images become a medium for active idea exchange between parents and children; AI also facilitates family discussions about images to move from life situations to sex education.

Conclusion

PAR integrates education, research, and action, allowing children to receive sex education and express their unique perspectives on sex and sexuality during the research process. It frees parents who lack expertise from the role of authoritative educators; meanwhile, it empowers children by transforming them from passive receivers to proactive learners. The use of Photovoice in family sex education triggers dialogues between children and parents so that they can build a consensus to "learn about sex education together". Moreover, AI technology also enables parents who lack knowledge about sex, making it possible to apply the "Photovoice" approach in family settings.

However, we found that some parents have concerns that using images for sex education may lead to inertia in children's thinking, making them associate various things in their daily lives with sex, which may have a negative impact on them. In this regard, in the future we will conduct long-term research to observe children's performance and find appropriate methods to study the link between images and the scale of sex education. Furthermore, we will also study the scale of artificial intelligence intervention in the process of sex education and form a set of evaluation criteria to provide guidelines for subsequent design.

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Co-design for the common good: a holistic approach to workspace projects

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Abstract

The design of workplaces that are both quantitatively and qualitatively aimed at creating the right work environment is a topic of extreme interest, at various levels. Starting from the indications of the International Labor Organization (ILO, 2022), it is essential to preserve, or establish, models that encourage a healthy lifestyle, in safe, and enhancing environments.

Elements such as perception of space, cognitive psychology, semiotics, and anthropology, become essential drivers to design contemporary workplaces: our society is constantly changing and, consequently, so are the spaces that define and characterize it.

Due to the radical change that are modifying the idea of work, a great transformation is being witnessed: time assumes a preponderant role in the definition of working environments, which must be constructed considering this dimension, that goes alongside the spatial one, in turn redefining the very concept of work.

In light of these introductory considerations, the contribution proposes the examination of different case studies that highlight the evolution of workspaces and environments and the best practices in the present, to create projects consistent with the new needs of workers, companies and, more generally, of society.

An approach based on a mix of of Co-Design (Sanders and Stappers, 2008) and Design for the Common Good (Dorst et al., 2016) can thus be effective to introduce the principles of inclusivity and care. Co-Design makes it possible to actively involve all stakeholders, such as companies and workers, by aligning their ideas towards a common goal, with the aim of defining some of the criteria that will affect future project developments. The Design for the Common Good (DftCG), born as an evolution of Design for All and based on the concept of the common good (Hussain, 2018), becomes fundamental to design in favor of communities, spaces and places. The contribution concludes, therefore, with the proposal of a vision, derived from a collaborative project actually carried out with an Italian company, that highlights the role of Design as a facilitator of complex realities and activator of innovative processes capable of triggering social and behavioral transformations.

Author keywords

Co-Design; Workspace; Common Good; Inclusivity; Care.

Introduction

In recent years, there has been a growth in awareness about the possible impact on health caused by the working environment (Jensen and Van der Voordt, 2020) and it has become even more of a concern during the Covid-19 pandemic (Cirrincione et al., 2020). A workplace is a complex composition of many different and sometimes conflicting elements (Colenberg & Jylha, 2021), therefore, the creation of healthy working environments requires a broad view of potential health risks and drivers for people. Generally, buildings are designed primarily for traditional working practices adopting patterns that tend to be repeated across multiple sectors and office typologies (Szarejko and Trocka-Leszczynska, 2007). However, they have undergone gradual change as work models have evolved towards flexible and agile practices. An integrated workplace strategy that takes into account people's requirements and needs is relevant to the success of the project (Appel-Meulenbroek, 2016). In a study conducted by Nanayakkara et al. (2021), the authors identify a relationship between organizational culture and office layout, suggesting that different layouts support different cultural dimensions; they state that one of the main reasons for changing the existing layout is to shift one's own culture or to further consolidate the existing. Thus, office spaces should be designed to exploit the physical environment and to add maximum value to the employer's objectives, allowing them to choose the degree of interaction that is desired. The design of workspaces that are suitable for the constantly transforming needs of workers and companies is a complex activity that involves various actors and that must necessarily understand the designed space as a means to enhance the common and shared good, which must be taken care of and, at the same time, must foster inclusion and accessibility.

The aim of the contribution is to present a vision for the design of corporate workspaces, based on the disciplines of Co-Design and DftCG, and derived from activities carried out in collaboration with an Italian company.

The soft design elements for workspaces: a case history

Considering the literature analyzed, it can be affirmed that if, on the one hand, the norms and quantitative values to be followed for the design of suitable and well-being-oriented places are rooted in the design culture, on the other hand, it becomes fundamental to take into consideration a range of qualitative factors that are equally necessary to achieve these goals.

Being physical spaces, an extremely relevant element is the sensorial perception one has of them: it is through the senses that human beings relate to the lived environment (Permana et al., 2020). These are stimulated through the spatial design of such elements as spatial partitions and transitions, furniture, lighting sources, sound insulation, materials, accessories and space-related technologies (Ching and Binggeli, 2018).

A further remarkable factor is the psychological cognition that the designed components provoke in the individuals living the workspaces. These places must be able to provide information on their use, and to give feedback on the actions performed within them (Ching and Binggeli, 2018); to emphasize the correct relationships between their constituent elements and those with human beings (Zhang and Ham, 2021). Places are connected to the identity value that is perceived and shared: signs and meanings establish a relationship between the occupants and the space (Brill et al., 2001). It is fundamental to consider what values should be communicated and how they can be perceived and understood during the design process.

Google's offices in Zurich are an excellent example as they are designed to welcome the employee in a peaceful environment, exploiting a playful configuration of the rooms and the activities to be carried out within them. One of the design principles is to move away from the mental construct of the standard office to transform the space in a debunking logic. Google was one of the first companies to support a hybrid approach to the organization of work (in the office and smart-working), to invite its employees to dedicate part of their time to personal activities, and to validate their work on the basis of the achieved objectives and not on time-based logics. This radical perspective has been one of the most influential drivers for the design of its workplaces.

If the workplace is the bearer of identity and intangible values (of the company of reference), so are the people who live and experience it, each with their own subjective, social and cultural differences. By applying an anthropological perspective, which contextually analyzes the attitudes and behavior of individuals, it is possible to understand work motivation, considering the personal cultural system and the set of collective values within which work activity takes place (Creary, 2020). Therefore, it is fundamental the contact points between both spheres: anthropological studies (Chang et al., 2021) highlight how social fabrics are constantly changing, analyzing various trends on different time intervals (secular trends, major trends, medium trends, minor trends). In this perspective, the Covid-19 pandemic has, on the one hand, opened up a reflection on the actual value of workspaces and on the possibility of alternating moments of physical meeting with others of exclusively digital connection; on the other hand, it has had a strong impact on the management of worktime.

A significant example is the Microsoft headquarters in Milan, which has a strong cultural value in the neighborhood in which it is located, through the promotion of aggregation and divulgative initiatives. The building connotes itself as a hybrid place, combining different functions, from work to entertainment and dissemination: on the ground floor there is a showroom that should immerse visitors in the corporate context; on the first floor the technological research center is designed to encourage, also, moments of meeting and networking between different actors. There are spaces entirely dedicated to hosting events, while the last two floors are occupied by employees' offices. The design of this building is guided by the concept of open space, which has made it possible to define a place capable of nourishing innovative working and relational logics, both within its own spaces and in connection with the urban context. An operation of this kind is beneficial both for the company and its employees, and for the community. Therefore, it can be understood how a workplace should be conceived as a complex organism, characterized by various dimensions and elements, capable of generating or modifying relations with and between the people who live it: the concepts of accessibility and inclusivity assume fundamental importance to design these environments.

The case studies underline the profound changes taking place in the working sphere and, in particular, in workplaces: time and the value given to it are becoming fundamental elements for the definition and construction of spaces that are suitable for the new needs. The sharing, both of activities and of the places that enable them, is another essential driver to design those. Again, the recognition that alterning physical and digital presence can be an important discriminating factor for corporate objectives, becomes a binding element to determine its success, as it is the capacity of the place to relate with the territory and the community that inhabits it.

Co-design and Design for the Common Good for workspace

The study of the reference literature and the analysis of the case studies made it possible to highlight which design methodologies are best suited to achieve the objectives, and which approaches and tools are most efficient in directing the process: this chapter introduces the disciplines of Co-Design and DftCG and how they can positively influence the design of workspaces.

Sanders and Stappers (2008) define Co-Design as an action of collective creativity applied to the entire design process, involving people directly in the delivery of products, services, etc. Its potential is represented, on the one hand, by the possibility of aligning the ideas and needs of the different participants; on the other hand, of being able to exploit transversal and peculiar competences depending on who is involved in the activities. One of the changes taking place in the world of work is the greater propensity of companies to consider their employees as key resources even in internal decision-making processes (Lundgaard and Brandt, 2019): for this reason, workplace design becomes a shared practice between all the corporate's actors and the design team cho-

sen to achieve the objectives. The participation and inclusion of employees in design processes can generate a desire to care for the space, as well as a positive sense of community and sharing, and personal satisfaction (Sanoff, 2011). For a Co-Design process to be effective, the context and the purpose of the activities must be interpreted correctly and become a source of inspiration to involve participants (Brandt et al., 2013). The achievement of these goals can be mediated and facilitated by participatory activities and workshops, through which a common language can be created, a creative and exploratory attitude can be fostered, the construction of future scenarios can be facilitated, and, finally, the roles of the participants can be defined (Mattelmaki et al., 2014).

DftCG (Dorst et al. 2016) is a discipline that evolves the principles of Design for All, Holistic Design and Universal Design, innovating their approach: there is a need for a concrete commitment to remove barriers, especially cultural ones, that limit the possibility of action and interaction between the environment, ecosystems, spaces and humans. In this sense, the DftCG implements a profound paradigm shift: it no longer places the human being at the center of design activities, but rather the common good, understood as part of an inclusive model that identifies values, structures and interests, recognised by the members of a community, stimulating and activating new relational forms, which can be translated into products, systems and ecosystems (Hussain, 2018). The common good is characterized by shared perspective, common structures, a privileged class of common interests, and a solidaristic and communitarian dimension (Fraser, 2021). Applying the principles of the DftCG allows to adopt a life-centered perspective, in which the communities and ecosystems are placed at the center of project activities. The concept of the common good suggests another one strongly related to it, and previously mentioned: that of care (Pennacchi, 2012). Introducing this principle into design practice has the aim of proposing a vision at the service of the environment, the community and relationships: design, understood as a collective and participatory work, must pay particular attention to places, communities and local resources. It must, consequently, be combined with the need for a higher quality of the built environment, which influences and defines the common good of a group, so that Design can contribute to spreading and applying the principles of sociality, participation, inclusion and accessibility.

Workspace design: the ENEL case study

Below, through the discussion of a case study of a research study in which the authors took part, a qualitative vision is proposed for the design of company workspaces, which draws, mainly, from the Co-Design and DftCG methodologies and which can become a tool for experimental validation, for the application, in the area of interest, of the principles of the above-mentioned disciplines.

The design activities were carried out in close collaboration with some members of the ENEL company, through workshops and focus groups: in the initial phases, it was necessary to build a relationship of trust with the company representatives, through moments of sharing and discussion; subsequently, through digital platforms that facilitate multi-person sharing, the participants were asked to communicate their vision of the company, specifying what their founding values were and what their expectations and future objectives were for it. In this way, after a focus group phase, it was possible to align perspectives and points of view and thus define a set of common and shared values, which were interpreted by the researchers to begin outlining the intrinsic characteristics of the project. A further shared and collaborative activity, carried out in a similar manner, and aimed at defining which models and types of relationships, existing or new, were to be stimulated and facilitated through the work spaces. From the results obtained here, it was possible to investigate and identify other aspects and characteristics that the designed place should follow, starting to give it a functional and spatial connotation. The Co-Design phases were alternated with research and conception phases completely vertically managed by the designers, which were the subject of discussion with the company and its representatives and the stimulus for conducting further focus groups. Designing the workplace must therefore be a collaborative and shared practice between the various actors that make up the company system, to allow the collective values and needs, conveyed by the designed space, to be aligned with personal and individual aspirations and needs. Facilitating this process, which must take into account the soft, value and relational components of the project, through tools and methods belonging to the discipline of Co-Design, can be an effective strategy capable of generating wellbeing in those who inhabit the realized environments.

Directing the design of the workplace according to the principles of DftCG, necessarily implies not considering it as a simple space, but, as stated above, as part of a complex organism, characterized by various dimensions and elements, which generate and modify relationships with and among the people who inhabit it. Compared to a traditional design approach, based on the performance objective of the individual, the application of DftCG principles to the development of ENEL's workspaces, allows it to be guided according to a holistic. This leads to the need to strongly consider the social component of Design (Manzini, 2015) that offers methods to design the set of processes that favor community well-being and care for the common good.

Furthermore, the introduction and application of a DftCG approach in the project of interest, has made it possible to change the perception of the workplace as a means of conveying the company's entire value system, to translate it into tangible and intangible elements that are aligned with the needs of the individuals that make up its corporate fabric. Moreover, being part of a system conceived according to the principles of the common good, unlike a project oriented by more traditional logics, it must be built to facilitate the establishment of profitable relations with the territory in which it is inserted, between the various actors that inhabit it and with the place itself, and, moreover, for the achievement of a shared and collective wellbeing (Fig. 1).

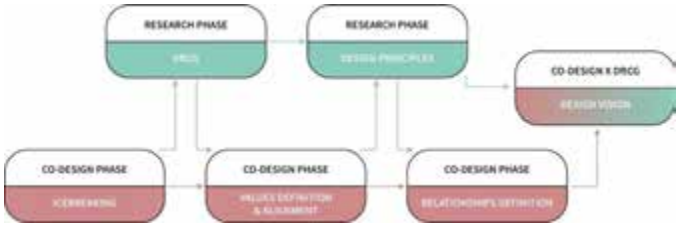

Figure 1. The process that, alternating between Co-Design and research phases, led to the definition of the design vision.

Unfortunately, some challenges were encountered during the shared process that to some extent limited the effectiveness of the operation. Beyond the project's corporate contact persons, ENEL's team of co-designers was never made up of the same figures, some of whom were added or replaced during the course of the project. This undoubtedly created a loss of focus in some of the participants and also introduced the second problem highlighted: the difficulty in aligning the heterogeneous figures involved in the project process, who represented different company departments, and the consequent obstacle in building smooth and effective interdepartmental relations, which was one of the objectives set for the project (Fig. 2).

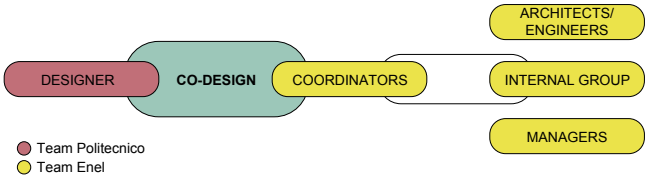

Figure 2. The actors involved in the co-design process.

Going beyond the principles of Human-Centered Design, an approach that can be defined as life-centered has therefore been preferred, which conceives, therefore, its entirety and which recognises, at the same time, a degree of independence and interdependence of the components (Fig. 3).

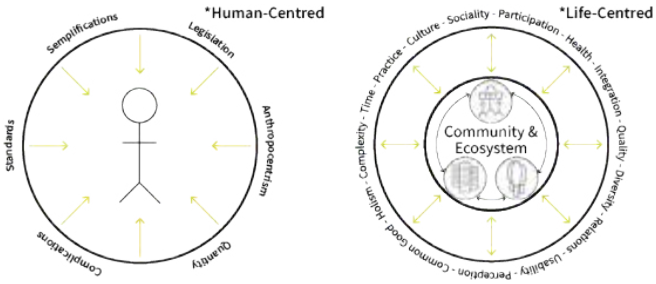

Figure 3. The differences between a more traditional, human-centered approach and one guided by DftCG and life-oriented principles.

From the experience gained, fundamental elements to be managed become the quality of the designed environment, understood as a set of values and sensations perceived and returned, effectiveness, efficiency and elasticity; the complexity that describes the interdependence of the constituent parts and implies the creation of shared meaning to be made comprehensible and acceptable; the practice of behaviors and activities mediated by the designed environment, which goes to influence the practices, uses and relations that are manifested within it. Finally, time and the value given to it become other essential drivers. The spaces must be hybridized, conceived, and built to perform different functions, from the more usual ones to those that meet new needs of the individual and the community, and, consequently, designed according to a physical and architectural flexibility, and management: barriers that negatively affect the establishment of relations between the environment, spaces and human beings must be removed.

Conclusion

The term inclusivity in the design context tends to be related to designing for categories of people with a physical and/or attitudinal impairment. In this case, what we are witnessing is a tendency to generate a form of design that resides in corrective interventions and that do not aim at resolving the problems underlying the design values, but rather, at addressing the problems as they arise.

To remedy these problems it is necessary to act at different levels: it is fundamental to consider all those qualitative components of the project that can be discriminating in its success. For example, being able to take a critical and observational perspective on current and latent trends makes it possible to anticipate the new or potential needs and requirements of the various actors living in the planned place. Again and in this direction, the application of a Co-Design approach allows to align and mediate their needs and, therefore, to generate shared wellbeing through the project itself. Finally, the DftCG methodology can guide the design process in a beneficial and innovative way, creating a shared value system, generating or modifying relationships, taking a life-centered approach aimed at caring for the common good.

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Co-designing neighbourhood identities. How to share memories and experiences towards a common sense of belonging

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Abstract

Participatory Design (PD) has expanded the field of Design in developing new ways of social engagement in the public sphere. The approach always aims at co-designing inclusive and shared solutions starting from a disarticulation and rearticulation (Mouffe, 2013) of different points of view freely expressed by individual people in a community. When applying PD in transformative processes for the public realm, researchers in Design have to deal with a complex but rich social party made up of pluralities (Manzini, 2015), enlarging the democratic arena and embracing all the participants and the different viewpoints (Björgvinsson et al., 2010). In this sense, PD is an effective way to deal with transformative processes in neighbourhoods as it gives the community a tool to democratically discuss together social, environmental, and cultural issues affecting the community. To design there - though aiming at an urban bottom-up renewal - means in the first instance to touch upon (shared or contested) meanings for the community, and possibly help the citizens to identify them, question them and re-assess them from multiple perspectives (Tassinari & Vergani, 2023). This is the case of Nolo, a neighbourhood in the city of Milan characterized by a proactive "creative community" (Meroni, 2007), where the research team the authors belong to fostered over the years social cohesion and innovation interventions through tailored-made PD activities. In this process – currently undergoing - specific attention is paid to address various points of view from the marginalized community of the neighbourhood such as immigrants, elderly, citizens with physical and cognitive impairment, children but also those agents coming from the non-human realm like plants, insects and others. In this framework, the paper presents a specific co-design session organized with some inhabitants of the neighbourhood to articulate a shared and inclusive *sense of belonging*, collecting, and comparing the viewpoints of the inhabitants. To map the neighbourhood's different identities – and understand the specific places to be redesigned together with the community using a bottom-up approach – we invited young and old people to join the co-design session, asking them to share their memories, tell their personal experiences and discuss cross-generational issues. The co-design session helped us to envision together future scenarios for their neighbourhood, while letting emerge the importance of preserving memories for the future of the community.

Author keywords

Participatory Design; Design for Social Innovation; Situated Knowledge; Sense of Belonging; Community of Care

Introduction

Participatory Design (PD) has expanded the scope of Design by introducing new forms of social engagement in inclusive processes and projects. The approach has been successful in creating inclusive projects and dialogues by engaging with diverse communities, such as neighbourhoods, and allowing for the co-design of solutions that consider the perspectives and needs of all members (Manzini, 2015). The process aims to generate a discourse, a cultural artefact, developed by that specific community, and can help citizens to re-assess shared or contested meanings (Mouffe, 2013). However, dealing with these diverse communities requires designers to step outside traditional dichotomies and engage with multiple epistemologies (Coccia, 2021; Latour, 2018). In this case, the authors looked to Donna Haraway's work on situated knowledge as a framework for counteracting power dynamics, engaging with diverse world-making projects, and embracing vulnerability and open-endedness (Haraway, 1988). According to Haraway's teachings, instead of fearing vulnerability, we should engage with it and explore its potential. The authors of this project used this approach by embracing their own vulnerability as designers and engaging with a specific form of situated knowledge in their PD process. This helped them to recognize the partiality and vulnerability of different perspectives in the community. In this context, it is important to recognize that participation in public discourse is not just about individuals, but about communities as well. Participation in PD practices risks being limited, and not including a diverse group of people (Reyes-García et al., 2012; de la Cadena & Blaser, 2018). To address this issue, the experimentation described in this paper explores a way to involve a diverse

perspective and experience, putting it in communication with other ones, still belonging to the same setting, in order to work on the concepts of historical memory and sense of belonging to a place.

The context

The experimentation presented in the paper was conducted in the context of Nolo, a semi-peripheral neighbourhood of the city of Milan (Italy) in which the research group Polimi DESIS Lab - the research lab of the Politecnico di Milano the authors belong to - is active since 2016. After several years of engagement with community actors through educational activities, the research group subsequently physically established in the context in 2020 with Off Campus Nolo, a living lab located in the area's historic covered market (Fassi & Vergani, 2022). Off Campus Nolo (an initiative from Polisocial, the social engagement and responsibility programme of the Politecnico di Milano) not only hosts research projects and community-making practices, but also events, volunteering activities and meetings organized by the Polimi DESIS Lab as well as the neighbourhood citizens. When the research team entered the neighbourhood, a vibrant process of urban transformation and regeneration was already in development, mainly thanks to the proactive community of newcomers coming from different parts of the country. In fact, the area in which Nolo is located was historically involved in various migratory flows - both national and international – that contributed to create a rich context in terms of a variety of cultures, traditions, behaviours (Fassi & Manzini, 2021). Today, newcomers with different cultural backgrounds represent over 34% of the local population (made up of about 25,000 inhabitants), compared to an average figure of 19% throughout the city of Milan (ibidem). The proactive community of Nolo – here defined as a "creative community" (Meroni, 2007) - have already fostered over the years a process of urban and social transformation that led to the opening of new citizen-centered services, but also the spontaneous aggregation of the inhabitants around different initiatives, activated both online and offline. These initiatives have taken up both formal and informal forms of association such as the "Nolo Social District", a "social street" managed by the inhabitants themselves through a Facebook group with more than 12,000 members, helping the socialization process between neighbours (Fassi & Vergani, 2022). The process triggered by the people involved in the "social street" led to the creation of a new identity for the neighbourhood, which is partially overlapping with other identities established in previous decades. In this sense, the authors are trying to uncover the different "overlapping geographies" (De Rosa et al., 2020) of the neighbourhood - intended as "physical portions of the city linked to social, cultural, and human identities which manifested over time and space" (ibidem) - by collecting past narratives lost in time.

Methodology

One of the main research projects that were developed in Off Campus Nolo (and still ongoing) is the Nolo *Situated Vocabulary*, a neighbourhood vocabulary whose aim is to help the community of Nolo to map the district both in its spatial and social features by including its wide network of "situated stakeholders" (citizens, shopkeepers, neighborhood associations as well as local administrators and the Municipality) (Fassi & Vergani, 2022). The *Vocabulary* is managed by the professors, researchers, PhD candidates and interns of the Polimi DESIS Lab that become curators, content creators, and volunteers when working at Off Campus Nolo) (ibidem) who are currently exploring ways to generate conversations around 9 keywords (*Public Space, Degradation, Common Good, Sense of Belonging, Memory, Change, Fun, Commitment, Nolo*) chosen by a group of members of the "Nolo Social District" Facebook group as hot topics experienced daily by the inhabitants. At the heart of the project lies the concept of using the *Vocabulary* as a physical prompt that evolves into an agonistic space or a "collaborative platform" (Huybrechts et al., 2022) to bring to light unexpected similarities and revealing potential divergences among the Nolo community (Vergani et al., 2023). Specific attention is paid to the *Vocabulary*'s potential to include (ontologically) different "voices" (human as well as non-human such as plants, animals and others), bringing them in dialogue to envision common matters of concern and new courses of transformative actions (ibidem). This collection of "voices" of the inhabitants - as well as those of writers, linguists, artists, designers, local activists, scientists (etc.) - takes place during co-design activities, workshops and interviews, both in the physical space of Off Campus Nolo and on online platforms and social media. The "voices" are collected in the *Vocabulary* and then spread in the community of the neighbourhood in several modalities, such as specific exhibitions, booklets and a podcast developed in collaboration with Radio Nolo, the neighbourhood web-radio created and supported voluntarily by local citizens, based in the Off Campus Nolo space. Through this approach, Off Campus Nolo and the surrounding neighbourhood transform into a physical "agorà" (Huybrechts et al., 2018), a space in which reflections on the Vocabulary can be shared, conversations can take place, and new courses of action can be envisioned (Vergani et al., 2023). In the case of the activities described in this paper, the authors focused on the word *Sense of Belonging*, choosing the elderly inhabitants of Nolo as the main target to work with. This decision was made as they represent the ones who own the memories of the location and, ideally, have a strong sense of belonging to the neighbourhood in which they have lived for a long time.

The activity

The workshop took place in the city of Milan, in an old-fashioned bar in the Nolo neighbourhood, called "Lido Bar". The location is a popular gathering spot for both old and young locals and it is known for its friendly owner, a long-time resident of the area. The activity - a one hour and a half-long co-design session - involved a group of elderly inhabitants of Nolo. The objective of the activity was to assess the perceived sense of belonging to the neighbourhood by comparing the opinions and personal stories of the participants through various phases (Figure 1) using several tools. In the first ice-breaker activity, participants were asked to pick three places that give them a sense of belonging, highlighting the memories and significant aspects associated with those.

Subsequently, the participants sketched those places on cards, telling their personal memories to the other members of the group in order to foster a confrontation to understand whether there were some common features assessing a shared sense of belonging (Figure 2). Another dimension that was mapped, apart from the one linked to the physical asset

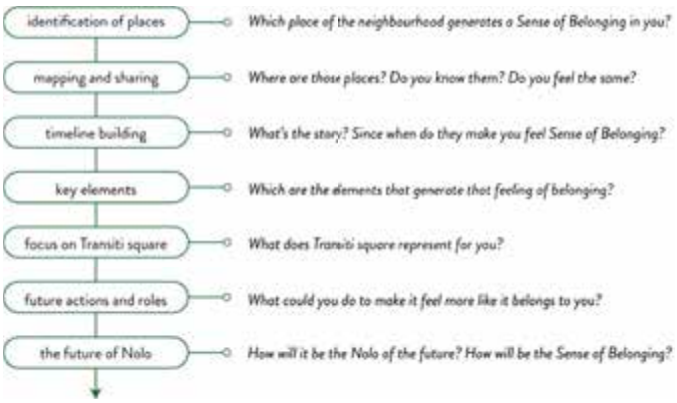

Figure 1. Workshop's phases (Diagram by the authors).

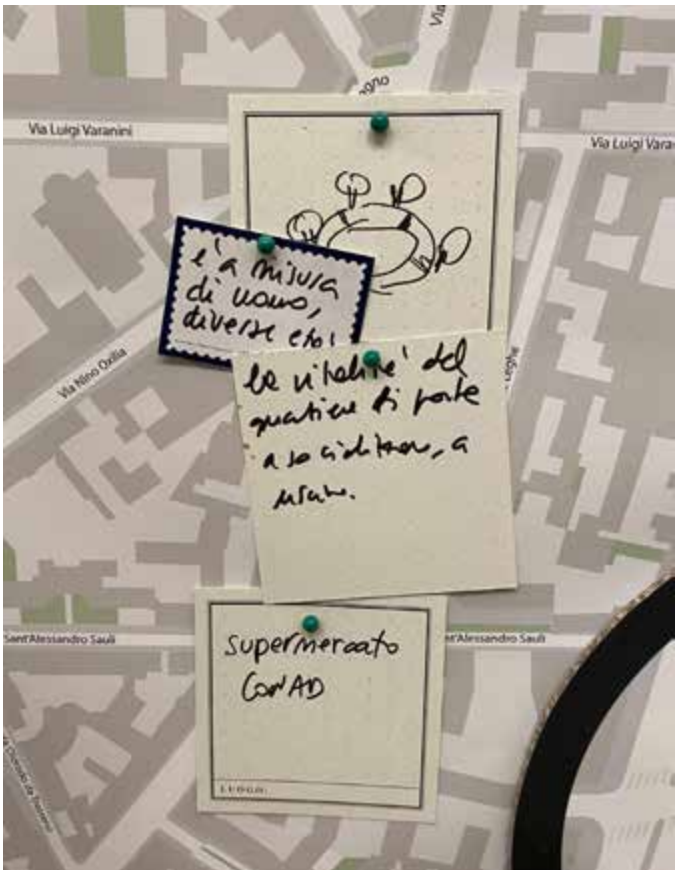

Figure 2. Interactive mapping (Picture by the authors).

Figure 3. Interactive timeline (Picture by the authors).

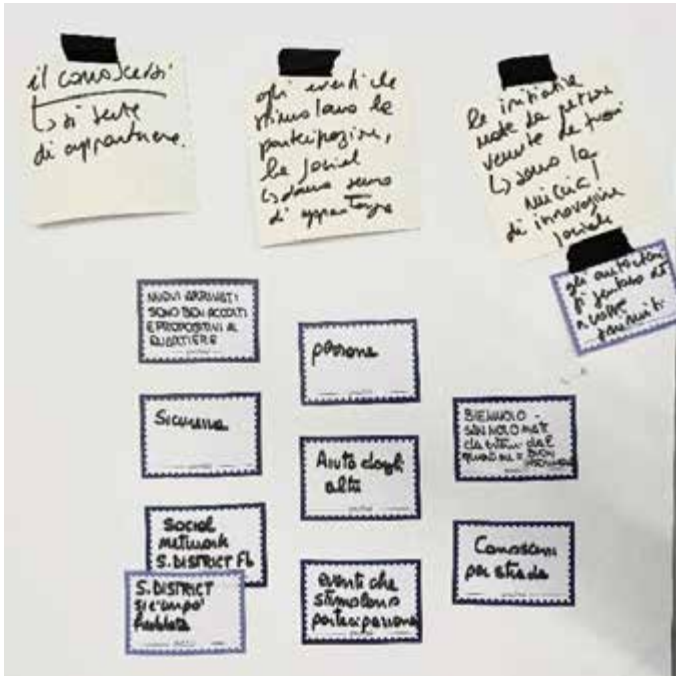

Figure 4. Activity to delineate the qualities and doubts about the neighbourhood (Picture by the authors).

Figure 5. One of the participants showing the neighbourhood old soccer team (Picture by the authors).

of the places identified by the participants, was the historical one. Cards were placed on a timeline, and participants were asked if they felt a sense of belonging from the start or if it changed significantly as time passed (Figure 3).

Participants hypothesised chorally the critical features and fundamental characteristics that generate a sense of belonging to a place based on the chronology that evolved, before distinguishing the qualities and criticalities of each significant place (Figure 4). After the mapping and sharing of "personal" places, a focus was done on a specific critical "spatial node" (Fassi & Vergani, 2022) in the neighbourhood identified by the community of Nolo during a previous co-design activity linked to the first word of the *Vocabulary* (*Public Space*). With the help of some cards, this part of the activity aimed at identifying qualities and criticalities as well as envisioning future potential initiatives and actions for the benefit of Nolo, as well as the inhabitants' responsibilities to foster the development of a shared sense of belonging through the local communi-

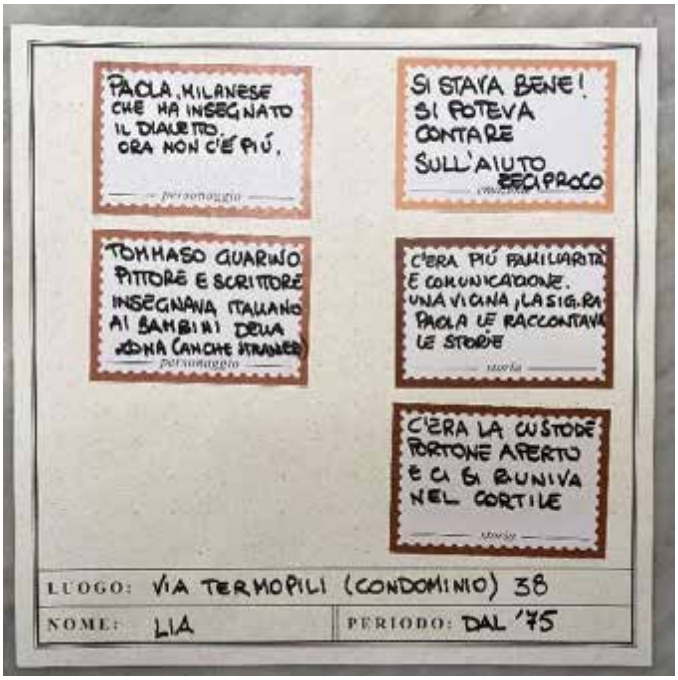

Figure 6. Activity to delineate the key elements of the places that generate a sense of belonging (Picture by the authors).

ty (Figure 6). The activity ended with a collective reflection about the future of the neighbourhood, taking into consideration all the aspects that emerged during the session.

Results

After the activities, which were successful in involving the participants proactively, some general emerging aspects were identified. As far as public squares and green spaces are concerned, it can be stated that some of Nolo's squares and parks, which have recently been revitalized, have emerged as attractive places for the whole community, encouraging frequent use. Many of these spaces are transformed during the day - or with specific events -, embracing different contexts and groups, and therefore different levels of belonging. However, sometimes this vibrancy manifests in forms of disturbance to the public peace, disorder, or littering, which generates dissent and outrage.

The second category of places that were mainly identified and discussed concerns private homes and buildings. It emerged that usually the entrance of private houses, and therefore the last steps towards one's apartment, convey security and protection. Therefore, the apartment building is perceived as an extension of one's own home, representing the first protective architectural element that precedes that intimate and familiar place where comfort can be found. Especially in the past, life in the apartment building was lively. Solidarity, mutual care, and inclusion marked the relationships between neighbours. Today, however, this kind of relationship often no longer arises spontaneously among apartment dwellers and must be rebuilt elsewhere, such as inpublic places to gather near home like bars, shops, schools, and parks. Afterwards, new hybrid gathering places that echo the old neighbourhood shops alternate with historical neighbourhood businesses, becoming a familiar part of residents' daily lives. A sense of familiarity and, therefore, the development of a sense of belonging to these places, is the thread that unites old and new, past and present.

Finally, cultural places such as schools and libraries are not just thought of in terms of education, but also as opportunities for stimulation, exchange, and comparison. They are references for approaching civic sense, inclusion, and respect, which, in a growing and increasingly diverse community, risk being lost, resulting in criminal actions and mistrust.

The participants of the activity let emerge an overall dimension of nostalgia for past times, especially related to the fact that a sense of "spontaneous humanity" and welcoming was widely characteristic of the neighbourhood. This was especially connected to the migratory socio-economic situation that characterized the area during the post-World War II period. At that time, inhabitants promoted a spontaneous grassroots social innovation phenomenon. This dimension, from what emerged from the activity, was deeply connected with the world of fun, pleasure, and conviviality. There were lots of parties, dances and music, food, sports, local championships, and open-air activities. These aspects are crucial and worth to be deeper explored, also in response to the sense of exclusion that the elderly inhabitants reported from the social innovation's processes activated by the newcomers. And in this sense, it's also worth mentioning that there are two different clusters of newcomers in the neighbourhood: the ones with a migratory background, and the ones that belong to the young and creative class, attracted by the social and creative vocation of the district. The sense of belonging is very personal, and it may be connected to completely different ideas. The frequent need among the participants to refer to past events in order to explain the present, confirmed the importance of the temporal aspect for the development of a sense of belonging, and therefore the stratification of personal and shared experiences and memories.

Thanks to the result of the experimentation, some useful and interesting questions emerged, and, starting from these interrogatives, the research group envisioned future scenarios in order to open new design possibilities for the neighbourhood regeneration process. These new and desirable narratives for the inhabitants and spaces of Nolo were shared on the neighbourhood's social street Facebook group and in the Off Campus Nolo spaces, in order to open up the imagination of citizens - from different points of view - and develop related actions to transform the neighbourhood in a collaborative manner, making it more inclusive, sustainable, innovative and resilient.

The 4 scenarios envisioned were:

- Condominium initiatives.
  Recover neighbourhood relations, encouraging greater involvement through sharing gardens, terraces, equipment, knowledge. Encourage moments of aggregation such as shared lunches, reading groups, bookcrossing, courtyard cinema (Figure 6).

- Neighbourhood shops.
  Set up a network of initiatives to transform even more the local businesses such as bars, restaurants, and shops into symbolic places of confrontation and dialogue, fostering moments of conviviality between different generations. For example, connect historic and new businesses by involving them as local sponsors for the formation of neighbourhood cultural and sports teams and competitions (Figure 7).

Figure 6. Condominiums initiatives (Picture by the authors).

Figure 8. Neighbourhood heroes (Picture by the authors).

Figure 7. Neighbourhood shops (Picture by the authors).

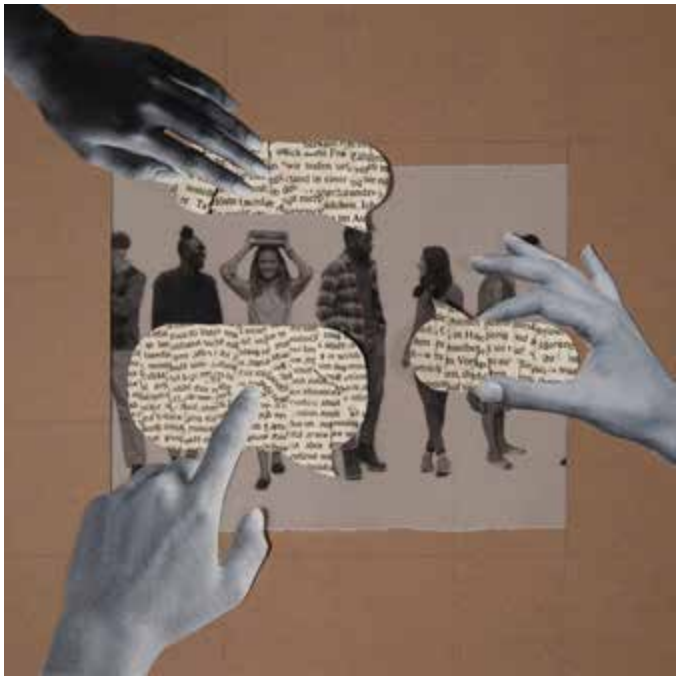

Figure 9. Neighbourhood "Agorà" (Picture by the authors).

» Neighbourhood heroes.
Involve citizens to periodically award a prize to prominent figures in the neighbourhood who have given an example of trust and social responsibility, solidarity and activism, to celebrate the development of neighbourhood initiatives in favour of the community and the environment, thus promoting the spread of good practices among resident (Figure 8).

» Neighbourhood "Agorà".
Restore an active neighbourhood network by fostering a form of participatory democracy with meetings run by the citizens themselves. The objective is to empower the area to develop actions against vandalism and bad practices, overcoming insecurities linked to the neighbourhood, recovering critical areas or spots, but above all fostering solidarity and the emergence of new local public events.

Conclusions

As for the *Situated Vocabulary*, the experimentation proved to be useful for collecting those unheard voices such as those of the elderly inhabitants. The work conducted let emerge the importance of preserving the heritage, the wisdom and the past memory of the neighbourhood and its elderly inhabitants by creating a link with the modern social innovation and regeneration processes undergoing in Nolo. This led the research team to focus next on two words of the

Situated Vocabulary: *Memory* and *Fun*. In fact, another interesting takeaway from this activity is the dimension related to a lost dimension of pleasure, conviviality, and fun around the concepts of care and social innovation. The pleasurable dimension, looking at it in relation to the dimension of slowness, quality, tradition, memory and conviviality, as Carlo Petrini wrote in the Slow Food's Manifesto, in the opinion of the authors should be recovered and inserted in the social innovation modern processes: "We believe that everyone has a fundamental right to pleasure and consequently the responsibility to protect the heritage of food, tradition and culture that makes this pleasure possible" (Petrini, 2016).

To conclude, this experimentation represented a good occasion for Off Campus Nolo in developing a participatory, inclusive, and care-based neighbourhood culture, this time from the point of view of the more mature people, intended also as a "bridge" to bring such concepts into the world of the younger newcomers.

A common thread needs to be (re)built, that can connect the older community of the district with the new ones: there's the need to recover those lost traces (there has been a big gap during the 80s and 90s) of spontaneous and pleasurable social innovation, care and sense of belonging.

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Universal design for learning as an inclusive teaching methodology for an African art and culture course in Ghana

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Abstract

Ensuring inclusivity in a highly diverse higher education classroom has been a challenge in many higher education institutions globally. In a highly diverse classroom, there is a need to ensure and sustain inclusivity where all learners feel respected and regarded as an important part of the teaching and learning activities. The universal design for learning framework has been empirically proven to be an inclusive pedagogy that ensures high inclusivity amidst the diversity in the makeup of learners. This convergent parallel mixed method study investigated the potential in ensuring inclusivity while improving the learning processes and learning outcomes of second-year students studying the Introduction to African Art and Culture course by designing the course to be UDL compliant. Data for the study were garnered from 120 students of the course via the UDL Observation Measurement Tool (UDL-OMT) and an adapted version of the ITSI-S Experience in Classroom (EIC) Questions of the ITSI-S. The results of the study revealed that UDL and its three key principles of multiple means of representation, multiple means of engagement as well as multiple means of action and expression were satisfactorily observed in the Introduction to African Art and Culture course. Also, it was evident in the findings that UDL's Implementation ensured high inclusivity while reflecting positively on the learning processes and learning outcomes of all the students who read the UDL-designed course. The study contends that UDL is an important inclusive teaching methodology that should be adopted by teachers in their quest to maintain a high level of inclusivity in a highly diverse classroom.

Author Keywords

African art and culture course; inclusivity; higher education; teaching methodology; universal design for learning

Introduction

Higher education institutions are increasingly becoming highly diverse (Koutsouris et al., 2020) due to the differences in the makeup of students such as personality traits such as academic, intellectual, and emotional background, age, gender, learning styles (Gried-Reed & Williams-Wengerd, 2018) as well as the current argument of internationalizing higher education institutions (Pineda & Mishra, 2022). Diversity in the study context agrees with the view of Dei and Asgharzadeh (2005) as the differences in the makeup of students that could be barriers to students' learning, including but not exhaustive, religion, culture, gender, age, language, etc. The high diversities in the student population often result in stereotyping, labeling, social exclusion, and segregation which are giant hurdles to achieving equality and equity in higher education institutions (Verdugo-Castro et al., 2022). The one-size-fits-all curriculum design and approach to education cannot address the differences in the makeup of students in higher education institutions (Kay & Hunter, 2022). To surmount the challenges that result from student diversity, there have been recent calls for instructors in higher education institutions to embrace inclusive pedagogical curriculum designs and methods (Pirchio et al., 2022; Woodcock et al., 2022). Since the Salamanca Statement and Framework for Action on Special Needs Education in 1994, the need for ensuring inclusivity, which is ensuring that every student has an equal opportunity to achieve educational success irrespective of their diversity, while removing any potential barrier to their educational achievement (Nasri et al., 2021; Butakor et al., 2020), has been echoed strongly, especially in the higher education context (Hernandez-Torrano et al., 2020). This call has been reiterated in the 2030 Sustainable Development Goal 4 on Quality Education which places a premium on inclusive and equitable education as the fluid for connecting and bridging the gaps within and between societies. Inclusive pedagogy in the higher education context is understood by inclusive education scholars in three main ways (Gale et al., 2017; Moriña, 2020). First, inclusive pedagogy holds the belief that every student is special and has unique values that could be brought to the learning environment. Second, an inclusive pedagogical curriculum design values diversity and strives to provide access for all students while creating an enabling learning environment where students feel highly motivated and engaged. Lastly, inclusive pedagogy aims at actions that foster a cohesive society that connects students with their communities. One of the highly endorsed inclusive pedagogical frameworks in recent years that aim at accommodating the diversity of students while fully advancing the global agenda of inclusive education is the Universal Design for Learning (UDL) (Adom, 2022; Nasri et al. 2021).

Universal Design for Learning (UDL) is a theoretical framework that embraces student diversity and ensures that learning

content is made accessible for all learners (Roski et al., 2021) by tactfully removing or reducing to a considerable degree, all potential barriers to education when designing and delivering courses (Burgstahler, 2021). UDL capitalizes on the diversity of students and offers options for students in engagement, content representation as well as actions to elicit their understanding of the learned content (Basham et al., 2020). As a flexible pedagogical framework, UDL provides an accessible learning environment that seeks to address student diversity to achieve high-quality education (Griful-Freixenet et al., 2020). It is not surprising that UDL has gained much popularity across education systems worldwide in its quest of creating inclusive classrooms (Capp, 2017; Landin & Schirmer, 2020). The UDL framework was designed by the Centre for Applied Special Technology (CAST) in the mid-1980s with the sole objective of offering choice and flexibility in the curriculum and pedagogical designs to cater to students' variability (CAST, 2018). The framework consists of three key principles, nine guidelines, and 31 checklists. The UDL framework pivots on three key principles that target multiplicity in the dispensation of teaching and learning activities (Figure 1). These principles are evidence-based and are driven by neuroscience and educational psychology theories (Adom, 2022).

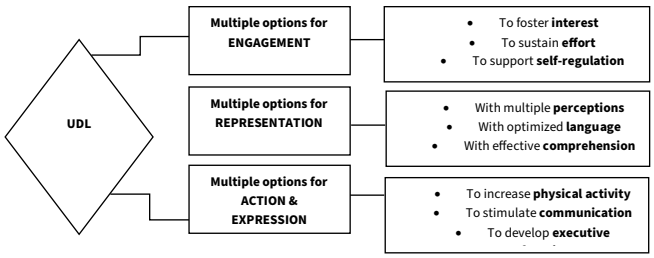

Figure 1. UDL Framework
Source: Ismailov and Chiu (2022)

The first UDL principle is offering multiple means or options for engagement that aims at helping diverse students to be able to find their pathway to the learning experiences offered by the instructor (Craig et al., 2019). This flexibility demonstrated by the instructor is targeted at fostering the interest, boosting the level of engagement and motivation for the students, sustaining their learning efforts, and supporting the self-regulation of their learning while making them active partakers in the teaching and learning processes in the classroom (Meyer et al., 2014). The second UDL principle is providing multiple means for representation. It concerns itself with the provision of learning content in a greater variety of methods, media, and formats to maximize accessibility (Flood & Banks, 2021). This variability in accessing the learning content in plural formats brings in multiple perceptions and heightens the comprehension of students. The third UDL principle is providing multiple means of action and expression. It offers choice and flexibility in ascertaining the understanding levels of students. Thus, it offers multiple means of assessment (formative and summative), varying means of assessment formats, choices in assignments, and formats of presenting them with accompanying comprehensive rubrics to increase students' participation, lubricate their communication with instructors, and aid in developing their executive functions (Ismailov & Chiu, 2022; Fritzgerald, 2021).

Over the years, the Ghana government through its education ministries has demonstrated its commitment to promoting the inclusive education agenda by developing an inclusive education policy in 2015. Also, the Ghana government is a signatory to all the international conventions that drive the inclusivity of all students toward achieving educational goals such as The Universal Declaration of Human Rights (UDHR), 1948; The Convention on the Elimination of all forms of Discrimination Against Women (CEDAW) 1979; World Declaration on EFA (1990), The Millennium Development Goals, 2000; United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) (2006); and International Covenant on Economic, Social and Cultural Rights (Swanzy et al., 2019). Inclusive education researchers in Ghana have responded greatly to the calls for equity and equality in education at all academic levels in the country (Botts & Owusu, 2013; Ametepee & Anastasiou, 2015; Deku, 2017; Opoku et al., 2017; Asamoah et al., 2022; Gomda et al., 2022). Though UDL has gained considerable popularity in educational institutions globally, its voice in the Ghanaian education context is very minimal. Few attempts have been made by authors to offer a conceptual understanding of it and how it could be implemented in education settings in Ghana (Deku, 2017; Adom, 2022). However, empirical studies aimed at implementing UDL to ascertain its impact on the learning processes and outcomes of students are rare. Thus, the overarching purpose of this study was to redesign the African Art and Culture course in the principles of UDL to offer empirical insight on how UDL could be actualized in Ghanaian higher education classrooms to accommodate student variability to achieve the country's education agenda of ensuring an inclusive higher education ecosystem. Specifically, this practice-based UDL implementation study aimed at measuring the UDL implementation in the Introduction to African Art and Culture class in tandem with the three key UDL principles using the UDL Observation Measurement Tool (UDL-OMT) developed by Basham et al. (2020). Aside from this, the study investigated the impacts of UDL on the learning processes and outcomes of the students who opted to study the Introduction to African Art and Culture course using the using adapted version of the ITSI-S Experience in Classroom (EIC) Questions which is the last set of questions of the ITSI-S (Celestini et al., 2021).

Methods

Research Design and Data Analysis Plan

The convergent parallel mixed methods design that aims at collecting and analyzing both quantitative and qualitative data sets was used for the study to get a more comprehensive understanding of how UDL impacted students learning processes and learning outcomes. The quantitative data that measured the level of UDL implementation using the UDL Observation Measurement Tool (UDL-OMT) was analyzed in descriptive statistics using the SPSS for Windows Version 26.0. On the other hand, the qualitative data collected using personal interviews were thematically analyzed using NVivo 12 software.

Study Participants

Participants for the study were second-year university students (N = 40) out of the total population of 157 students who enrolled in the Introduction to African Art and Culture

course for academic purposes in the first semester of the 2021/2022 academic year at the Department of Integrated Rural Art and Industry, Faculty of Art in the Kwame Nkrumah University of Science and Technology, Ghana. The study participants were selected via a convenient sampling design based on their availability and willingness to enroll in the study. An informed consent form that explained the nature of the study, as well as its voluntary nature and conformance to research ethical procedures, was agreed upon and signed by all the study participants.

Data Collection Instruments

The UDL Observation Measurement Tool (UDL-OMT) is a 42-item assessment tool designed by Basham et al. (2020) to measure the level of UDL alignment within an instructional environment or experience. All the items in the UDL-OMT are aligned with the UDL principles and guidelines by CAST (2018). It was designed to identify places in a lesson delivery where specific UDL checkpoints within the three key principles were observed. The individual items are scored using a scale of 0 (no evidence of UDL), 1-1.74 (Pre-emergent of UDL), 1.75-2.4 (Emergent of UDL), and 2.5-3.00 (dynamic and interactive, UDL observed). The instrument has been validated by Basham et al. (2020) in their study with an internal reliability Cronbach's alpha score above .80, (Good) and internal consistency with Cronbach's alpha score above .90 (Excellent). The UDL-OMT measures an alignment of UDL implementation in a class within the context of four sections below:

(a) introducing and framing new material (six items),
(b) content representation and delivery (nine items),
(c) expression of understanding (seven items), and
(d) activity and student engagement (nine items)

Aside from the scale for the scoring, the UDL-OMT offers observers of the lesson an opportunity to write down comments on their perceptions of the implementation of UDL during the lessons observed. In this study, only section s b-d (consisting of 25 items) were used to evaluate UDL implementation in the Introduction to African Art and Culture course because they were deemed closely knit with the three key UDL principles that were of interest in the study. A total of 12 lessons were observed by two persons trained in UDL and oriented on how to use the UDL-OMT instrument. The scorings were done independently by the two observers as recommended by Basham et al. (2020) to ensure the validity of the scores (Schutt, 2018). They were compared and analyzed together quantitatively. Also, the views of the students on how the UDL-designed course impacted their learning processes and outcomes were garnered using an adapted version of the 14 items on the ITSI-S Experience in Classroom (EIC). The instrument uses open-ended questions aimed at finding out evidence in the delivery of the lessons that show compliance with the UDL principles and how students' learning was impacted by them. Each personal interview with the 40 students took roughly an hour. The interviews were audio recorded, transcribed, and interpreted. Member checking was used to validate the transcribed data before the analysis.

Results and Discussion

Table 1 indicates the average score of individual items of UDL as observed in the Introduction to African Art and Culture course according to the three UDL principles. Concerning Content Representation and Delivery (Multiple Means of Representation), UDL was highly observed indicating that students relied less on teacher dependence and had more control over the use of instructional tools and/or strategies because they were customizable, interactive, dynamic, and highly conformed to student variability. Students experienced/or used at least two or more instructional strategies and/or tools in accessing course materials, demonstrated understanding, took action, or engaged actively in the course activities. The items *supports understanding of relationships across disciplines, settings, or concepts* and *Clarifies content-based syntax and structure* had a score between 2.08 and 2.25, which indicates emergence of UDL. This implies that the instructor often tried to link discussions in the Introduction to African art and culture course to disciplines such as geography, archaeology, religious studies, and social history. The instructor made some efforts to discuss some content-based syntax and structures within the art theory. Students were helped to bring in knowledge from those disciplines to make affirmative decisions during class discussions but in other lessons, this was fairly observed. The qualitative views from the students affirmed that the multiplicity in content representation and delivery impacted positively on their learning processes and learning outcomes as it enhanced accessibility and student engagement while fostering understanding of the content:

'The course materials were highly accessible in different formats, helping us to learn in the learning styles we preferred. They were even on our social media platforms (IRAI-12)', 'It made the class more interactive and we understood the course content well (IRAI-21).'

These results confirm earlier studies that though the efforts put in ensuring multiplicity in content representation require more time and planning (Singleton et al., 2019), it improves students' understanding of the course content and improves their learning processes and outcomes (Ferguson, 2019; Burgstahler, 2021).

With regard to Expression of Understanding (Multiple Means of Action and Expression), in five (5) out of the seven (7) items, UDL was observed. The average score of the five items was between 2.63 and 3.00. This indicates that the instructor offered plural media, tools, opportunities, and formats for assessment or for students in demonstrating their knowledge and understanding of the learned content. Efforts in supporting and monitoring the learning progress of students were provided by the instructor. However, two (2) items of Multiple Means of Action and Expression showed the emergence of UDL. These include *providing options that guide students to plan, develop strategies, and/or goal-setting that promotes expression of understanding* ((2.17) and *the environment facilitates the management of information and resources to achieve desired learning outcomes* (1.96). These two items of this UDL principle were not fully observed according to the UDL-OMT, the instructor did his best by always being present to offer clarifications whenever there was any form of confusion, especially on the students' platform and in class. Again, though the learning environment was inclusive and the climate was supportive in most cases, it was observed that the physical space was not too encouraging for the large class of over 150 students. How-

Table 1. The Average of the combined score of UDL Principles using the UDL-OMT in the Introduction to African Art and Culture Class

	Mean score	Scale
Multiple Means of Representation		
Presentation of information allows for customization	2.88	UDL Observed
Instruction allows alternatives for the visual display of information	2.96	UDL Observed
Instruction allows alternatives for auditory information	2.92	UDL Observed
Supports options for multiple languages	2.96	UDL Observed
Supports multiple levels of content understanding	2.96	UDL Observed
Supports understanding of relationships across disciplines, settings, or concepts	2.25	Emergent of UDL
Clarifies content-specific vocabulary, symbols, and jargon	2.96	UDL Observed
Clarifies content-based syntax and structure	2.08	Emergent of UDL
Highlights options for self-directed clarification of vocabulary and symbols	2.91	UDL Observed
Multiple means of Action and Expression		
Allows option for learners to express understanding in a variety of ways	3	UDL Observed
Provides access to a variety of tools and/or technologies for students to express their understanding	3	UDL Observed
Build competencies in the use of multiple options for expressing their understanding	2.63	UDL Observed
Intentionally provides support for students' problem-solving and critical-thinking abilities	3	UDL Observed
Provides options that guide students to plan, develop strategies, and/or goal-setting that promotes expression of understanding	2.17	Emergent of UDL
The environment facilitates the management of information and resources to achieve desired learning outcomes	1.96	Emergent of UDL
Facilitates student self-monitoring of progress	2.75	UDL Observed
Multiple Means of Engagement		
Promotes learner choice and self-determination while engaging with the content	3	UDL Observed
Provides a variety of activities relevant to all learners	3	UDL Observed
Promotes sustained effort and focus	2.58	UDL Observed
Encourages learners' use of strategic planning to complete instructional tasks	3	UDL Observed
Encourages collaboration and communication among learners	3	UDL Observed
Supports multiple levels of challenge	3	UDL Observed
Provides for self-reflection and self-assessment	3	UDL Observed
Provides formative progress monitoring and content checks	2.42	UDL Observed
Provides closure that reiterates big ideas and instructional purposes	2.83	UDL Observed

Note: The individual items are scored using a scale of 0 (no evidence of UDL), 1-1.74 (Pre-emergent of UDL), 1.75-2.4 (Emergent of UDL), and 2.5-3.00 (dynamic and interactive, UDL observed).

ever, attempts were made to reach out to all students while offering ways of managing learning resources effectively. The students remarked during the qualitative interviews that there was freedom and flexibility in expressing their understanding without any form of intimidation:

'We do receive prompt feedback from the instructor anytime we expressed our understanding of the learned content in class or on our virtual platforms. When we express our understanding and it is not right or true he does not bring us down. He commends you and tells you that you should have done it this way or that way, he shows you the right path in doing it and that is very good. That is how I feel like I'm learning and he won't bring me down when I'm wrong but show me the correct way to address it (IRAI-27).'

The prompt, constructive, and supportive feedback from the instructor was a great form of motivation for students' learning as Roski et al. (2021) similarly observed in their study.

In terms of Activity and Student Engagement (Multiple Means of Engagement), UDL was observed in all nine items. The mean score ranged from 2.42 to 3.00. The instructor offered the students multiple means of engaging by providing different formats of the learning content as well as making them available on a variety of platforms to meet their learning pathways. It was observed that in class, the instructor was going around, taking note of the facial expressions of students to ascertain their level of understanding or confusion and offering immediate remedial aid by giving such student(s) special attention. There were times he used icebreakers such as songs, rhymes, and short hilarious activities to eradicate or reduce students' anxiety while embarking on projects in class and to rekindle their interest in the activity carried out in class if they were feeling bored or tired (especially in the afternoon classes). These approaches adopted by UDL-designed courses were found to be highly motivated students in the studies by Mayes (2020) and Dalton (2017). Also, the instructor gave students a template timetable and comprehensive rubrics to aid them in strategically planning all their assigned individual and group projects. He assured the students of his assistance in helping out with their projects so that they could stay within the timelines he had given them. Moreover, the instructor was not very strict with the deadlines for completing and submitting instructional tasks. There were times he gave extensions of the time for the entire students when other unforeseen occurrences disrupted the academic calendar, and when students collectively pleaded for extensions due to assignment loads from other courses. Individualized extensions in submission dates were issued for students with peculiar challenges (such as those with learning challenges, those with health and emotional challenges, etc.) and many more. The qualitative views from the students affirmed the observations made:

'The lecturer creates a climate that respects the diversity of students and this makes me push and go on to do better (IRAI-09)', 'I feel motivated to learn because it allows me to learn in any way or the way I feel comfortable to learn and the way I want it and it boosts my academic performance (IRAI-01)', 'The lecturer is approachable even when he does not have a class with us he still does interact with us on our social media pages (IRAI-25)', 'Usually when lecturers come to class we do not normally pay attention in class but with this UDL-designed course, all of us get highly engaged (IRAI-13).'

Table 2 shows the average of the combined score of the three UDL principles used by the instructor in the classroom. The

Table 2. The Average of the combined score of UDL Principles using the UDL-OMT in the Introduction to African Art and Culture Course

	Average of the combined score
Multiple Means of Engagement	2.87
Multiple Means of Representation	2.76
Multiple Means of Action and Expression	2.64

Note: The individual categories are scored using a scale of 0 (no evidence of UDL), 1-1.74 (Pre-emergent of UDL), 1.75-2.4 (Emergent of UDL), and 2.5-3.00 (dynamic and interactive, UDL observed).

three categories of UDL principles were identified to have scores between 2.64 and 2.87 (see Table 2). The classroom that scored in the range of 2.5 to 3.00 was characterized as having UDL observed or dynamic, interactive UDL, where the application of the principles of UDL was obvious and consistently applied during the observations.

Conclusion

This study measured the extent to which an Introduction to African Art and Culture course implemented the three key principles of UDL as well as the impact of UDL on the learning processes and learning outcomes of students who read the course. The findings have shown that UDL proved very beneficial as an inclusive instructional methodology in motivating and ensuring the active participation of the students in the teaching and learning activities because of the flexibility of choices and the multiple pathways to learning it offers. Though UDL was largely observed in the course delivery, the lack of resources to support its implementation narrowed the observance of some of the items under the key principles. It is recommended that the Ministry of Education and heads of educational institutions across Ghana consciously train their instructors to understand the requirements of UDL and how to implement them during teaching and learning activities. Since UDL requires careful planning and the use of diversified course materials and instructional tools, educational institutions should endeavor to support the efforts of instructors who redesign their courses in UDL with the needed logistics. While the subjective views of the two observers might have affected the scoring based on the UDL-OMT, the qualitative views expressed by the students validated the scores. It is recommended that future studies use more than two observers to measure the level of UDL implementation in course delivery. Other studies must use both experimental and control groups to be able to measure the impact of UDL's implementation better by comparing its impact on the learning processes and academic output of students.

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Material-led thinking as a practice of care: a strategy from art and design education

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Abstract

In this paper, we present an online workshop that uses making as a strategy to reveal new insights and facilitate interdisciplinary collaboration. The paper is intended to start conversations about different forms of material engagement in learning environments, and how artists and designers can use material approaches to respond to complex challenges, such as care. Our aim for this material-led workshop was to encourage students to engage with care as a topic of critical analysis by adopting making as a way to think about this abstract concept. As educators, we also experimented with making as a strategy to create a caring learning environment. Our analysis identified that the workshop fostered inclusive collaboration, sparked stimulating conversations, connected theory and practice, and created experiences and spaces of care. We discuss our findings based on three categories: care as a subject of art and design education, care through teaching and care through making. We also consider how the workshop might be different in physical spaces and propose aspects that we can incorporate in future iterations, such as having more time to learn about the objects created. The workshop can serve as a model and be applied to explore other abstract concepts in various contexts and is relevant to professionals interested in making and applying similar approaches in their practice.

Author keywords

Care; Making; Art and Design; Inclusive collaboration; Interdisciplinarity; Material engagement.

Introduction

The Royal College of Art delivered, for the first time in 2022-23, AcrossRCA, a college-wide unit in which students collaborated across different master programmes to respond to challenges of complex, uncertain and changing physical and digital worlds. Students chose one of four inaugural themes to address: being digital, caring society, climate crisis, and justice, equality and misinformation. These themes encouraged students to expand their knowledge beyond discipline-specific dimensions and were broad enough to encompass several interpretations. The unit launched with a series of theme-related expert talks, followed by sessions on academic and research skills. Throughout the unit, students also attended small group tutorials where they interacted with peers and received support to reflect on the critical, innovative, and responsible ways creative practices can answer the selected themes.

As tutors for the caring society theme, we developed a series of activities in our group tutorials to encourage students to explore synergies between art, design and care. Although there are many ways to promote creative explorations at this intersection in education (Tan, 2019), we argue that making can prompt new ways of engaging with care as a concept. It can encourage independent thinking, stimulate conversations, and facilitate collaborative critique. Making, as in handling materials and creating physical objects, can be particularly relevant as a form of idea generation and communication for interdisciplinary teams at the beginning of the creative process. It can also be used as a neutral, collaborative approach that is not dominated by a particular discipline and does not rely on verbal expression and language. From that perspective, there are five different ways in which we propose care can be investigated. They are grouped into three categories:

- **Care as a subject of art and design education**, in which (1) care can be a topic of critical analysis (what it means, what societal issues this includes, how creatives contribute to caring practices), and (2) care as an art and design objective (how student projects can respond to the theme of care).
- **Care through teaching**, in which (3) making can be used as a way to think about abstract concepts, such as care, or (4) making can act as a means to create a caring learning environment (spaces of care, inclusive education).
- **Care through making**, for instance, (5) craft use in therapy and other healthcare settings.

These three categories emerged from our interpretations of the theme of care, the literature review, reflections on our roles as tutors for the caring society theme, and the development of activities for our tutorial sessions. One of the activities we developed and delivered was a workshop in which we used material-led thinking to encourage students to explore synergies between art, design, and care. For this workshop, we were particularly concerned with points (1) exploring care as a topic of critical analysis, (3) employing making as a way

to think about this abstract concept, and (4) making as a way to create a caring learning environment. This workshop is an example of a strategy that can equip artists, designers, and educators to approach the theme of care through making. This paper is intended to start conversations about different forms of material engagement in learning environments and how artists and designers can build material approaches into their creative practices.

The paper begins with a literature review on the generative potential of making to reveal new insights, how it has been adopted in practices of art, design, and care, and how material handling can be used as a tool in education. We then describe the workshop structure, activities, and how we analysed the data generated to construct the four themes guiding our analysis: inclusivity, engagement, bridging theory and practice, and creating experiences and spaces of care. The paper concludes with a discussion of our findings in relation to the care categories introduced above and considerations for future iterations of the workshop.

Literature Review

Scholars have argued that material handling is key to opening new insights and critical understanding of the world around us. Bolt explores how this idea links to the notion of care (2006, para. 19), stating, "understanding is the care that comes from handling, of being thrown into the world and dealing with things." She applies these concepts to her own artistic and educational practice, discussing how materials and processes are not only useful in the service of ideas but are "productive of ideas in their own right" (2007, p.33). Bolt's concept of "material thinking" (2007, p.29) signals the importance of interaction, the intelligence of both the material and the artist resonating with each other, and the interrogation and experimentation with materials and processes as a starting point. In terms of cognitive development, humans are born to learn through interaction (McLeod, 2018). Specifically, with regard to the sense of touch, Leroi-Gourhan states, "the human hand is human... because of what it makes, not of what it is" (1993, p.240). For Hallam and Ingold (2014), too, material engagement is significant as a way for creative practices to be continually "generated and regenerated" (p. 179). In this way, making can be a method of reflecting on and contemplating abstract concepts, including care.

Within the context of arts and design education, Orr and Shreeve (2018) emphasise the significance of tacit knowledge, a term attributed to Polanyi (1967), who states this is "that which we know but cannot tell" (p .4). Orr and Shreeve underline how 'doing' is a critical part of what it means to be human and therefore of crucial importance in learning. They state, "practice lies at the heart of art and design" and explain that practical learning is a valuable mode of idea generation. Akama et al. (2018) have applied these concepts in an educational setting in workshops that use making as a collective activity to facilitate disruption. They found that more dynamic and physical approaches over theoretical approaches to thinking created a more educationally flexible space as a way of critically reflecting on idea generation. A similar emphasis is found in artistic educational philosophy, where there is consensus on the criticality of practice-led research.

Making has been used to support care through occupational and other forms of therapy. Pöllänen (2009) documents the therapeutic effects of craft, which are similar to the impact of making outlined above, and which resonate with the pedagogical objectives and student experiences of the workshop described in this paper. The act of making, including engaging with materials and other people, and the satisfaction of producing an object are both considered therapeutic. Craft can be a "catalyst for emotional experiences and cognitive processes" and is thought to create "a safety zone which makes it possible to analyse events and situations in life, difficult emotions and experiences from a symbolic distance" (p.139). Other therapeutic uses of craft include skills development, rehabilitation, recreation, and pleasure (Pöllänen, 2009).

Making has proven valuable at the intersection of creative practices and care for related reasons. Designers use collaborative making in participatory design processes with vulnerable groups to elicit information, externalise complex and challenging subjects, and facilitate contributions in a way that supports participants to feel safer and more comfortable. For example, in a project about miscarriage and journeys of care, Raman and French (2022) invited participants to use craft materials and pre-prepared 'charms' to visualise their emotions and experiences. The objects they created became metaphors and tools for sharing their stories with each other and health professionals. Similarly, in a project about cross-cultural design in rural China, making facilitated non-verbal communication, allowing participants to create "artefacts which became mirrors for local people to reflect their own culture" (Wang et al., 2020, p.243). Hands-on making is recognised to render the participatory design process more accessible and democratic. Rather than working in abstract design terms to develop proposals that will be realised after a co-design workshop or with team dynamics that prioritise designer and professional expertise, a craft approach allows for more immediate, tangible outputs and values everyone's ability to make (Hansson & von Busch, 2022). Designers have also created craft experiences to support people with dementia to live fuller lives (Kenning et al., 2017). While these examples outline the benefits of making for building empathy and sharing personal perspectives in practice contexts, they also invite us to consider how this form of hands-on engagement can be applied in educational environments to reveal new insights about care both as pedagogical practice and as a topic of study.

Methodology

Given that interacting with materials enables ideas to emerge and stimulates critical analysis, we developed a workshop for a group tutorial for the caring society stream of AcrossRCA. Our objectives for the workshop were to challenge students' understandings of care and support them in investigating the practical and philosophical dimensions of health and well-being. As educators, we also wanted to experiment with creating a caring learning environment and reflect on how the process of thinking through making could be incorporated into our learning and teaching practices.

Workshop Overview

A total of 63 students in our tutorial groups participated in a two-hour workshop (we mixed students from three tutorial groups). The workshop was originally intended to be in person, but because of public transport disruptions, we delivered it online. We provided written instructions for students to digest ahead of time, containing an overview of the objectives, structure and short descriptions of the planned activities. In addition, we asked students to prepare the following:

- **A word** that captured their experiences and knowledge of care. We emphasised that there was no right or wrong word. For example, this could be a word that describes an emotion, a problem, a solution, etc.
- **Materials for making** so that they could quickly create a few small, three-dimensional objects during the workshop. These could be materials students had around home, the studio or found objects.
- **A workspace** at home, college, or wherever was convenient and comfortable for making during the workshop. We mentioned that we would ask students to direct their cameras at the objects as they made them so they could watch each other working.

We used Zoom as the communication platform for the workshop. It started with a brief introduction, with everyone together. Then we conducted the following activities:

- **Making.** Using the breakout feature on Zoom, we divided students into groups of three and four for a making session. The instructions were for students to start by sharing their word representing care with each other, explaining how they chose it and what it meant to them. Part of this process was to listen carefully to others and consider how they interpret other people's words in light of what emotions, meanings, and thoughts came up for them. After that, they spent time making something that represented one or more of the words. During this time, cameras were kept on, focusing on the students' hands and the things they were making.
- **Reflection on concepts of care.** In the same groups, each student had a few minutes to explain what they created, how it reflected care, and what they heard from others. They compared their interpretations of care as a group and reflected on the similarities and differences of individual approaches and understandings. We provided some prompt questions to support the reflection, such as 'what is it about your forms that you feel expresses these words of care?' This could be answered through the form their interpretation had taken and the sensory process involved in the actual making.
- **Reflection on process and conclusion.** For the final section of the workshop, students were divided into three larger groups. With the support of a tutor in each breakout room, they reflected on three topics: thinking through making, spaces for creativity and caring, and redesigning the workshop for others.

During the 'reflection on the process' section of the workshop, we used Jamboards to facilitate the discussion. Students contributed anonymously to the boards by adding comments and reflections using digital sticky notes. We also shared links for students to access the boards after the workshop and invited them to add any additional considerations. To maintain anonymity during this process, we ensured the board settings enabled contributors to join anonymously, and no identifying information was collected or recorded. As educators, we also had a debriefing session after the workshop to discuss our experiences and learnings. Throughout the unit, we collaborated through reflexive practice as a continuous way of learning (Hallam & Ingold, 2014) and critiquing how we engage with care in our teaching.

Data analysis and limitations

We followed the principles of reflexive thematic analysis (Braun & Clarke, 2019) to engage thoughtfully with the data generated from the workshop and our notes. The analysis process consisted of reading the Jamboards to become familiar with the overall content of the group discussions and then discussing our initial impressions and identifying information relevant to our workshop objectives. Finally, we collated our interpretations of the overall data to construct themes that captured this reflexive process. We acknowledge the subjectivity of our analysis and are aware of the influence of personal bias on the themes' conceptualisation. We are also mindful that our conclusions are based on a relatively small-scale workshop conducted with a group of art and design postgraduate students. Therefore, by sharing our learnings and findings from this experience, we hope our contributions inform further iterations and applications of this material-led strategy.

Findings

The data analysis produced four themes. Although the workshop objectives were centred around exploring students' perceptions of care, experimenting with a caring learning environment, and reflecting on integrating thinking through making, the analysis revealed that the identified themes connect with the five ways we suggested care could be investigated. The first two themes (inclusivity and engagement) respond to point (4) making as a means to create a caring learning environment. The second two themes (bridging theory and practice and creating experiences and spaces of care) respond to points (1) care as a topic of critical analysis and (3) making as a way to think about abstract concepts. The final theme also touches on points (2) care as an art and design objective and (5) the use of craft in therapy, as students analysed how they could apply creative skills to potentially contribute to caring practices.

Inclusivity

The workshop format supported an inclusive learning environment by prioritising non-verbal communication through making, by being online and encouraging students to join the workshop from convenient and comfortable working spaces, and by providing students with written instructions to digest beforehand. This removed some barriers to learning that language or background might implicitly present.

Engagement

Several students discussed the workshop's positive effect as a space that created an engaged and relaxed setting. The focus on material exploration, and the intentional suggestion for students to focus their device's camera on the objects they were making, created a space for them to 'open up' in conversation or remain quiet with confidence. As an overall experience, students reflected on the workshop as 'therapeutic', 'immersive' and 'engaging'.

Bridging theory and practice

Abstract concepts of care introduced through the course and by the students in the workshop, such as 'empathy,' 'kindness', or 'support,' were first thought through the process of making. Students reported that 'complex ideas' were made 'tangible' and 'feelings' were easier to 'translate.' It reduced the challenge of having to think of something to say on a top-

ic and allowed them to explore making as a non-verbal form of expression, to let 'the materials guide them' and 'just start somewhere.' In addition, the material-led approach successfully opened a space where words and speaking could be used as a reflective tool in evaluation rather than in the initial development of ideas.

Creating experiences and spaces of care

Issues of care can be emotionally overwhelming. One student reported that during the workshop, the feeling of being creative 'gives hope and a sense of freedom.' Others found that the materiality was 'stimulating' and could be a good distraction and even therapeutic. Asking students to create their own workspace also helped them to reflect on what spaces of care could look like and how this knowledge might translate to other spaces, such as hospitals.

Discussion and Conclusion

Tutoring in a college-wide unit with a focus on interdisciplinary collaborations to respond to contemporary issues presented an opportunity to reconsider our pedagogical approach. We used a material-led workshop to encourage critical thinking and explore care from multiple angles. This strategy fostered inclusive collaboration, initiated critical discussions of care, connected theoretical concepts to practical applications, and generated a caring learning environment. These findings are linked to the three care categories outlined in the introduction.

Care as a subject of art and design education. The workshop is an example of how intuition, materiality, and touch are important modes of idea development and a way of linking practice and theory (Orr & Shreeve, 2017). Although material practice has the potential to reveal new insights and possibilities, it is not often used as the starting point for idea generation. Over the past few years, it has become more evident to us that students rarely adopt (and are rarely asked to adopt) making as a method of idea generation at the starting point in collaborative projects. Rapid transitions to online learning and teaching to overcome Covid-19 pandemic restrictions might have influenced this phenomenon. For instance, in some cases, students had to navigate limited access to resources by developing projects only at a conceptual level. Bolt (2010) identifies a risk when conceptual and theoretical discussions prevail over making in academic realms. That is, material handling may be used only to demonstrate ideas already formed instead of as a way to generate ideas.

Care through teaching. This experience taught us that material-led workshops could create a supportive space for fostering non-hierarchical student-teacher relationships due to the relaxed and explorative nature of material engagement. For example, a playful environment can build confidence and trust that teaches both students and educators about what a caring space can be and how they can emerge through material connectivity. An open-ended exercise can also enable students to express themselves with less fixation on delivering a finalised idea.

Our workshop created a common starting point, unconstrained by disciplinary silos. Students developed responses to the theme of care individually within a group setting, which created a supportive environment for diverse identities and ideas to emerge through material expression. This approach to encouraging independent thinking and stimulating conversations allowed qualities such as courage in individual identity, freedom of discovery and confidence within uncertainty to arise through a mutual, connective, and respectful space with others.

Care through making. Finally, the workshop was an opportunity to reflect on how care through making could be used as a teaching model, adaptable to other contexts and topics. We believe it would be suitable for exploring other abstract concepts, where making serves to express feelings, emotions, and impressions rather than to represent more concrete proposals for design outcomes. None of the objects created in this workshop represented final pieces, technical experiments, design products, services or systems of the kind art and design students are commonly expected to develop. The same activity could therefore be applied to the other themes of AcrossRCA to generate conversations and insights around, for example, being digital, climate anxiety, justice and equality. It could also be applied more broadly and outside of the academic realm by creative practitioners keen to use making to incorporate care into their practice and to build community engagement.

Overall, the workshop generated a space to challenge understandings and facilitate collaborative critique of care. However, it is important to consider how the workshop would need to be adapted to achieve similar outcomes if it was delivered in person. This is due to conceivable limitations such as space availability, accessibility, and convenience for participants, as well as the potential inability for people to customise their workspace in advance to make it comfortable. Despite this, a classroom, or any other physical space could provide advantages such as acting as a neutral space for collaboration and enabling peers to co-create objects, in addition to allowing participants to see more extensively what others were making. One suggestion for an in-person version of the workshop would be to standardise materials for all participants, such as providing everyone with clay. This could create a greater sense of community, and facilitators would have more time to observe participants and be involved with the process. Therefore, both online and in-person modes of engagement have advantages and disadvantages, although employing material-led thinking in both spaces is possible. Finally, during the workshop, we observed that when we switched from making to a more standard form of online learning by using Jamboards to reflect on the process, we perceived a shift in the energy and engagement of the students. From that, we inferred that students would have preferred more time focused on making rather than shifting back to a more traditional online learning environment.

In reflecting on the workshop, some aspects could be altered to improve future iterations. First, it would be interesting to hear from students how and if participating in this workshop impacted their work during the AcrossRCA unit. This could be done by incorporating reflections throughout the term. We only have anecdotal evidence of the workshop's impact based on the work students submitted as part of the final assessment, some of which incorporated activities like workshop plans and public service campaigns using making as therapy. Secondly, we needed more time for us, as educators, to learn about the objects students created. While they talked in their groups, we could not hear their discussions about the meanings behind what they made. It would have been interesting to have them submit pictures of their objects with a few sentences about their thinking.

In conclusion, the process of creating and facilitating the workshop described in this article has been a valuable and fulfilling experience. The positive outcomes and insights gained from using making as a strategy have motivated us to continue exploring its potential applications in teaching and interdisciplinary research collaborations.

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Artful care for self and others in daily design practice

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Abstract

This paper examines how arts- and nature-based interventions can support thriving and mental health as an integrated part of daily design practice for freelance designers and one-person companies in precarious working conditions. The research is conducted as a practice-based, explorative case study at The Royal Danish Academy in collaboration with The Union of Architects and Designers (FAOD) and Design denmark and financed by The Velliv Association. Thirty-two professional designers participate in a course of two full-day workshops and two coaching sessions. Data consists of preliminary questionnaires and questionnaires after each workshop, observations and registrations during the workshops and coaching sessions. Findings show that many designers place their full day-to-day attention on the outer world, making them forget to listen to and care for inner worlds central to being creative, e.g., the experience of personal meaning, playfulness, vulnerability, personal needs, and boundaries. The arts- and nature-based interventions can help designers connect to deep inner resources that are easily forgotten in times of rapid change, uncertainty, competition, and conflict. This in turn changes their focus and level of kindness towards themselves and others, and through this, the way they tackle projects, clients, collaborators, finances, and their role as designers, leading to new learning and more holistic ways of contributing to the community

Author keywords

Arts-based methods; creativity; design practice; mental health; nature; well-being

Introduction

In Denmark, the design labor market is under increasing pressure from companies with demands for loose affiliation and 'freelancing' (FAOD, 2021). Project-based employment is on the rise, and the competition is fierce, not least due to global online players offering cheap solutions for standard tasks (Julier, 2021). These aspects of the market can cause a 'race to the bottom' in wages (Julier, 2021; Gleerup, 2016) creating precarious work conditions for freelancers not able to obtain permanent employment and for those who are voluntarily self-employed. The external dimensions of the industry can affect a person's internal well-being and development as well as professional identity formation (Gleerup, 2016). Many may experience stress symptoms and there may be an informal pressure to 'perform' a professional identity of creativity (Julier, 2021). In a working situation as the one outlined, it is difficult for designers to find the time and financial resources to prioritize well-being and mental health measures, therefore, the present research project investigates the potential for this target group to establish mental well-being and care for themselves as a part of their daily design practice. The approach is to include arts– and nature-based interventions in the design work. These are methods originating in art– and nature therapy, which are adapted to organizational creativity, e.g., within innovation and management (Darsø, 2018; Darsø & Meltzer, 2021). Along with the creative purpose, the methods have shown the potential to bring awareness to and strengthen the designer's personal resources (Friis & Mølhave, 2021). We adhere to the WHO definition (2023) that 'Mental health is a state of mental well-being that enables people to cope with the stresses of life, realize their abilities, learn well and work well, and contribute to their community'. At the same time, we embrace the 'broaden-and build' principle (Fredrickson 2004) within flourishing, in that we seek to build and strengthen what already works in relation to well-being in the designers' practical workflows and enhance this as part of self-care. The knowledge produced about the challenges that professional designers in precarious working conditions experience forms the basis for developing a guide with hands-on advice for how to include arts- and nature-based interventions in individual and collaborative practice.

Method

The research project is a practice-based (Woolley in Dixon, 2001) exploratory case study where qualitative data production provides new knowledge about the methods and tools to be used in professional practice. The case study supports in-depth, multi-faceted knowledge about a complex situation (Flyvbjerg, 2011; Stake, 1995). The objective is thus to create 'robust' knowledge, which can lead to new workflows and procedures in design practice (Friis & Gelting, 2014). The term 'knowledge production' refers to knowledge that is produced in the context in which it takes place, where uncertainty is a condition and learning and the development of new knowledge are understood as closely related (Friis, 2007). According to Flyvbjerg, the closeness of the case study to real situations is important because human behavior is context dependent. By using preliminary questionnaires, questionnaires after each workshop, observations and registrations during the workshops and coaching sessions, the participants' own words about their situation and experienc-

es are collected. This provides a detailed and coherent data set about the possible potential of the methods to promote mental health and well-being.

Workshops and coaching sessions

The workshops and coaching sessions run from March – September '22 in four groups of eight (a total of 32 participants). Via LinkedIn and newsletters from the collaborating union and associations, professional designers sign up for the workshops to experiment with the interventions and share their experiences. They bring along a theme or question within their practice to explore. The aim is for them to gain an understanding of the personal inner dimensions of their working conditions and an experience of the interventions' potential health-promoting and creative effects. Having concluded the course, the participants are expected to be able to use the methods directly in their daily work, according to their own choice and needs. Before starting the course, participants fill out an online questionnaire, 'Psychological working environment and well-being in the workplace' from the National Research Center for Working Environment (NFA). This provides a quantitative description of their working conditions and a general impression of well-being in the group. Following each of the two workshops, there are individual coaching sessions where the participants can talk about their experiences at the workshop and the methods in practice. The coaching is guided by the principles of building on that which works for each individual designer and their situation.

Theory

The layout of the workshops and the use of arts- and nature-based interventions is informed by the four psychological functions identified by Jung: intuition, thinking, sensations, and feelings (Jung 1953–79). These are based on the movement of energy in our psychic activity. Out of habit, we often develop one dominant function. To most professional designers, the quick thinking-function is paramount. By bringing focus to the other functions, we seek, through a common design process, to provide new balance and let the body and mind open to new impressions and perspectives regarding the participants' practice and specific work tasks.

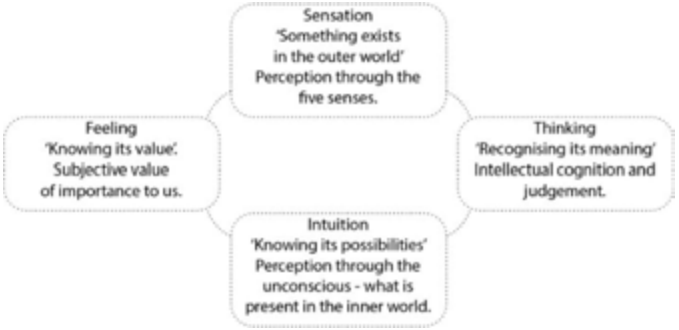

Figure 1. Four psychological functions. Based on Carl Gustav Jung (1979).

The arts- and nature-based interventions are incorporated into the design process to activate all four psychological functions in the investigation of a question or topic. Art is a way to our feelings and our humanity (Eisner in Darsø, 2001) and artistic approaches can redirect our attention to what is meaningful and makes a difference (Darsø, 2001; Darsø and Meltzer, 2020). In the workshop, we use interventions from an existing palette of methods that are easily transferable in a daily design business, e.g., creative writing exercises and making a stakeholder map in clay (rather than post-it notes). The workshop layout is based on Theory U (Scharmer, 2007; Scharmer & Kaufer, 2013), devising a transformation journey that takes the practitioner from everyday consciousness to deeper levels of cognition and connection to future collective possibilities. Scharmer describes how the awareness and ability to change the place in ourselves from which we operate is central to the results we produce - and thus how internal states and experiences are closely connected to external ones.

Empirical data

Before the workshop course

In the preliminary questionnaire, the participants provide insights about the inner conditions of their work life and their well-being. As self-employed, many express the demands and stress of always being on the look-out for jobs and find it hard to enjoy quiet periods in-between jobs. There's a lack of calm and ongoing worry about finances. Some of the participants have been down with stress, others feel that they are about to collapse and are worried that the duress is turning into physical defects. Some say that they are bad at listening to themselves and feel they need to be in a certain way with clients, which is a 'square and hard place to be'. The majority feels lonely and squeezed artistically due to money, time, and client demands. The designers in their 40s and 50s worry about pension plans, which many of them can't afford. There are feelings of being overwhelmed by work and a longing for freedom, working creatively, and being able to balance personal and professional life.

The Interventions

During the two workshops, the participants experience nine interventions of which three will be unfolded and examined here. The interventions are stringed together in a process labeled 'artful inquiry'; a process ignited by a 'burning question' and explored via the arts- and nature-based interventions. Answers, insights, and new questions emerge, carrying the process forward. An artful inquiry process can be based on a single method or a sequence of methods.

The Other Hand is to explore a situation from two different perspectives by drawing and writing, first with the dominant hand, second with the non-dominant hand. It's a way to tap into the potential of the often-under-used right hemisphere of the brain, to explore the poetic, holistic perspectives that might arise (Capacchione, 2001). It is used several times during the workshops, initially for the participants to investigate their first question or theme, later to discern what has been learned about their working situation. The duration is 20 minutes. The participants work in silence with the dominant hand for 5 minutes then continue with the other hand on a new piece of paper for 10–15 minutes. Overall, participants are genuinely surprised by the perspectives appearing when using the other hand: unexpected ideas, attitudes, sentiments that they find strangely familiar and welcome. For many, working with the other hand is a way to let go of self-censor-

ship and set aside internal criticism and perfectionism. Some talk of a fruitful dynamic between the two different voices, others how it's like having a friend to ask for advice. Several of the participants experience the other hand as forgiving, loving, and expressing self-care (something they are not in the habit of feeling, but are touched by). In between the workshops, The Other Hand is the method that most participants experiment with. One communication designer in her 50s, who 'hasn't been creative for years', feels the urge to make large drawings on the wall, but feels too vulnerable to share this with others. She waits for her husband to leave the house, puts up big pieces of paper on the wall and lays out her brushes. She then uses The Other Hand to cross the threshold of fear and inner criticism. Only then is she able to lean into the work and be in the process.

Fülge is to let your hands surprise you whilst making an aide in clay for the work that you are about to embark on and is introduced once the participants have decided the question each of them wants to explore. Fülge is the Norse equivalent to a power or totem animal–a spirit being, that represents qualities and characteristics that a person needs or is in the process of developing. The duration of the exercise is 5 minutes and participants work in silence with their eyes closed. Each person gets a handful of clay and are asked to shape a helper for the journey ahead. Once the time has passed, participants open their eyes and one at a time talk about the experience and the figure in their hands. Just like the previous exercise, participants are surprised by what they have made. It can be a bear that was expected to be strong but looks disarmingly playful and sweet. A panther with wings. A bird that is resting instead of flying. Having to close the eyes lessens performance anxiety because it is impossible to be in complete control–and in that space something else can come forth. Most people react with care towards their fülge, however some squeeze the clay back to a lump, finding it too ugly, or not what they wanted. One found it too difficult to engage with the material with her eyes closed, later explaining that she is too much of a perfectionist. However, most participants express how working with the clay, eyes closed, provides unexpected new experiences and insights: 'Being in the space, feeling welcome the way I am. Filled with energy, a loving, including space'. A female participant models the head of a male 'full of himself', resting in his own authority. She feels resistance towards the figure and only after talking about it does she begin to see how the authority can support her in her work. In the coaching session, she has warmed to him and exclaims: 'It is completely caricatured - the authority and calm that the figure expresses–there are core truths in this–it's wild!'

Medicine Walk is to bring a question into a silent, aimless wander, in conversation with nature to seek its advice. It's placed at the end of the first workshop. Participants start in a circle in nature (in our case, a green lawn in town bordered by shrubbery) and are invited to share their question to inquiry about. Next, they identify a threshold, e.g., two flowers in the lawn, to cross at the beginning and end of their walk. Setting a timer for 20 minutes, they walk slowly, question in mind and being led by experiencing what draws their attention. For many of the participants, the Medicine walk is an intriguing experience even though they initially fear that they won't get any answers, and some find it hard to let go of the need to perform. Several say that it is like a sacred walk, and helpful to only focus on a single question– something falls into place when sharing a question with nature and the surroundings. Some people pick up things while walking, for instance a four-leaf clover or a snail house–and find that it brings deep significance to their question, particularly once they write and talk about it afterwards. One of the participants explains that the medicine walk is to invite aimlessness in. It is transgressive and demands of you a loss of control. She finds that her need for control is linked to insecurity - and she would like to be more welcoming, honest, get rid of the parades and have trust. Medicine walk helps her with this.

Analysis

In the following, commonalities across the participants' experiences of the interventions are identified and discussed with the theoretical perspectives to examine their potential for supporting thriving and mental health as an integrated part of daily design practice.

Let go of pressure to perform

Common to the described methods is, that they support the participants' open inquiry about a situation by enabling the critical mental function to be set aside for a while. This parallels Scharmer's encouragement 'to let go, in order to let come', i.e., dare to lean into the future and experience the unknown. The arts- and nature-based methods enable this 'release' to happen in practice, for instance through drawing with a hand of which you have no expectations or walking in nature exploring a question without attachment to the answer. This openness allows for novel perspectives to surface and be noticed – it's like setting the door ajar to a different level of perception and consciousness. It's a way to bypass the censorship of an inner critic and gain access to ways of knowing that the participants somehow recognize but have forgotten are there. The experience of release is quite literally a relief to many. It provides them with joy, the ability to relax, letting go, and beginning to see what might come from within.

Grounding, inner calm

Setting aside the thinking function, helps the participants embody their feelings, sensations, and intuition as described in Jung's four functions. Scharmer describes a similar movement in awareness in Theory U: Going from 'seeing', to 'sensing' to 'presencing'. Our participants describe the space that they encounter as 'deeper', 'calm', 'magical', 'coming home', 'grounding'. For instance, a communication designer, becomes aware that he is over-reliant on what the clients think and mainly uses the visual sense when working, a monotonous type of stimuli. Using clay opens to enjoyment and to a more versatile design process in which he reencounters instinctual and rebel energies that have been lost in what he labels the 'corporate world'. This, he finds, reconnects him to core feelings of self-worth. 'It's hard to describe what happened [in the workshop]. You encountered something different than you are used to being in contact with. It was a bit like winter bathing, you get down into another element.' Hence, the interventions transport the participants to places within themselves that provide them with meaning and nourishment–and the experience of self-care and self-inclusion.

Healing design practice

The arts-based methods resemble the process of 'active imagination' described by Jung, which is to give form to images and sensations in text, pictures, and sculptures to gain access to the mythopoeic imagination (Shamdasani in Jung and Shamdasani, 2009). By systematically eliminating critical thinking and taking seriously the inner notions and figures that we see, they begin to emerge - and by giving them physical form it's possible to enter a conversation with them – a conversation between the awake, normal personality and the underlying ways of knowing. Says Darsø and Meltzer: [It helps us] access layers of knowing, which would otherwise remain tacit and non-conscious. [...] The material "speaks back" in surprising ways, metaphorically and symbolically' (Darsø & Meltzer, 2020). According to Jung it's a way of including the personal and collective unconscious constructively rather than having it control us in often inappropriate ways (Shamdasani in Jung and Shamdasani, 2009). 'He [Jung] saw inner health as requiring a practice of inner work or dialogue. Early on he began to draw mandalas as a daily form of healing practice. He discovered that using his hands allowed a greater depth of the unconscious to emerge. Crafting images from dreams and visions into paint and wood became for him a form of relationship-building with the unconscious' (Bobroff, 2020, p. 11). Hence, by bringing to light and enabling a dialogue with unconscious material, the arts- and nature-based interventions helps the designer accept and care for their deeper inner dimensions, build a stronger relationship to all parts of themselves, and in turn enhance both their well-being and their creativity.

Implementation

There is an overwhelming request from the participants for a continuation of the workshops and for more help with integrating the methods into daily work. This indicates the potential effect of the interventions, but also the limitation of our project due to its 1-year scale. Most participants experimented with the methods at home, and several had ideas for how to use the methods in their practice, e.g., in a project, a collaboration or a work-life situation, however, many felt limited in terms of fully implementing them. Integrating a new habit, let alone working practice, can be difficult when facing the pull of demands in daily life. Being part of a culture that is fast-paced and thinking-based is a barrier when having to set aside time for something that may need artistic materials at hand or getting to a location in nature and is without a guaranteed outcome. Says one of the participants: 'Many of us have had an experience. We found an opening. It is vulnerable. It's round and soft. But how do we get back into the square [life] with this?'. This elucidates a level of trust and courage that may be needed for practicing this way and going against the norms. For many it was a new experience to become aware of and start caring for their inner life. Some saw the methods mainly as an intimate and personal practice with limited professional use, for instance, only in the final coaching session does a participant under great economic duress realize that she can use The Other Hand to investigate and find ways to cope with the situation. Others found the workshops helpful for starting to identify and articulate the value of this type of practice–several went on to use some of the methods with clients. This hints at the benefits, and possible necessity, of regular practice with these methods, as demonstrated by Jung in his experiments. Also, Scharmer recommends daily contact with what he calls 'source' (2013), to help oneself embrace and face uncertain situations.

In conclusion

The presented research shows that the arts- and nature-based interventions enable designers to work creatively with greater care for themselves and others. The methodical approaches help them to let go of internal barriers and criticism and connect them to inner resources. It's a holistic way of designing that balances control and rational thinking with 'softer' sides like intuition, feelings, and sensations, thereby gaining a more comprehensive understanding of the situation, as described by Jung. Hence, the participating designers see with greater clarity the situation that they are in. They find new ways to creatively inform their projects and shed light on and resolve conflicts whether internal or with other people. It is a process that mirrors and contributes to the devised path through Theory U, with new concrete and simple ways to gain access to diverse forms of knowledge. It is also in line with the definition by WHO that describes mental health and well-being as a prerequisite for being able to contribute to others and to the world we are a part of, providing practical approaches for how this can happen. This research is thereby timely since many of the designers, express feelings of being overwhelmed by work, a longing for working more creatively, and being able to balance personal and professional life. Future research will include participants from a wider range of disciplines to further investigate the significance of using the arts- and nature-based interventions in daily practice–for the practitioner's creativity, mental health, and well-being. There will be a focus on long-term effects, the quality of the creative output and the design of learning spaces supportive to the implementation of these practices.

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Material Metaphors: method for physicalizing relations and experiences

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Abstract

Physicalizing or materializing relationships between ideas and experiences can be an effective and creative tool for people to discuss otherwise hidden concepts around diverse topics. Earlier research has shown how toolkits can help people express themselves by representing concepts and relations physically but can demand effort to prepare and substantial time investment by participants and researchers. In this paper we discuss how these barriers to such physicalization toolkits can be lowered by using easily obtainable household materials. The Tangible Thinking workshop was analysed and critiqued, and an example is given of how to creatively iterate on it, resulting in the novel Material Metaphors workshop. By performing the Tangible Thinking and the Material Metaphors workshops, it became apparent that the diverse materiality of Material Metaphors helped the participants to tell a more personal story, due to the ability to adapt elements to their own meanings. This study gives an insight into what happens when people collectively seek for accessible tools to explore a connected future, like the one we were introduced to during the time of COVID-19.

Author keywords

Thinking with things; Mental Landscapes; Co-design; Qualitative Research; Design Research; Material Practice

Introduction

Physicalizations can be effective tools for exploring ideas, experiences, and relationship dynamics. People have used artefacts, drawings, arrangements, movements, and other physical representations to enhance the communication of ideas (Kirsh, 2010; Tversky, 2015). Creating physicalizations can help people communicate their ideas, feelings, or experiences that might be difficult to share with just speech. There are many tools to facilitate this process (Aguirre-Ulloa & Paulsen, 2017; Andersen, 2013; Fass, 2016; Lockton et al., 2019; Rygh, 2018; Rygh & Clatworthy, 2019). Often the resulting physical representations contain elements whose metaphoric meaning is derived either from their *topological* aspects (i.e. static properties), their *connective* aspects (i.e. relationship qualities to other elements) or their *performative* aspects (i.e. dynamic properties) (Lockton, Brawley, et al., 2020).

One tool that exploits all three aspect types is the Tangible Thinking (TT) workshop (Lockton, Brawley, et al., 2020), which takes the Mental Landscapes Toolkit (Ricketts & Lockton, 2019) as a topological core and adds connective and performative elements in stages during a workshop. Participants are provided with cardboard cut-outs representing elements found in natural landscapes such as rivers, mountains, and clouds. Using these materials, metaphorical representations of experiences can be made and related to the physicalizations of other participants. This process results in a rich physical 'landscape' representing a dialogic understanding of the topic.

This workshop takes three to four hours and has mostly been applied to discuss the topic of interdisciplinary work (Lockton, Forlano, et al., 2020). We note a couple of points needing improvement:

- The workshop is quite time-intensive both during the workshop and for preparation.
- The materials are not easily accessible, as they require a large quantity and variety of laser cut cardboard in different colours, for a total of hundreds of individual elements.

We set out to make the tool more accessible for both researchers and participants from a time and material perspective. We adapted the workshop setup to a more limited list of materials qualities, which could encourage the creative use of materials by constraining the material freedom (Rosso, 2014). This resulted in the adapted method, coined Material Metaphors (MM).

In this study, we set out to answer the question: *"How can a toolkit based on household materials help facilitate discussion about dynamic relationships with technology, through materialising metaphors?"* As a case study, we examined the change of relationship between students and technology caused by the COVID-19 pandemic. This topic was chosen as it is a recent and impactful experience that participants could visualize (De' et al., 2020; Vargo et al., 2021).

Note however, that the focus of this research was not about this specific case, but to examine the workshop method, which should give insights into the collective use of accessible tools for exploring a connected future, as it was accelerated during COVID-19. This method is not intended to be constrained to creating physicalizations of relationships and experiences related to only technology. Ultimately, MM should also be applicable for use cases such as facilitating discussion through the materialization of relationships like those between co-workers as was done using Tangible Thinking (TT) workshops by Lockton et al. and beyond.

In the following sections, we first review related work on physicalizations and then set out the formative design and evaluation method. Next, the findings will be presented, discussed and finally be concluded into the core findings.

Related work

A variety of physicalization methods use metaphors to make complex ideas and feelings tangible—from improvising using salt and pepper shakers to explain the offside rule in football, to constructive projective techniques in psychiatry and art therapy, to more formal methods such as LEGO Serious Play (Kristiansen & Rasmussen, 2014). In recent years there have been a number of design projects and toolkits in this domain. There is no 'right' way to externalise thoughts: (Jonassen & Cho, 2008), we often need "visual prostheses" to share our mental imagery with each other, inclusive tools to help people capture, and communicate the qualitative dimensions of their experiences, to enable discussion or peer support, or even to facilitate group or team sensemaking. Some approaches use abstracted metaphors of real-world elements, such as the 'navigation charts' (Rygh & Clatworthy, 2019)—supporting cross-disciplinary work in the healthcare sector, making communication otherwise hindered by jargon, more inclusive—or the Mental Landscapes kit (Ricketts & Lockton, 2019) which uses cardboard elements such as mountains, trees, fences, rivers, and more to facilitate the creation of a 'mental landscape' to physicalize career paths and project experiences. Other approaches use more abstract forms, physicalizing digital experiences in participatory design research (Fass, 2016), or Emotional Modelling (Luria et al., 2021), which uses geometric shapes from different materials and colours that can be connected to help participants communicate mental health experiences.

Other projects build further on material properties as metaphorical components. Relational Material Mapping (Aguirre-Ulloa & Paulsen, 2017) physicalizes systemic relationships (in public services) by connecting elements using different materials with multisensory meanings associated to them (e.g., hemp meaning nature, nylon meaning transparent, etc.). The Tangible Thinking (TT) workshop (Lockton, Brawley, et al., 2020) uses a three-phase workshop session. In the first (topological) phase participants create a landscape; in the second (connective) phase, the participants add material such as wires and strings to connect the elements in their landscapes, the materiality of the connective tissue giving metaphoric meaning to the relationships.

The last (performative) phase adds a time component to the landscapes, where the participants make their landscapes dynamic by moving elements or for example turning lights on or off.

There are more complex physicalization methods, such as Making Magic Machines (Andersen, 2013; Andersen & Wakkary, 2019), a workshop for children—and later adults—in which they create non-functional 'magic machines', lo-fi props that facilitate speculative use scenarios, physicalizing possibilities that new technology could bring. Equally, there are simple approaches to using metaphors for expression, such as New Metaphors (Lockton et al., 2019), a card-based workshop method for creating unexpected metaphors for difficult to describe ideas. The degree of customization or alteration encouraged of participants is reflected on by many authors. While the language used is often different, the methods discussed in general physicalize ideas from a *topological, connective*, or *performative* point of view. Most of them are only based on one or two of these perspectives, and only the TT workshop integrates all three. There is a gap in methods that creates a representation of complex ideas in a topological, connective, and performative way. But as discussed in the introduction, this method takes a substantial time and material investment.

Method

First, interviews were conducted to gain insights into which metaphors and mental models students use to discuss the chosen topic: "The change in the relationship between students and technology during the COVID-19 pandemic". The choice to focus on relationships was due to an emphasis on physicalizing relationships in previous work done with the Mental Landscapes toolkit. Semi-structured interviews were conducted with five participants, which consisted of a series of open-ended questions that encourage spontaneous and in-depth responses (Ryan et al., 2009). Moreover, the sentence completion method was incorporated, in which the first part of a sentence is given to the participant, inviting them to complete the sentence (Dittmann-Kohli & Westerhof, 1997).

The interviews were recorded and transcribed, and a thematic analysis was performed on the transcripts by multiple researchers. The themes were based on the metaphors that were used by the participants to describe their experiences during the interviews. The metaphors were translated by the researchers into a list of material properties, from which a selection of materials was made with which those metaphors could be represented (Figure 1). Materials were chosen to afford a diverse range of constructions and easy to purchase at budget hobby-stores.

The workshops

The MM workshop had 4 participants and the TT workshop had 3 participants. In both workshops, the participants were asked to use the elements provided (Figure 1) to visualize their experience with the change of relationship with technology during the COVID-19 pandemic, which was the same topic shared by the explorative interviews in the previous phase. The session started with the participants working on their personal physicalization. Afterwards they were asked to present their creations to the researchers and to each other to see if the workshop would aid the participants in talking about their experiences, which started a group discussion and if it facilitated the dialogic joining of experiences together. A structured observation method was conducted during both workshops, as to analyse the process guided by research questions. Afterwards, the workshop was evaluated with the participants using open questions.

Figure 1. The materials used in the Material Metaphors (MM) (left) and Tangible Thinking (TT) (right) workshops.

Analysis

A thematical analysis was done of the two workshop transcripts using the free and accessible analysis tool, Taguette (Rampin & Rampin, 2021). The themes used for this were focused on the workshop experience, in contrast to the interviews' themes, which focused on the participants' actual relationship with technology during the COVID-19 pandemic. Furthermore, the created physicalizations during the workshops were analysed based on material use and how the participant described their creation.

Findings

Exploring metaphors

During the first interviews, a material qualities list consisting of 15 categories was created based on the metaphors used by the 5 participants (P). For example, P4 mentions: "I think it's difficult for me to see the balance between [work-life balance]" which lead to materials with the quality of creating balance or endangering it being included. Round or firm objects were considered, as well as objects with different textures to ensure that participants can express their (dis)comfort levels. P2 mentioned doing activities with their roommate to separate work and their personal life, which translates into the qualities of separation (clay, scissors, and varied materials to create spaces, like paper) and different actors (wooden statues, LEGO figures and objects with different shapes). P5 mentioned: "I've noticed that I find it hard to get to work when you're stuck at home the whole time", which translated into heavy objects, like the crystal rock and weight.

The workshops

Metaphors analysed during the interviews reappeared in the explanations of the physicalizations during the MM workshop. Multiple actors, connectors and objects with different properties were used to explain special relationships or strong bonds. In every physicalization, diverse representations of actors and metaphors were being positioned in dependency on one another. As seen in Figure 2, ropes or cable ties were used to show the connections between actors and the different states of the relationship between themselves and technology. P7 describes a heavy feeling, represented by the crystal, which leads to a clutter of responsibilities, portrayed by the strings of confetti. These were metaphors for the time spent working at home, which eventually led to a more structured work-life balance, shown by sponges that represent nature and the structured packaging of the sealing rings. P6 visualises space by building paper islands connected by cable ties but separated by a clay wall. The participant's loved ones and colleagues were in different countries and every interaction had to happen through digital environments. Heavy objects were used to show either a strong bond between two loved ones or a crushing feeling of technology. Connectors, like a rope or a cable tie were used to express relationships, closeness, and correlation, but were also used to portray an arrow to show the movement of time.

The biggest similarity between both workshops was that the combination of both metaphoric and non-metaphoric elements by participants in their landscapes. Moreover, they liked the group aspect, due to them being helped and influenced by the others their stories and materials used. Although

Figure 2. Physicalizations from the Material Metaphor (MM) workshop: timeline landscape from P7 (left) & island landscape from P6 (right).

the materials were different for both workshops, both groups appreciated the variety offered. Both groups found it difficult to start creating their landscape. However, the TT group started quicker, as the materials being pre-made helped them with creating metaphors.

The biggest difference in both workshops was adaptability. The MM group quite enjoyed the number of options offered whereas the TT group wanted more elements or the ability to customize them. Moreover, some TT participants mentioned that they would like to have the objects made of different materials.

MM was experienced as a bit chaotic, as participants wanted a more structured overview of the provided materials. The variety of materials ensure due participants were inspired by others using different materials. One participant even used residual materials from another participant. Some would have liked a larger quantity of certain fabrics, as some were scarce. However, the participants found that the diversity of materials made it more challenging to create a shared landscape. They ended up not combining their unique dual landscapes but positioned them relative to each other instead. However, the TT group did combine them (Figure 3). The MM group mentioned that they sometimes got ideas by looking at certain materials and other times picked materials based on ideas they already had; the TT group only stated the latter.

Interaction-wise there were also some differences in both workshops. The TT group had more social interaction during the workshop itself. When somebody talked about what they were doing and what materials they were using other participants asked questions or shared memories. Once a negative experience came up, more negative stories were told, which occurred less with MM. While the original topic was the same for both workshops, the generated themes differed: MM physicalizations often visualized relationships, while TT often depicted more barriers.

Figure 3. Combined landscapes of the Material Metaphors (MM) workshop (left) and Tangible Thinking (TT workshop (right).

Discussion

The workshop toolkit was created based on a research question *"How can a toolkit based on household materials help facilitate discussion about dynamic relationships with technology, through materialising metaphors?"*.

The diverse set of materials helped the participants to decide which story they want to tell. The representations of the timelines varied by person as well as the presented detail of different relationships. When comparing the details of the two workshops, it could be argued that the more material is available, the more personal the creations will be. Seeing the difference in storytelling, chosen colours and amount of detail let us believe that people can identify themselves more with different materials and can tell their story in a personal way.

The materials provided in the MM workshop had too much variety, which made it harder to combine them and confused instead of inspired participants. Therefore, it is important to select more essential materials and sort them in a coherent way, like keeping the materials within specific themes. Making these changes might improve the combining of the landscapes phase, which is an essential, as it triggered much discussion. Seeing others work might also make the process easier for people who are less familiar with creative processes.

The differences in the discussed themes between both workshops could be attributed by the materials provided by the toolkits. The rivers and mountains from the TT workshop might explain the barrier theme, due to these being large barriers found in nature.

Moreover, future research is necessary to see if the adapted toolkit is also suitable for other topics. Lastly, more work could be done on the selection of materials and their perceived metaphoric meanings. We anticipate that our adaptation will be useful for design researchers at the initial and 'messy' phases of their design research.

Conclusion

The aim of this research was to compare the Tangible Thinking (TT) workshop to an adapted more accessible version. Interviews were conducted to gather data on how material metaphors could be created around the stories participants expressed. Out of this, the Material Metaphors (MM) workshop was created based on a diverse list of material qualities.

MM has been tested and compared with TT during two workshop sessions. The goal of this research was to analyse the impact of allowing participants more freedom to customize and adapt the materials offered to them when making a physical representation of their past experiences and to discover what the impact is of offering a larger variety of accessible materials. It is difficult to make strong claims about the data collected during this research due to its small scale and qualitative nature. However, some interesting observations can be made, which are summarised in table 1.

Table 1. Observed similarities and differences between the MM group and TT group.

Material Metaphors	Tangible Thinking
Inclusion of both metaphoric and directly representative elements in the created land-scapes	
The group aspect was experienced as positive and participants inspired each other	
Participants appreciated the variety of materials	
Accessible material selection	Defined materials, needing machinery for workshop preparation
Highly adaptable and Diverse materials	Standardized materials
More chaotic and slower start	Structured and faster start
Material exploration and inspiration	Pre-made metaphors
Difficult to combine landscapes	Easy to combine landscapes
Landscapes were positioned next to each other	Landscapes were combined into one super-landscape
Materiality inspired ideas, leading to the selection of materials used in landscapes	Ideas defined materials used in landscapes
Positive stories visualizing relationships	Negative stories depicting barriers
More personal landscapes	More shared experiences

It was shown that the material qualities of the MM workshop have a positive effect on participants storytelling and recollection. More personal and experienceable stories were created and shared, which led to in-depth discussions. This could be derived from the tactile experience of the material or from different methods of material storytelling. The materials were selected based on a variety of potential themes. Separation is encouraged by some materials, while others encourage communication. The relative weights of various materials played a role in the final selection. The contrast between the rough and highly smooth surface promoted unique ways of thinking. This workshop and the characteristics of the materials could serve as the basis for future research.

The MM workshop is more accessible than the TT workshop, as researchers do not have to have access to machines that produce the materials, and no additional preparation is needed aside from gathering.

The TT workshop's strength is to communicate shared experiences due to the possibility of combining the created landscapes, which was found difficult in the MM workshop. This workshop creates more personal physicalizations of experiences that cannot easily be combined. However, MM can facilitate discussion among participants comparing their created works.

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A South African approach towards caring design practices

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Abstract

The digital global economy, although democratised in some respects, also creates vulnerability in less-resourced contexts. Small to medium enterprises on the one hand can access markets digitally but on the other, cannot compete with large scale mass production of global companies. In addition, the digital environment can also create *virtual distance*, the opposite of community and care. Using critical posthumanism as a lens, in this paper we explore examples from a South African context – that, through empathy and care, demonstrate resilience in challenging and rapidly-changing environments, to improve economic activity. Braidotti's posthuman theory offers an ethical sense of collective and relational accountability. This finds strong resonance with postcolonial, race and feminist theorists including the notion of "African humanism" or "Ubuntu". Data was collected from creative practitioners in South Africa through observation and interviews. The findings point to alternative solutions based on mutual interdependence in extended communities of practice. Themes from the selected examples were used to develop a framework as a counterpoint to the linear, outcomes-based design process. This framework is presented as a tool that can be used in each phase of the design process to facilitate collaboration, community-building and empathy, whilst questioning what affect our actions (as designers) have on all others. In this paper, we acknowledge the responsibility of the designer as a facilitator of ethical practice. The framework points to a way of working with others, but also with available resources. Furthermore, this framework aims to augment the sustainability of a design project, by building a caring community.

Author keywords

Posthumanism; care; empathy; design practice; Ubuntu

Introduction

The digital global economy, although democratised in some respects, also creates vulnerability in less-resourced contexts. Small to medium enterprises on the one hand can access markets and resources digitally but on the other, cannot compete with the large-scale mass production of global companies. In this context, the digital environment can also create *virtual distance*, the opposite of community and care (Lojeski & Reilly, 2007).

Design and innovation play an important role in increasing profitability and ensuring sustainability of globalised economies underpinned by advanced capitalism (Brasset, 2015). Design's concern with innovation and value (profit) can be at the cost of human and non-human others (Bjögvinsson, Ehn & Hillgren, 2012). In response, designers have developed frameworks (Kouprie and Visser, 2009) and toolkits (Sampson and Chapman, 2019) to try and navigate the ethical concerns that emerge from participatory practices and, more recently, with the ethical implications of artificial intelligence (AI). The literature consulted does not address challenges and experiences in South Africa.

In this paper we consider what these ethical implications mean in a South African context, where unemployment rates for the first quarter of 2022, was 63,9% for those aged 15-24 and 42,1% for those aged 25-34 years (Statistics South Africa, 2022). South Africa has highly digitised design workplace environments, but it also has a large informal creative sector. In 2017, the South African Cultural Observatory reported the creative and cultural sector accounts for almost 7% of employment in the country. According to a 2020 survey approximately 35% or creative and cultural practitioners were working informally (unregistered) and 65% working formally (registered). The survey also included freelancers and those who were employers (South African Cultural Observatory, 2022). The purpose of this research was to explore what designers and creative practitioners in South Africa can do to build resilient and sustainable creative communities in increasingly challenging local contexts.

Posthumanism

Posthumanism questions what it means to be human under the context of "globalisation, technoscience, late capitalism and climate change" (Herbrechter 2013: 107-34). According to Braidotti (2013), posthumanism stresses the self-organizing (or auto- poietic) force of living matter and rejects dualism, especially the opposition of nature–culture. Braidotti (2013:26) objects to "the unitary subject of Humanism, including its socialist variables" and seeks to "replace it with a more complex and relational subject framed by embodiment, sexuality, affectivity, empathy, and desire as core". This theoretical position acknowledges our co-existence with all matter including machines.

The authors are guided by the posthuman philosophy of Braidotti (2013, 2011,2006). Braidotti emphasises a "cognitive brand of empathy, or intense affinity: it is the capacity for

compassion, which combines the power of understanding with the force to endure in sympathy with a people, all of humanity, the planet and civilization. It is an extra-personal and a trans-personal capacity, which should be driven away from any universalism and grounded instead in the radical immanence of a sense of belonging to and being accountable for a community, a people and a territory" (2006:205). Braidotti's ethical argument is not based on a vulnerability or lack, but rather on assets and empowerment gained through understanding. Nomadic thought considers the 'effects of truth and power that actions are likely to have upon others including external and non-human forces' (Braidotti, 2011:300). The emphasis therefore clearly lies not on the individual, but on relationships between individuals, and not in the dualistic mode of self and 'other', but as an integral part of a mutual specification and co-dependency.

Inspiration is also taken from Haraway (2016:10) who looks not to the past for "reconciliation or restoration", but to a present "becoming-with each other in response-ability", in anticipation of a "still possible recuperation". Haraway (2016:2) argues for approaches that are present, engaged, and responsible. She calls for "making kin" to survive and thrive in a troubled world, by people forming alliances and making- with all others. including non-humans, animals, plants and living cells. Haraway mobilizes an enlarged sense of community, based on empathy, accountability and recognition. The researchers chose to adopt a Posthumanist perspective for this research as it offered a suitable language to comprehend the contemporary global situation. Additionally, they found some similarities with South African Humanism, which is highlighted in the presented findings.

Design and Empathy

Themes in design discourses are concerned with design futures, speculative methods, and narratives, all underpinned by a notion of care. Participatory practices including co-design and human-centred design were developed to acknowledge the values of human participation as crucial, viewing the people involved as partners in the relationship (Sanders and Stappers, 2013: 63, 67).

While the need for designers to develop a deep understanding of their users is noted (Newell, Gregor, Morgan, Pullin & Macaulay, 2011: 235; Mattelmäki, 2008: 68), the details of how to do this in practice are limited (Kouprie & Sleeswijk Visser, 2009: 438). The idea of empathy in design practice has not been well defined or described, (Dong, Dong & Yuan, 2018: 295). Mattelmäki suggests empathy is "the skill of trying to look at the world from another person's perspective, making interpretations and imagining how it could feel or look like" (2008: 68). Surma-Aho and Hölttä-Otto (2022) present a five-factor construction that is premised on designers aiming to understand users and their context (2022, 2). Their model suggests a starting point in the exploration of what it means to empathise in the process of design, by placing empathic understanding in the middle – with internal and external factors on either side. For this paper, the authors focus on the external aspects which are most manageable in a working context.

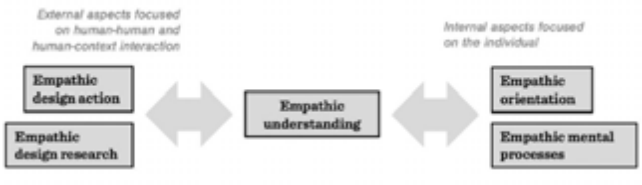

Figure 1. Construction of empathic understanding in design (from Surma-Aho & Hölttä-Otto 2022, 5)

In the global context of war and recession (Russian – Ukraine conflict, energy shortages, climate pressure – to name a few), it seems unlikely that more monetary resources will be available to contribute to small or non-formal industries in underdeveloped countries. With this in mind, we question what can designers do to harness their human resources, making use of empathy and care, to build more sustainable creative communities?

Method

Using critical post-humanism as a lens, in this paper we explore examples from a South African context – that, through empathy and care, demonstrate innovation in challenging and rapidly-changing environments, to improve economic activity. For this paper we refer to two sets of data. The one set addresses designers and their understanding of empathy in practice. The other explores design and making in the informal sector in SA.

For the first set, data was collected by interviewing design practitioners about empathy in their design practice. Because empathy is so poorly described in design practice and the literature, it was important to find out more from designers themselves. The design practitioners selected were involved in co-design practice, universal design, or freelancers and design consultants working in community projects. A Co-design workshop with 3 designers was held prior to the design practitioner interviews – to design appropriate ways to enquire about empathy and, identify design empathy behaviours and barriers to the research. As empathy is largely viewed as a positive attribute, it is critical to research in a way that the designer does not give the "right" answer – to give a positive impression of themselves, making the interview design complex. The questions were first tested on a designer to critically adjust for best results, prior to use in the final interviews.

For the second set, data was collected from creative practitioners in South Africa through observation and interviews, targeting informal sector makers of hand-crafted products and designed goods. The participants were selected for observation because they had proven to be sustainable as a group for about 20 years despite not forming part of the formal sector. The number of participants varied from day to day during the observation as attendance is influenced by the daily personal circumstances of the practitioners.

In both cases, consent was obtained prior to the collection of data, anonymity was ensured, and the data, once transcribed, was stored in secure, password-protected digital repositories. The transcribed data was organised and analysed using thematic coding as described by Saldaña (2013). First cycle in-vivo coding of transcripts from the interviews and analytic memos, and second cycle coding was used to group the data into categories and themes to saturation point - where no new themes emerged.

Findings

After coding the interviews with designers, the data showed internal and external features of empathy. Designers may or may not have these traits in personality/ make up (BEING), however the behaviours and actions (DOING) can be utilised to enable caring environments when working with stakeholders. This resonates with the model of empathy proposed by Surma-Aho and Hölttä-Otto. In addition, this possible dichotomous nature of designers corresponds with the model of 'being' and 'doing' which was developed in the coaching field (and this is well illustrated in Figure 2). The 'being' (inside oneself) refers to the assumptions of an individual, including values, worldview, and beliefs, which become partly visible in the actions or behaviours - the 'doing' of the individual. The individual 'being' of practitioners in a professional environment would also be impacted by corporate culture/ norms, and this culture could impact the collective cultural practices – thereby impacting the 'doing' of the designer.

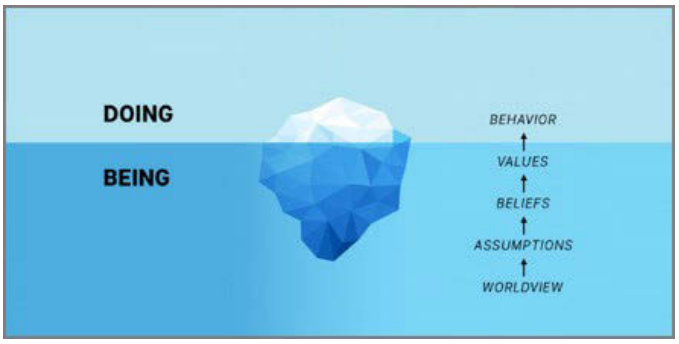

Figure 2. Doing vs Being (Source: Carabi, 2018)

In Posthumanism, duality is rejected in favour of an embodied monistic view of the mind and body in that the two are one and the same, hence we reframe this by placing the "doing" within the "being". The description of empathy as an embodied practice, a dialogue between empathy as part of the design process, and empathy as part of the designer themselves is reinforced by the notion of being, doing and becoming. The notion of 'becoming' is integral to this position as an affirmative, future-focussed concept. 'Becoming' in the future holds the potential of self-fulfilment and transformation (Allart Wilcock, 1999: 1).

The three themes that emerged from the informal practitioners are briefly described in this next section which speak to empathic methods to resilience and sustainability in a South African context.

Storytelling (language and diversity)

Storytelling provides the opportunity for sharing of stories and conversation within a community of practice. By not privileging the written word, storytelling gives each participant agency in exploring their own designs and enabling each participant to have a voice. In turn, this unlocked potential for innovation. Using storytelling and drawing as means of conceptualising new subject matter, a range of products was birthed to which customers responded positively. In this instance, the focus of the training was on the development of a process through storytelling and drawing, rather than on focussing on the final artefact. This approach provides the project with a process to ensure the authenticity of the subject matter and by extension, innovative products.

Authenticity

The success of the makers observed and interviewed is based on everyday objects being made and interpreted in an authentic way, rather than on innovation of new products. This resonates with literature indicating that in the digital age, authenticity can take on different dimensions and is process-driven rather than artefact focussed (Loh, Burry & Wagenfeld, 2016). This authenticity is based on what participants bring with them in terms of their personal stories, experiences and daily circumstances rather than responding only to consumer trends.

Ubuntu (Cultural norms)

One prominent observation was that there was a tendency for the group of practitioners working together to work to the speed of the slowest person in the group. This tendency to work to the [s]lowest denominator could be attributed to the principle that by working to the level of the weakest member of the group, no one is left behind or is denied the opportunity to contribute. Therefore, by protecting the group, the interests of everyone are protected. Interestingly, this does not seem to apply to very strong craftspeople - who tend to leave the group and work from home.

The protection of the individual within the group speaks to the African notion of "Ubuntu", and it also references the reciprocity between the members of the community of practice. Economically, this is counter-intuitive: why not make more units and increase the potential for profit? Yet in this instance, the protection of the group took precedence: as without the group there would be no projects. This is a philosophical position strongly embedded in African tradition.

Discussion

Amongst the informal practitioners the emphasis is not on the individual, but on the preservation of the group in support of the individual. In contrast, in the formal sector, the focus is on designer and influence of their being and doing on the design process. In both instances the issue of power dynamics was pronounced - with the designers there is a power dynamic between the trained designer/s, possible interdisciplinary partners and the other stakeholders in the process such as clients, and end users. In the case of the design-makers the power dynamics centre around difference in resources, access to materials or vulnerability due to economic and social circumstances.

The findings point to alternative solutions based on mutual interdependence in extended communities of practice. The African philosophy of Ubuntu is underpinned by a strong ethical sense of collective and relational accountability. Braidotti's posthuman theory resonates in this aspect with post-colonial, race and feminist theorists including the notion of "African humanism" or "Ubuntu" (Braidotti, 2011:211-218).

We found that empathy and care behave as the 'social glue' for informal businesses and communities of creative practitioners. Themes from the selected examples were used to develop a framework to complement the linear, outcomes-based

design process. In this framework, we acknowledge the responsibility of the designer as a facilitator of ethical practice. In addition, we acknowledge the natural diversity of designer personalities, values and beliefs. The findings, supported by literature and theory, put forward the idea of embodied design practice as 'being, doing and becoming'.

In designing the framework we took a cue from Clarke and Parsons (2013: 35), who consider that 'rhizome researchers' should "...recognize their embeddedness, allow the research to lead them, accept that attempts to synthesize are never finished, listen to those before them and on the margins, and give themselves to a life of becoming, thus 'breaking' the binaries that can capture or stifle their attempts to be educational researchers ...". Therefore, we have placed the designer in the middle of the framework. This positioning also speaks to a situated context regarding finding innovative alternative solutions to complex problems.

Becoming care-full speaks to the affirmative potential of transformation and mobility of thought. The 'doing' of the design practice includes behaviours and actions that can show the care and empathy needed to support users and stakeholders, in seeking affirmative solutions. 'Becoming' a care-full designer is the centre of the model (figure 2), with the 'doing' actions and behaviours around it. The 'Being' of who you are as a designer (values, beliefs) underpins it all.

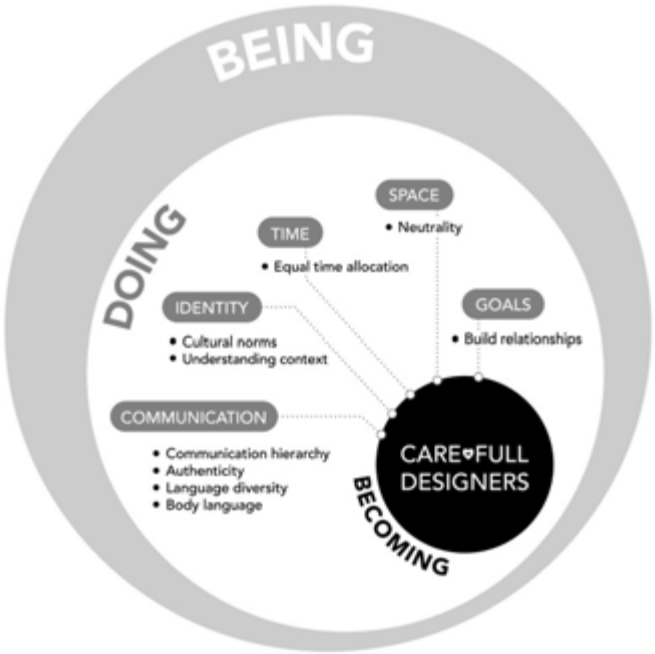

Figure 3. Becoming Care-full Designers (Authors, 2022)

CONCLUSION

In response to the question that we posed regarding what designers can do to harness their human resources, making use of empathy and care, to build more sustainable creative communities, we present this framework. It points to a way of working with others, but also with available resources such as people, environments, and skills. This model encompasses an iterative part of the design process and is underpinned by the principles of Post Humanism to provide a guide for care-full design.

This framework is intended as a non-hierarchical and affirmative tool that can be used in each phase of the design process to facilitate ethical collaboration, and community-building, whilst questioning what affect our actions (as designers) have on all others, including non -humans. The prompts serve as reminders to enable dialogue and empathy throughout the design process. By acknowledging the responsibility of the designer as a facilitator of the design project/ community/ process, we place the onus on them to address the power dynamic in the situation. They can use the features of the framework to ask leading questions about their behaviour (see table 1).

Table 1. Aspects of Becoming Care-full Designers (Authors, 2023)

DOING CARE-FULL DESIGN	
COMMUNICATION	**ASK**
Communication hierar-chy	Whose voice seems to be most important? Who is being heard? Everyone needs a voice
Authenticity	Is this a place where participants can be authentic and real?
Language diversity	Does the conversation make space for all languages?
Body language	What is the body language of the designer/ participants saying?
IDENTITY	**ASK**
Cultural norms	Am I aware of the cultural context?
TIME	**ASK**
Equal time allocation	Is the time equally allocated? Both participants and de-signers need to be heard
SPACE	**ASK**
Neutrality	Whose space are you working in/ meeting in? Is this a safe, comfortable place for participants?
GOALS	**ASK**
Build relationships	What needs to be in place to build understanding of participants and context?

The framework can be used as a reflective tool for practitioners or to inform a code of conduct in co design contexts to harness the care and empathy behaviours needed to build resilience in informal and formal creative industries.

Developed and affluent nations are increasingly embracing machine working and AI and all that these technologies offer. However, as they harness technology, the economic divide between these countries and the less- developed and differently resourced nations increases. Given that in times of conflict, concerns for domestic economies are more pressing, it remains likely that nations will be left to fend for themselves as this digital and resource divide grows. It is hoped that this framework for - *Becoming a Care-full Designer* – could facilitate the harnessing of available resources to mitigate the challenges faced by creative practitioners in South Africa. Recommendations for future research include care-full testing of the framework in various design contexts.

Authors' note

The datasets described in this paper were collected as part of two doctoral studies, as detailed below:

Di Ruvo, M. 2022. *Towards resilience in South African craft enterprises, from design theory to craft practice.* (DTech: Design).

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Weighing the tensions of nostalgia, necessity, and care in contemplating the future of the Nigerian design-scape

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Abstract • (Handle with care/Inclusivity track)

This paper presents perspectives derived through methods of critical reflection and from my positioning as a Nigerian product designer and researcher aimed at defining a research gap and constructing a contextual framework on which planned research can be undertaken. The planned research inquiry asks, what could the future of design ethos, production, and even definition in Nigeria hold today? What lies at the intersection of contemporary designing and efforts to preserve her myriad cultures and heritages? This paper contemplates three tensions - the *nostalgic* motive for, the overall *need* for, and the consideration and duty of *care* required to engage in this inquiry. As a general contribution, the reflections discussed encourage the adoption of a nuanced mindset, well-considered urgency, and ethical bedrock for designers and researchers planning and engaging in decolonization research and practice.

These reflections are informed first through a grounded understanding of Nigeria's relationship with art and design over its formation and then through a review of literature, such as Svetlana Boym's critical musings and cautions on nostalgia, Gui Bonsiepe's writings on design activity and potential in the 'global south,' and the potential value of traditional points-of-origin for contemporary designing as discussed by Demas Nwoko, amongst others. Contemplatively relying on Uche Okeke's theory of *natural synthesis*, — which embraced hybridity as a remedy in fine art making as Nigeria transitioned to independence in 1960 — predictions for a methodological approach for this continued research in Nigerian design transitions and cultural preservation are also introduced, and discussed.

Author keywords

Design, decolonization; Nostalgia; Necessity; Care; Nigeria

Nigeria, art, and design

"The negro, many have believed, is a man without a past," historian Basil Davidson (1960, p.20) writes in *Old Africa Rediscovered*, "No ingenious manufactures among them, no arts, no sciences," commented David Hume." Throughout history, European commentators have tried to downplay the contributions of Africa and its history, questioning the quality of *art* and whether *design* even occurred. This served to justify and glorify colonial conquest. Despite the hierarchy established by colonialism, historical African art objects, most of which reside in Western museums, significantly influenced modern concepts of form. However, their context and function were often disregarded (Parker & Rathbone, 2007, p.58); These things were displaced from their physical origins, thus unable to continue shaping the culture from which they originated. On the other hand, local perceptions of these things grew negative as the foreign and modern were deemed better. Efforts of decolonization and decolonial thinking are ongoing, working on challenging this narrative and re-examining past interpretations to create a new perspective on the future.

As a researcher, these spaces hold interest: *past, future*, and *design* in relation to Nigeria. Designer, Victor Papanek (2019, p.03) called design the underlying matrix of life. Everyone designs. Humans have created unique ways to interface with the world around them in response to their need and by imitating the design and order seen in diverse environmental landscapes. If design is the ability to communicate, plan, *solutionize*, and shape, culture is the *context* through which all this is done. The common understanding of *art*, unlike design, is individual creative expression. However, in a general African understanding, this isn't always the case; some African languages don't even have a specific word for 'art' (Parker & Rathbone, 2007, p.58). Arguably, a thicker connecting line can be drawn between art and design here. In Nigeria's myriad pre-colonial societies, objects and systems were made for specific functions (physical and metaphysical). *Art* was an integral consideration in *design*ing everyday things. To craft was to express but also record-keep.

Over time and through acculturation, art and design in Nigeria were divorced and compartmentalized. In 1958, charged with the excitement of impending independence, Nigerian painter Uche Okeke (2019, p.23-24) reflected on the role and purpose of 'Nigerian' creativity moving forward. He founded The Zaria Arts Society, made up of eight fellow student artists (*the Zaria Rebels*), with the goal of *synthesizing* traditional Nigerian creative practices with the Western form they were being taught. The society's mission was to give its members a sense of direction as Africans and artists concerned with making work in a colonized reality and tussling with "culture conflict" (Okeke-Agulu & Picton, 2006, p.03). Nigerian fine art today — like the ethereal watercolors of Tayo Adenike, which preserve the Igbo practice of *Uli* mark-making on paper rather than skin, textile, or earthen-wall — has become a vessel for preserving

Figure 1. Igbo chair. European influence in form, yet Igbo creative vocabulary is seen in the structural pegs (solely holding all components together) ornamented with human and animal figures. From *Bonhams*, (n.d.). (https://www.bonhams.com/auctions/21022/lot/183/)

cultural elements as well as individual expression. *Industrial* design creatively transforms material with solution, efficiency, and/or enhancement in mind, specifically driven by the speed and benefit of technology and mechanized production. Gui Bonsiepe – a design theorist focused on design in the global south (Latin America, specifically) – writes that industrial design is closely tied to the socioeconomic context in which it is used (Bonsiepe et al., 2021, p.326). Today, Nigerian "industrial design" is budding yet less assured; dependence on foreign imports and poor leadership has hindered the country's ability to refine available materials and produce diverse goods. Fellow *Zaria Rebel* Demas Nwoko advocates for traditional inclusions in present-day Nigerian design and production through his architecture, furniture, and creative efforts. Nwoko (2022, p,205) recognized that connected '*artdesign*' that defines Nigerian creative history and material culture in saying, "To our ancestors, Architecture was a Fine Art just as the performing Arts was." The African Designs Development Centre (ADDC), set up in 1978 in his hometown of Idumuje Ugboko, was an experimental "production unit" producing goods (Nwoko's furniture designs and building components) out of the area's abundant forest timber (Nwoko, 1992, p.126-128); it was a model for local-first production that employed and taught skilled locals and relied on sustainable material sourcing. With this rich historical foundation, there is room for today's Nigerian designers to define a method of design and production that makes sense socioeconomically and sustainably. Could cultural and historical preservation be an optional consideration like it is in Nigerian contemporary fine art? What could the future of design ethos, production, and even definition in the Nigerian design-scape hold?

In this paper, tensions born from critical questions such as, *"of what benefit to the future is gazing at the past?"* will be addressed in the context of these intended research motivations. Three tensions are contemplated - the **nostalgic** motive for, the overall **need** for, and the consideration and duty of **care** required to weigh when defining the rationale for decolonization research and practice.

Isn't this nostalgia?

The topic of "cultural transference in design" is gaining traction in academic design discourse and research; Wenjin Yao's (2013) investigation of capturing "Chineseness" in product design is a prime example. Despite understanding the inherent value of cultural knowledge to its people, Bonsiepe (2021, p.165) labeled such investigations *nostalgia* and didn't consider it possible or practical because of perceived false equivalence: "How could a pocket electronic calculator or a water tap be designed with formal elements of the Maya culture? Nostalgia is not an effective way to prepare for the future," he postulated.

To be nostalgic implies giving a romantic and somewhat futile look at the past. Cultural critic Svetlana Boym (n.d) defines two distinct types of nostalgia: restorative nostalgia, which seeks to restore the past in the present, and reflective nostalgia, which reflects on the past in the present. While restorative nostalgia is characterized by a romanticized desire to return to a lost or idealized past, often through the reconstruction or preservation of historical sites, objects, or traditions, reflective nostalgia, on the other hand, is characterized by a critical and self-aware engagement with the past. Boym recommends a healthy fear and responsibility when looking backward and proposes that both reflective and restorative can co-exist, but it is important to distinguish between them. In short, nostalgia as "countercultural practice" (Boym, n.d.) needs to be handled with care. Compared to Bonsiepe's earlier stance, Nwoko (2022, p.155), speaking as a Nigerian, thought differently, "Our industries will remain in the woods until it admits the activities of indigenous creative designers into its product development process." For designers in a post-colonial space, a knowledge gap exists between historical *thens* and contemporary *nows* that could affect design approach and process when explored. To look back and examine the usefulness of one's historical *thens* should remain an open right and choice, and an ability to recognize nostalgic tensions could keep the investigation bias-free.

It is pertinent that the designer and design researcher, culturally connected to a once-colonized space looking to offer decolonial options by choosing to examine the past, intentionally widen the gap between '*post*' and '*colonial*' in their approach; the history of a post-colonial space is not linear; like multiple fibers woven together in a tight braid, multiple *histories* make up the history of a once-colonized nation. If '*postcolonial*' is agreeably a term that "registers the ongoing effect of colonialism on a former colony" (Tsang, 2021) and the introduction of the hyphen in '*post-colonial*' marks simply the time after colonization, '*post colonial,*' with a confident space in-between, can describe a desire to *move beyond* being *defined* by a period of colonization, despite its paradoxical appearance. Recognizing that colonialism was not the story's beginning allows for the desire to engage with the unique perspectives and contribu-

tions of the past in a forward-looking present. This mindset keeps the decolonizing designer/researcher aware and helps them engage with the past responsibly. Basil Davidson (1960, p.21) poetically cautions against being caught on either "the rock of prejudice" or "the whirlpool of romance" when generally enquiring into African past and history; it's also important in this reflection not to force the observed past into the mold of "modern convention" to valorize. Responsible nostalgia looks like this: determining what stays in the past and what can be meaningfully brought into the now for the future. 'Reflective *decolonization*' with a '*post colonial*' motivation is a position worth taking.

Inspired by theorist Walter Mignolo's stance on options over alternatives, the intended research is also driven by the belief that while '*cultural-preservation-through-design*' as a potential product design method is not obligatory, its occurrence is arguably invaluable for creating designed options accessible to all and the growth of the Nigerian design-scape. "If you look for alternatives, you accept a point of reference," Mignolo (2011, p.xxviii) states, "instead of a set of existing options among which the decolonial enters claiming its legitimacy to sit at the table when global futures are being discussed." Nigerian designers can actively investigate *options* that could move Nigeria towards the future and actively deconstruct colonial systems and thinking. All in all, there should neither be dependence nor dismissal (by labeling investigation itself as futile nostalgic activity), but the inherent curiosity known to every designer in rediscovering what once was and a recognized responsibility in the method, purpose, and goal of rediscovery, especially if there is a connection through one's heritage.

Still, is it absolutely necessary?

"Genuine disalienation will have been achieved," Frantz Fanon (2008, p.xv) writes in *Black Skin, White Masks*, "only when *things*, in the most *materialist sense*, have resumed their rightful place" [emphasis added]. Though this *restorative* statement could be identified as "relinquishing critical thinking for emotional bonding," as Boym (n.d.) warns, a critical pause is needed to consider what this truly implicates. Again, in a post-colonial context, there could be an argument that for the actual people whose creative histories are alien due to external forces and internal disregard, this is less of a nostalgic exercise and more necessary retrieval. A remedy to embedded insecurity. Material restoration as decolonization, as expressed in Fanon's statement, can be interpreted as an urgent push towards situated options that introduce balance and harmony (in the most *tangible* sense) in these spaces, driven by a *post* colonial motivation (as introduced in the previous section).

The dominant belief is that modernization is necessary for progress, and industrialization is the way to achieve it; anthropologist Arturo Escobar (2018, p.209) puts it evocatively, "it is easier to imagine the end of the world than the end of modernity." For designers in post-colonial spaces defining contextual modernity, remaining critical about what that looks like — what Boym (n.d.) calls 'off-modernism' — is necessary *because* of coloniality; Mignolo (2011, p.2-3) defines the Western rationale for colonialism, expansion, and civilizing as the logic of coloniality, of which modernity is its other, darker side; one does not exist without the other. The ideas of "backwardness and progress" have been used to construct weak hegemonies of knowledge, race, and others; Davidson (1960, p.32) calls out this "illusion of Europocentric...thought" and stresses that "the interplay of men and their *environment*" are a better indicator and metric for interpreting and planning progress. Man's *overplay* of the environment has reached a breaking point. Manufacturing processes are being rethought in response to the warming climate. Sustainability has become a design responsibility. Gisela Carrasco-Miró (2017, p.104-105) critically dissects "growth is good" rhetoric by revealing that sustainable development tells "a totalizing modernity story with capitalism as its universal telos and that it hinders the possibility of accessing the critical insights of those who have been 'left behind', colonized, or bulldozed over in the Capitalocene"; Carrasco-Miró proposes saying '*sí*' — meaning '*yes*' — to engaging with currently devalued economies for a more equitable approach to sustainability practice and discourse.

Design does not and can not *save*; design advocates for the better and encourages a hopeful shift toward it. Nwoko (1992, p.82) believes that developing spaces need the freedom to evolve their own voice and design better futures while balancing outside influence, to make and learn from mistakes to improve. To experiment with options for how modernity manifests. In this experimentation, decolonial options to unsustainable modernity emerge that benefit the local *and* global. Nigerian economist and World Trade Organization (WTO) Director-General Dr. Ngozi Okonji-Iweala makes a case for continued engagement with globalization. "Re-globalization," she calls it, is "bringing more countries into international production networks." She petitions for "deeper and more diversified international markets" to fortify the global supply chain (Hermosa, 2022, 19:58). It is necessary for makers to experiment for local benefit and more *equitable* global exchange because out of experimentation comes options and answers to needs — known and unknown.

Where does care come in?

In the context of this intended research, ethical care for the *process* — this inquiry into product design as 'preservation' — is vital. This looks like avoiding gimmicks or playing into over-saturations; for determining the right method for investigating *then* for application *now* in designing the *onward*. The ether is more saturated with Afrocentric signals that bear little to no foundation in any specificity than those that do. Bonsiepe (2021, p.176) speaks to a similar "*indigenism*" phase in design in Latin America in the 1960s (which was also a way to counteract echoes of colonialism) and the concerns and aftereffects of what might be considered a poor practice of cultural transference method and result, "...the rich stock of forms for craft products is linked to a traditionally rather narrow range of products. By romanticizing the notion of "design" it then becomes possible to present these products as authentic design informed by hypostatized Latin American essence." This intended research hypothesizes that correct transference can go *beyond* crude aesthetic interpolation, but determining the method's feasibility will only come through trial. By doing so, an etiquette for recognizing and classifying tangible and intangible elements in a historical object and its "transference" to a designed product through experimental making can emerge. Bonsiepe (2021, p.176) also calls out the ethical and exploitative ramifications of poor transference practice, "When industrial designers adopt craft designs and deliver products then

made by craftworkers – primarily by women – this brings with it the danger of using these workers purely as labor rather than fostering their innovative abilities". For the design researcher, the attitude of participatory decolonization research should be non-hierarchical; it is not a mission of design knowledge depositing but of expanding the knowledge *of* design for oneself and the field at large. One way to do this is through the centering of local knowledge-makers. Co-creating and co-futuring is a decolonial method in its own right, given its focus on communal skill sharing. Ethical care for participating designers is key.

Care also applies when considering the *person* impacted by all this design contemplation, and people *within* cultures spark musings of individual and collective *identity*. Boym's (n.d.) position that a nation's nostalgia-driven rediscovery of identity "puts an end to mutual understanding" since "the universality of longing" in the human experience can cause us to alienate each other as we focus on being part of a certain group may place greater value on outer considerations when insular ones remain fractured; not all nations evolved equally. Nigeria is a once-colonized, "imagined community" (Anderson, 2016, p.07) of ethnic societies (wholes and fractions) under a green and white banner, named by a Brit after a river. Still, for Nigeria, it is worth considering Boym's position carefully, as postcolonial *tribalism* can be fed if this investigation into the past is unbalanced in its source of reference. On an individual level, Bonsiepe (2021, p.165) believes "identity is not the realization of a potential that lies hidden somewhere in the lower depths of what is believed to be [indigenous] character" and is "not in the past; rather, it needs to be created." Ideally, identity needn't lean on these things. However, colonization of one's surrounding culture, and consequently of oneself and perspective, can lead to a distorted understanding of identity and place in the world. There is a need to decolonize lingering ways of thinking; revisiting the past could be an essential reckoning with a *part* of the self, not the whole, and for the designer, could affect process and output.

People make culture and not the other way around. Designers and researchers engaging in decolonization practice should care for *what* is created and how it inserts into public realms for tactile engagement, for "cultures thrive when they best serve and reflect the people" (Adichie, 2023). Design theorist Tony Fry (2017, p.28) speaks on designers in the "global south" providing care by designing ontologically *caring* things; Care becomes transmutable and tangible when designers understand the impact of the things created and put out and their power to transform by "making and unmaking." Only with uninhibited and consistent interaction by *all* can these design experiments — these caring objects and experiences — communicate a new possible future.

Conclusion

To reiterate Demas Nwoko's (2022, p.155) warning, Nigerian industries "will remain in the woods until it admits the activities of indigenous creative designers into its product development process." What emerges — once all tensions are taut — is a gap to examine this "admission" Nwoko speaks of. The *how*.

Therefore, the research plan is to explore the role of design in Nigerian historical preservation — through ethnography, co-design, observational engagement with objects from Igbo historical culture (as a case study), and personal practice — through the methodology of *'synthesis'* (as historically experimented with in Nigerian fine art) over transference; if hybridity as creative remedy was explored when Nigeria was transitioning to an independent state, it might be a worthy methodology for researching her future transitions. As a Nigerian product designer and design researcher, this reflection uncovers an opportunity (for myself and Nigerian designers alike) to rethink and deconstruct the consciously or subconsciously dominant definitions and processes of *design* itself for the benefit of the Nigerian design-scape and the spaces and people it creates for. The historically and culturally backed perspective of *'artdesign,'* discussed in the first section, forces one to consider its effect on the contemporary order of operations for design ideation, production, and manufacture.

Okeke (2019, p.23) saw synthesis in fine art as a *natural* happening, an instinctual, "unconscious" response and responsibility between the artist and the historical reference being preserved; the projected next step in this research process is to ask: *does the same apply to the product designer today or are there models for product designers, looking to preserve culture in post-colonial spaces by offering options for sustainable transitions into a more self-reliable future, to apply when approaching this process?* There is ripe potential to explore this through the development of new methods for *proper* synthesis in making and unmaking design processes, to define what *proper* and *improper* synthesis looks like and if those distinctions even exist, and to determine *what* can be synthesized with or into *what* in order to inform this possible etiquette of synthesis, through experimental and engaging practice.

As an overall contribution, these contemplations ultimately encourage the adoption of a nuanced mindset, well-considered urgency, and ethical bedrock for designers and researchers, particularly those with heritage aligned with the researched space, to decolonially (with a *post* colonial motivation, as earlier introduced) reflect on the past to individually and collectively make and un-make the future in once-colonized spaces.

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Food as a form of care: designing social innovative processes and practices

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Abstract

Food in Italian culture is traditionally considered a form of care for others and, by definition, conviviality, and these concepts extend beyond the stages of preparation and consumption. If we also include the stages of cultivation, production and processing, the concept of care potentially expands far beyond caring for people. While the scientific and grey literature on food and social innovation is rich and extensive, there is still room to explore the relationship between food and *care*, especially regarding the contribution of design in making food a tool of care for people, the environment and cities. Building on these premises, the paper moves from the case of a social innovation policy in Milan to construct a preliminary conceptual interpretation of the relationship between food and the notion of care, exploring how design contributes to strengthening this relationship through shaping strategies and services and of empowering people with entrepreneurial and creative skills, nurturing an innovation culture in society at large. The study builds on the analysis of 7 cases incubated within the program The School of Neighborhoods, promoted by the Municipality of Milan and designed by a consortium of partners including the Polimi Desis Lab of Politecnico di Milano. With the purpose of laying the basis for a conceptual framework to be adopted in ONFoods (a project funded under the National Recovery and Resilience Plan in Italy with the aim of taking a substantial step toward the sustainability of food systems) the authors introduce an interpretation of the cases in which food is a way to: i) care for diversity and inclusion; ii) care for the neighborhood; iii) care for the environment; iv) care for the quality of work. The discourse around the case studies benefits from having been developed in a vibrant urban context in terms of food policies that help shape and expand the city's capacity for experimentation and innovation. The paper discusses the contribution of design in reshaping the notion of care through food, both in supporting the presented social innovation projects as well as in infrastructuring the scouting and incubation process that led to the generation of public value.

Author keywords

Design; care; food system; social innovation.

Introduction

Food has always been a central ingredient in the history of all people of the world. And this is particularly recognized in Italy, where food is culture and where it is considered one of the highest expressions of caring for others (Montanari, 2011). Defining the dimension of conviviality and care in Italian society are above all the acts of preparing and transforming food and the ones of sharing and consuming it together, which are strongly and mainly related to the dimension of people. However, if we broaden the perspective to all stages of the food chain, from production to the recovery of surpluses or leftovers, there clearly emerges a potential space for the expansion of the concept of care from the primarily human-to-human relationship to the inclusion of the non-human world. The food system is, according to the authors, a paradigmatic sector in which to trigger change towards sustainability, leveraging both the definition of care as a guiding design principle and as an outcome of the design process itself (Meroni, 2012). To explore this area of work, two kinds of premises are needed: a preliminary reflection on the recent debate around care and a reference to the food system and related services as forms of social innovation.

For the purpose of this paper, with the term "care" we refer to the debate that defines care as a relational action of shared responsibility (Fisher and Tronto, 1991; de la Bellacasa 2017; Popke, 2006; Manzini, 2022). When care is considered a collective (not individual) and diffused process emerging from interactions and collaborations, it becomes a process of co-production (Manzini, 2022) involving a variety of subjects, mutually responsible to each other. These actors are all providers of competences, resources and knowledge as well as sharing the same potential attentive capacity which is at the basis of caring. This implies moving beyond the conception of care associated to a performative and delivering model, which envisages a relationship between a producer of care solutions and a person who expresses the need for them (the carer vs the cared for). In this sense the discourse is linked to both the idea of interdependency as well as to the one of caring communities (Krzywoszynska, 2019; de la Bellacasa, 2017; Care Collective, 2020). The first acknowledges that our survival is always contingent on 'others', and thus on the health of the ecosystem, understood as the vitality of interactions between its species and the environment. The second one builds on enabling relationships of care that include a wider and "flatter landscape of interconnections" beyond humans (Krzywoszynska, 2019), pointing to multiplying the potential and unusual subjects and forms of care. Moreover, it addresses a dimension of

proximity as trigger of such interconnections (Manzini, 2022). The Care Collective (2020) goes even further by defining care as promiscuous in its generation and deployment, assuming it to be extensive, diffused, indiscriminate, universal and inclusive. These ways of referring to care beyond conventional approaches can open a room for processes of change (Conradi, 2015) which, supported by emotional processes of awareness, belonging, hope and agency, can feed transformative imaginaries and practices. In Moriggi et al. (2020) everyday experiences and emotions are discussed as crucial determinants of decision-making and these emerge from, and drive practices of care. Indeed, "more radical, transformative change can be fostered via three mutually reinforcing dimensions: ethically informed practices; relational response-ability; and emotional awareness" (ibidem).

While the debate on linking sustainability and transformation to care is relatively recent, the scientific and grey literature on connecting the first two notions to the food system and social innovation are rich and extensive (Ardill, 2022; Vivero-Pol et. Al, 2018; European Commission, 2021). In the words of António Guterres, United Nations Secretary-General, food systems hold the power to achieve our shared vision for a better world (UN, 2021). "A food system includes all the elements (environment, people, inputs, processes, infrastructure, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food. It also encompasses the outputs of these activities, including their socio-economic and environmental impacts. Food systems are complex, adaptive, multi-actor, multi-level and multi-functional systems that exhibit non-linear dynamics such as trade-offs, synergies and feedback loops. They are shaped by economic, environmental, political, technological and social factors, including cultural norms and lifestyles" (European Environment Agency, 2002). The impact of food systems is recognized as responsible for a third of global greenhouse gas emissions (Crippa et al., 2021) and addressed with strategies aiming at (e.g.: Farm to Fork European strategy) creating a sustainable system "that safeguards food security and protects people and the natural world" (ibidem). Being food so central to the personal and community values, social innovations are spreading within this sector as seeds of change, prototyping innovative partnership, forming new alliances and experimenting with different ways of producing, trading and consuming food. They testify the ambition to enable radical as well as aspirational shifts in lifestyles towards sustainability, and thus there's an evident need of accelerating their growth, replicability and scaling up, out and deep. This is manifested by European and local policies, research projects and funding schemes, aiming on the one side to understand how to reinforce social innovation capacity to work efficiently and impact, and on the other side to monitor and evaluate their outcomes (AAVV, 2015). Design for social innovation, defined as designer capabilities and knowledge to support cases of social innovation, can contribute to make these initiatives more visible by helping to design, in a collaboration with users and stakeholders, their products, services, and communication strategies, through a set of approaches, sensibilities, and tools that are transverse and range from product to service design, from communication to interaction and strategic design (Manzini, 2015). The design discipline can also play a role in establishing processes to recognize the seeds of social innovation in society and work to incubate them while empowering prospective social innovators and communities (Meroni, 2019; Meroni et al., 2017).

A case study

Over the last decade the city of Milan has witnesses a renewed attention for the food system as a way to experiment innovative service models and social innovation policies, as well as to feed new transformative scenarios for the city, citizens and the agricultural surrounding.

The role played by Expo 2015 "Feeding the Planet Energy for Life" has undoubtedly contributed to accelerate the birth and growth of programs and initiatives that were already emerging from local organizations, the academic and the private sector and, more important, has transformed and expanded the concept of food system into a system for sustainable development, evolution and care. The Milan Urban Food Policy Pact, launched by the Milan Municipality in 2015 is an international agreement committing cities "to develop sustainable food systems that are inclusive, resilient, safe and diverse, that provide healthy and affordable food to all people in a human rights-based framework, that minimize waste and conserve biodiversity while adapting to and mitigating impacts of climate change" (www.milanurbanfoodpolicypact.org). On the basis of such agreement, the city of Milan has adopted a local Food Policy [1] which created the conditions for additional activities to be prototyped on the topics of managing food waste and surplus (*Local Food Waste Hub*), establishing local food chains for food procurement (Local supply chains for canteens), opening hubs for biodiversity and sustainable production and distribution (Cascina Nosedo, Hearth Market), activating inclusive and accessible food practices (*Spesa Sospesa, Recup*, food donations). This renaissance goes beyond the food sector and pervades the city thanks to a series of public policies and private projects on social innovation contributing to shape its identity of vibrant, restless, city and to expand its capacity for experimentation and innovation (Clark et al, 2018). Within such context, the program presented in this paper is a 4-year social innovation policy from the Municipality of Milan, with the goal of giving shape to a process of emersion, scouting, support and growth able to benefit fragile outskirts of the city and to empower citizens in taking action and make thing happen (Corubolo and Meroni, 2015).

The School of Neighborhoods

The School of Neighborhoods (2018-23) is a program initiated by the Municipality of Milan (co-funded by the European Union - European Social Fund, as part of the Metropolitan Cities Operational Program 2014-2020) to stimulate and enable social innovation in some disadvantaged areas of the city. The rationale of the School is to create a safe environment for education, experimentation and incubation of ideas proposed by citizens. With a low entrance barrier (an innovative and useful intuition responding to local needs is enough) people are encouraged to propose solutions able to improve the quality of life in the neighborhood. Aim of the program is to attract or make emerge ideas consistent with the strategy of the Municipality for the future of the city and desirable for creating public value: e.g. new models of aggregation,

1 https://foodpolicymilano.org/

food-related services, alternative forms of care and accessible and inclusive cultural initiatives.

The program was organized into 3 main cycles of scouting and incubation, impacting different areas of the city in the outskirts. Each cycle was slightly different from the previous one (also because of the outbreak of the CoVid Pandemic), lasted about one year and comprised 3 phases. The first phase consists of scouting and takes a form of *cultural-empowerment*: a free and open program of designed encounters to let needs and opportunities expressed by the neighborhoods meet prospective social innovators. The third phase of prototyping and accelerating solutions is a form of *technical-empowerment* (Meroni et al., 2017), providing personalized support and a project grant to co-finance the first year of activity. The second phase, which consists in an 'Advanced training' is in-between: on the one side, it is about supporting people to tackle challenges and invent innovative responses, on the other it deals with design solutions and developing entrepreneurial skills. An additional cycle of the program was launched in 2022, expanding its reach to the entire city and focusing on supporting the projects in the prototyping phase.

During these 4 years, the School of Neighborhoods was able to attract more than 200 proposals from citizens, and to support and fund 56 of them with a grant up to 30.000 euros each. Politecnico di Milano's Polimi Desis Lab, a research group focused on design for social innovation and sustainability, is involved in program design, delivery of training and incubation formats, and monitoring and analysis of solution scalability trajectories, conducted through field observations, reports and data, coaching sessions, and 1to1 interviews. Building on this knowledge, the authors selected 7 case studies that contribute to build a preliminary conceptual interpretation of the relationship between food (and related services) with the notion of care.

Caring for: expanding the concept through food related social innovations.

In the following paragraphs we will present the cases, describe how they contribute to expanding the concept of care, and how design can reinforce food-related services as tools of care.

Caring for diversity and inclusion

A first cluster moves from the willingness of leveraging food to established connections and links between cultures, to design inclusive and participatory processes of learning and exchange, and to impact on the beneficiaries by involving them in the production of food.

Forno Condiviso aims at strengthening "a community around bread". Through a pop-up, nomadic format of baking together, the solution is envisioned both 'as a school for those who want to learn and a workshop for those who want to experiment' (Forno condiviso, 2021). Partnering with neighborhood kitchens and proposing recipes from cultures represented in the neighborhood, it prototypes a place for learning and building trust and empathy across different backgrounds.

Moving from the same values of diversity and inclusivity, Co-cooking Lab proposes ethnic and circular workshops where "Co-Cookers" (non-professional cooks from immigration backgrounds) teach a class of "Co-Labers" how to prepare typical dishes from their own country, using food surpluses from local markets and sharing the meals during convivial dinners.

These two cases bridge the cultural and convivial dimension of food with a process of care for fragile communities, by involvement, empowerment and upskilling of their members, by creating services and places of learning and practice based on multiculturalism, trust and empathy, and by linking them to nearby enterprises.

Caring for the neighborhood

A second cluster gathers solutions that propose a form of care towards the neighborhood, mainly through service models that activate local production chains and transform food into new products to be distributed through multifunctional spaces and informal networks.

This is the case of *Ibrida*: a community beer that gives a second life to unsold bread recovered from neighborhood bakeries. It is produced in collaboration with marginal areas of the city, to support local entrepreneurship and promote short supply chains. By envisioning itself as an encounter between local breweries, bakeries, and urban gardens, *Ibrida* supports community building: stakeholders act in a double role of promoters and beneficiaries of connections, thus strengthening community's identity, sense of belonging and ability to contribute to its wealth.

Also based on the scale of the neighborhood, *Labciocojob* is a multifunctional place that aims to mix a coworking space with a chocolate workshop, so to "combine the idea of work with that of taste and the pleasure of being together." Its ambition is to support the social activities of the residents of the neighborhood, becoming a place where citizens' needs find attention through access to a welcoming and supportive space, a network of skills and likeminded actors.

In both cases, food is understood as a trigger for establishing and weaving unusual ties within the neighborhood (bakers and brewers, chocolate makers, co-workers, and citizens), which is manifested through spaces, products, and services offered to the community. Food is thus a means of caring for the vulnerable ties of a community, its social and economic fabric, and activates collaborations that can strengthen it from within.

Caring for the environment

A third cluster is related to the environment, gathering cases that promote participatory projects for the renewal of urban spaces with productive and non-productive vocations, the reduction of the use of materials and the disintermediation between producers and consumers.

Ortaja aims at becoming the neighborhood reference point for sustainable initiatives linked to the world of food, agriculture and environmental protection. By disintermediating and making the purchase of sustainable goods more accessible and distributed, by activating projects of urban farming, renovation and cleaning of urban spaces, and by proposing courses, festivals, and cultural initiatives, *Ortaja* has the ambition of stimulating inhabitants to become active players in the rebirth of their neighborhood.

Localized in the biggest peri-urban park of the city, *Fermenta* works on the protection of biodiversity through the participative and collaborative production of fermented beverages. By opening a reflection on the relationship between food, well-being and the environment, the project aims to raise awareness of the impact of food production on ecosystems and climate change, as well as the health consequences. Thus,

the production of fermented flavored beverages is a driver of the relationship between communities and their territories, preserving them and redirecting them toward the production of collective well-being.

These two services are thought as integrated ecosystems offering viable alternatives to the mainstream food systems: they are not individual but community actions of care towards the environment, its biodiversity, and its capacity of regeneration. To recognize the interdependence between humans and the environment is to recognize a dialectical relationship in which the environment shapes humans as much as humans shape the environment (Booth, 2013).

Caring for the quality of work

A final cluster focuses on supporting actors in the entire food supply chain for socio-environmental regeneration through forms of work that respect people, communities, and lands.

Soulfood Forestfarms works on regenerative agroforestry for ecological and cultural transition, enabling it by actively involving private players, entrepreneurs, and farmers as well as citizens as coproducers of food. Advanced educational and experimental formats dedicated to professional farmers are combined with companies' sustainability strategies and with cultural initiatives of citizens' involvement. To give sustainability to agro-ecogical production systems, *Soulfood farm* aims at activating a new socio-economic-cultural paradigm in which consumption chains are defined designed with local communities, and consumers become protagonists of territorial regeneration in support and integration to the agricultural organizations. Culturally based urban regeneration practices are indeed those who follow a co-creation approach in their design and development, thus exploring the feasibility of an effective transition towards a more sustainable food system. For creating innovative agricultural ventures based on a solid ecological infrastructure, this practice points outs that is necessary to support the redesign of food products and services while maintaining production capacity and enhancing the existing resources.

Discussion

The clusters are a first attempt to define how food (and related services) can expand the notion of care beyond the conventional delivering model, by placing this concept at the center of the design process, these cases reinforce their objective of pursuing and proposing alternative and more sustainable ways of living. Although placed in one group, each practice overlaps with all, reflecting the fact that all these social innovations take on care as a broader notion, which may emerge in one predominant element (e.g., caring for the environment) in the pursuit of which it simultaneously activates other forms of care (toward diversity, community, etc.), thus reinforcing the idea that care must be understood as an integrated and systemic process. More specifically, it is possible to recognize common logics that allow care to be amplified. These logics can in turn be supported and sustained by the discipline of design:

- *a systemic logic*: many practices, while starting from a specific need or on a particular sector, seek to consider the complex system of relationships and dependencies from which health and wellbeing derive. They also seek to leverage dependencies and emotional bonds to regenerate these interrelations, becoming seeds for processes of care and just transition. In this case design, bringing a system perspective and using methodologies that allow for the consideration of multiple perspectives, objectives and impacts, allows to address multifaceted challenges as those of the case studies.
- *a collaborative and inclusive logic*: almost all the case presented are services that imply an active collaboration of the actors involved and shared responsibility: transforming consumers into partners and co-producers, opening up to codesign, activating participatory and collaborative service models. Design, giving shape to these interactions (in time, roles, and space), makes it possible to conceive care as a viable, and effective co-production process. Furthermore, a codesign approach allows for more inclusive solutions to be imagined, addressing the perspectives of diverse and often overlooked stakeholder groups.
- *a resilient and adaptative logic*: design can support social innovators in shaping solutions adaptable and resilient to change, by using a human-centered design approach, incorporating principles of systems thinking and service design, and designing for modularity and scalability. Additionally, design educates to adopt a continuous prototyping mode: ideas are rapidly tested, monitored and improved. This helps create solutions that provide benefits over time and that adapt to changing circumstances without losing the capacity of producing public value.

When it comes to designing food systems that aim to make a difference in sustainability, initiate processes of change *from farm to fork*, and achieve social impact, adopting a perspective of care can help frame the contribution that design can make. As we have argued, curation can be enabled by the combination of different design logics (emotional and rational, personal and collective, collaborative and systemic) in a co-design dialogue with innovators who can work to address various needs where food can be a component of broader solutions and service offerings.

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Designing with posthuman kinship. Outlining new human-non human collaborative design approaches

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Abstract

Technology has increasingly become embedded in everyday activities, an extension of the human body, identity, and abilities. Our relationship with technology is becoming more symbiotic, leading us to establish new intimate and affective relationships. Following feminist philosopher Donna Haraway's concept of *making kin* (Haraway, 2016) with human and non-human creatures to 'rebuild' the world, the first part of the paper investigates the development of *kinship* between humans and technological artefacts, and how these relationships can become a key element for a posthuman approach to design, identifying posthuman entities and their network of interactions. Specifically, it reviews literature from Science and Technology Studies (STS), Multi-species ethnography, and Haraway's works. These theories and theoretical models underpin new methodologies and practices in the field of design that are breaking out of the boundaries delineated by the human-centred design (HCD) perspective and are expanding the interest of design beyond humans, addressing the non-human entity as part of a complex network of actors that dialogue, co-evolve, and co-operate in the evolution of the social order and the world.

These transformations are challenging designers to question the centrality of humans (and of designers themselves) in the design methods, structures, and models, as well as focusing on how new artefacts will interact and relate with humans, the environment, and other non-humans. The second part explores the potential contribution of a posthuman-centred design approach in developing human-non-human collaboration with a focus on care environments, considered a frontier. The analysis of two exemplary cases in the evolving context of care practices identify the entanglements with assistive devices, the emergence of the hybrid combination of human-technology in the care settings, their engagement with the environment, and the consequences of this increased permeability of technologies in everyday life. Finally, by mapping the values of a design practice involving non-humans, the paper considers how *posthuman kinship* could be drawn upon to contribute to both design research and development of technological artefacts within healthcare and care practices, stimulating posthuman design-driven forms of social and technological innovation.

Author keywords

Posthuman Design; Posthuman kinship; Human-technology interaction; Healthcare practice; Assistive technology.

Introduction

This paper merges sociological theories with design practices influenced by posthuman theories investigating the emerging phenomenon of posthuman kinship (or more-than-human kinship) trying to answer three research questions: Why are posthuman kinships relevant to design? How does design change when we consider posthuman kinship? How can these relational dynamics and capabilities of non-humans be considered when designing future technological artefacts? The paper aims to contribute to developing a collaborative design methodology in which posthuman kinship represents an evolutionary step to be considered in designing technological artefacts and interactions between humans and artefacts.

Emerging forms of kinship between humans and technological artefacts

Over recent years, an increase in academic interest has been seen in the social interactions between humans and non-humans, particularly in sociological analysis on human attitude towards technological artefacts. Our relationship with technology, now symbiotic and constitutive of everyday life itself is changing, leading to the creation of more 'intimate' relationships on an emotional level. Through advances in robotics, artificial intelligence, and *affective computing* (Picard, 1997), new forms of interactions and relations with technological artefacts are developing. The key element in the discussion of the role of non-human agents in the creation of social relations is *agency*, the socio-culturally mediated "capacity to act in a way that is not entirely attributable to the inputs of one's action." (Volonté, 2017, p. 38).

The capacities that are perceived in non-humans with agency are manifold. Nass revisited social psychology experiments that analysed person-to-person responses in social interaction, replacing two human subjects with a human and a non-human (Nass et al., 1995, 1996, 1999; Nass & Moon, 2000, as cited in Cerulo, 2009). The results show that the communicative capabilities evolution of technological artefacts led to a change in their perception, evoking a sense of intersubjectivity and encouraging a social response (Reeves & Nass, 1996; Nass & Brave, 2005; as cited in Cerulo, 2009). Turkle reported similar results in her studies of the interaction between humans and robots. Experiments between 'smart' robots – capable of recognising their owners, obeying commands, and adapting their personality – and elderly people suffering from dementia led to an improvement in emotional states, reducing anxiety and favouring the feeling of companionship (Turkle et al., 2006; Turkle, 2007; as cited in Cerulo, 2009). Children, on the other hand, perceived robots and related to them as autonomous and almost living beings (Turkle et al., 2005; as cited in Cerulo, 2009), while recognising they were not actually alive.

The above investigations show the human/non-human interaction from the human's perspective, in which people endow objects with social capabilities. Theoretical ideas and empirical studies from HRI (human-robot interaction), on the other hand, focus on the robot capabilities and skills which allow them to be recognized as social actors in interaction. Breazeal maps several attributes of social robots – robots that are able to "conveying intention in a human-perceptible way, and are empowered to resolve goals with fellow agents, be they human or robot" (Daily et al., 2017, p. 217). Moreover, eight classes of robots based on their *social-ability* are identified (See Breazeal, 2002, 2003; Fong et al., 2003). Therefore, technology is co-protagonist and *actant* (Latour, 1992) in the definition of society and in the way people interact and relate with other entities due to its inscribed social characteristics.

The co-evolutionary dimension of technology and society (Figure 1), opens reflections on the posthumanist movement, which stems from the need to redefine the concept of the human, determined by the onto-epistemological, scientific, and biotechnological developments of the twentieth and twenty-first centuries (Ferrando, 2013). Posthumanism can be defined as post-dualism, unhinging the Western exclusivist and binary vision, which places two elements in conflictual opposition, favouring an inclusive and pluralist dimension that integrates the human and the non-human. Haraway (2016) proposes a new posthuman geological epoch, the *Chthulucene*, to overcome the Anthropocene, in which humanity, which considers itself superior to any other form of life or matter, has irreparably compromised its relationship with the world. The main purpose is *making kin*, to create relationships with other creatures to 'rebuild' the Earth. These new forms of kinship, which cross species, environments, biological, and social relationships result in the creation of assemblages of more-than-human entities. Making kin is to be pursued by cultivating *response-ability* (Haraway, 2016, p.28), the ability to care for others, where *care* includes "*everything that we do* to maintain, continue and repair 'our world' so that we can live in it as well as possible. That world includes our bodies, our selves, and our environment, *all of which we seek to interweave in a complex, life-sustaining web*" (Tronto, 1993; as cited in Puig de la Bellacasa, 2017, p.3, emphasis added by Puig de la Bellacasa).

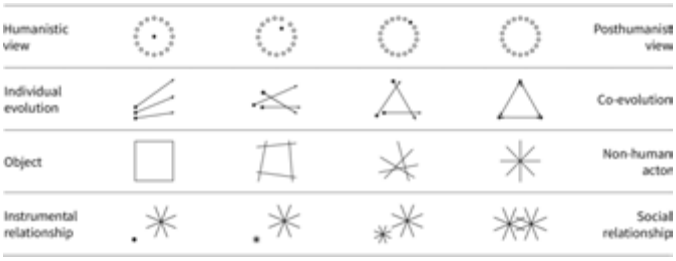

Figure 1. The key concepts for shifting from a humanist to a posthumanist perspective.

The new role of care-giver, confidant, and collector of intimate and personal life, previously reserved exclusively for other people, allows technology to replace, build or augment personal bonds with humans, which will be defined, borrowing Haraway's concept, as *posthuman kinship*. Kinship is therefore an exchange, a desire for human and non-human self-revelation; it is care because it is not an exploitative but an affective relationship; it is adoption, because the human has a lack, which can be somehow filled by adopting a technology, creating a bond; it is affiliation, thanks to the technological artefact the human being becomes part of a posthuman network. The emergence of this phenomenon opens up new challenges that can stimulate designers to focus their attention on the evolution of these complex socio-technical systems, transitioning from a human-centric towards a post-human, inclusive and collaborative perspective. The type of relationship and the emotional responses vary according to the context and the characteristics of the technological objects and will become fundamental elements in the design of new artefacts, particularly from an ethical, political, and moral point of view. It will be increasingly important to understand what the consequences will be – intended and unintended – of this increasing permeability of technologies and of the effects of these relationships in everyday life.

The concept of posthuman kinship and the implications for design

The advent of a posthuman society, based on emerging kinship systems between humans, technologies, and the environment, can stimulate the evolution of design-driven forms of innovation, as it is characterised by the connection of human and non-human design agencies. Posthuman kinship thus becomes a relevant element for posthuman design because it identifies all more-than-human entities and their networks of relationships. Only by considering the plurality of all entities, their language, and relationships, it becomes possible to design for a posthuman world. Design has the operational power to transform tensions in society into innovations and is therefore considered as one of the most suitable tools to facilitate a transition towards a posthuman, inclusive and pluralistic perspective. Posthuman design is capable of connecting and co-operating human and non-human entities in innovation processes. Alongside Human-centred design (HCD), in which the human is at the centre of the design activity, new visions are being developed, expanding the field of interest of design beyond human-centredness. Currently, there is not a codified more-than-human design practice like the HCD standard (ISO 9241-210:2019). This may be because considering the posthuman as integrated and central in design is still an emerging practice, or perhaps because the quantity and heterogeneity of these new entities do not allow

the definition of a single or unified methodology. At the present time, given the emergence of the phenomenon, it is interesting to map and study exemplary cases of projects and design experiences in which a kinship-like evolution of the relationship between human and technology is evidenced and in which themes and issues pertaining to the transformation of participatory and collaborative design approaches and processes in a posthuman perspective are identified. Forlano (2017) traces emergent discussions relevant for the development of a posthuman approach to design crossing from ANT, object-oriented ontology, transhumanism, and multispecies ethnography, and proposes practices that, while not identified explicitly as posthuman design, focus their attention on the interrelations between humans and non-humans.

A posthuman design methodology defined *Xenodesign*, implemented by Johanna Schmeer (2021), proposes transversal engagement approaches for including multi-entity non-human agency in design, merging discursive design methods with speculative realism and ethnographic practices. The combination of traditional ethnographic methods with design practices is also at the foundation of Anne Galloway's *More-than-human design approach* (Galloway, 2013), as well as Elisa Giaccardi's research on things as co-ethnographers (Giaccardi et al., 2016). Ethnographic research, such as environmental observation and participant observation, becomes one of the main tools to investigate, empathise, and learn about non-humans, as well as expressing the point of view of the non-human, both actively and passively. Indeed, also in the field of ethnography, the re-discussion of human exceptionalism has begun, with the need to refound ontology, epistemology, and ethics in a posthuman perspective, also reasoning about the development of new methods to analyse reality with the aim of highlighting how gender inequalities are produced, enacted, and materialised in complex systems (Hamilton & Taylor, 2017; Taylor & Fairchild, 2020).

One example is *Thing Tank* (2016), an IoT research project developed by Giaccardi et al. in which a kettle, a refrigerator, and a mug were connected to autographers (small cameras with sensors), which provided information on the use patterns, the relationships between the three smart objects and other co-inhabitants, and their trajectories and movements in space and time. The concept of co-inhibition is at the heart of the *Mitigation of Shock* project, first presented in 2016, by Superflux. In this installation, set in a London flat in the year 2050, a station for growing food occupies the space previously designated for relaxation. People thus find themselves reflecting on the need to share space and establish relationships with other living species and non-human entities, all co-inhabiting the same flat. A different approach on the relationship between living entities, designers, and technology, is proposed by Neri Oxman. Using computational design, synthetic biology, and digital fabrication, Oxman designs products through the method of *form-finding*, overturning the traditional conception of design in which the material is considered secondary to form. The structures, now organic, are no longer limited by the assembly of parts of 'dead' materials with defined properties, but grow and adapt to their environment, just like living beings. Manufacturing is no longer a method of production, but takes on a generative value (Oxman, 2011).

In the above examples approaches and projects, speculative design occupies a pivotal role, for several reasons. Speculative design is future-oriented and exploration-oriented, and lends itself to designing for the consequences, not necessarily positive or negative, but merely alternative, of scientific, technological, social, and cultural innovations. This discipline, therefore, does not follow human-centred practices based on needs and problem-solving, because its main purpose is *problem-finding*. The creation of scenarios, through storytelling, diegetic prototypes, and other media, allow projects to be placed in an application context that promotes understanding and create a direct link with the environment in which the ethnographic research took place. Ethnographic analysis cannot be carried out in an aseptic environment, and consequently the resulting projects are also deeply integrated. Another element to consider is that even projects dedicated entirely to non-humans presuppose a fundamental human component, given by designers who interact and design for non-human entities. Likewise, non-humans are not only those at the centre of the design interest and to whom the design outcome is addressed, but also have the role of co-participants and co-designers.

Exemplary cases of posthuman kinship in care practice

Moving from theory to practice, we can observe that the theme of posthuman kinship is present in the experimental projects and in the personal-professional experiences of designers but is not yet consciously focused on at the design level, again. This new intimate dimension becomes particularly relevant in healthcare environments such as nursing, care, therapy, rehabilitation, and *ageing in place* – "the ability to live in one's home and community safely, independently and comfortably, regardless of age, income or skill level" (Kim et al., 2017; in Mois & Beer, 2020). Recent technological, demographic (e.g., ageing population), and social developments, as well as the pandemic, have placed the healthcare sector in a leading position for the innovation, enhancement, and adoption of new technologies (Capone, 2022) – e.g., genomics, nanotechnologies, AI, digital health, robotics, and wearable devices. Moreover, innovations in public health through services of telehealth and remote patient monitoring are leading to combined and personalised data-driven care delivery models – inpatient, community, and home-based care –, with predictive analytics to support wellbeing, prevention, and the overall patient experience. While these are not the exclusive fields in which the relationships unravel, these contexts address aspects and feelings of the human being such as loneliness, illness, boredom, and the strive for affection, consideration, and care. People (or patients) profoundly rely on technologies, and, on the other hand, technological artefacts operate in close relation with the human subject, allowing the redistribution of emotional power between them.

Certainly, one of the most iconic examples is that of care robot PARO, a zoomorphic companion robot developed by Takanori Shibata, who actively engage humans' emotions and encourage patients to carry out interactions with it as they would with other humans, while also having a positive psychological and physiological effect: it improves the relaxation of people with dementia, reducing aggressive behaviour, and mediating the interaction with other patients and with the caregivers. AI controls its behaviour according to touch and sound stimuli; it learns to react to the voices it frequently interacts with; moreover, it shows emotions of surprise, happiness, and anger, and cries when it does not re-

ceive enough attention. But PARO's strength is its innocent and pure appearance, with white fur and large, deeply human eyes, which aim to trigger an emotional reaction of affection and parental instincts. Turkle argues that robots like PARO provide the illusion of a relationship. People who have difficulty sustaining human relationships turn to companion robots, replacing and sometimes denigrating more socially demanding interpersonal connections with simpler, more stable ones (Turkle, 2011). On the other hand, humans are inherently social beings. The emotional relationship between humans and technology is unidirectional, as there is still no technology that can match human emotions. However, the behaviour of technology towards humans is not static, but generates a significant emotional response in humans (See also Breazeal, 2001, Breazeal et al., 2016, Esposito et al., 2016, Feil-Seifer & Matarić, 2011, van Maris et al., 2020; on the interaction between children with autism and robots see e.g., Billard et al., 2007, Dautenhahn & Werry, 2000, Golestan et al., 2017; on elderly and robots, see e.g., Fraune et al., 2022, Lee et al., 2006, Pirni et al., 2021).

PARO and other socially assistive technologies, as well as social robots designed for entertainment (an example is Sony's pet robot Aibo), already have an inscribed social interaction component. They have been developed to assist the human with general or specific needs such as learning, training, rehabilitation, or daily activities either at home or in care facilities, but also to provide intellectual, social, and emotional care (Mois & Beer, 2020). However, the development of a symbiotic and intimate relationship between humans and technologies also occurs with technological artefacts that were not specifically designed to have a social interaction. This is the case of embedded devices, grafted into and onto the body, and mainly used in the medical field for people with impaired bodily functions. These devices have a tangible physicality, and the body is no longer composed only of organic elements, but becomes a virtual body, due to the interaction of both genetic and technological information codes, with the skin as interface. Therefore, pacemakers, cochlear implants, diabetes' insulin pumps and monitoring systems, among others, are also to consider for the development of a new emotional, but also physical relationship with the human, and together, they navigate the environment and interact with other entities (humans or technological) as a configuration human/machine. The grafting leads to a co-evolution of both parts into a new combination, a biological and long-term, or even life-long, interaction, often indispensable for the survival or improved health of the person. But this new reality is not always accepted, especially if related to a chronic illness, and rather than working symbiotically, this system could cause, like any relationship, *friction* (Forlano, 2022).

In *Hacking the Feminist Disabled Body* (2016), through an autoethnographic research – "an autobiographical genre of academic writing that draws on... the lived experience of the author and connects researcher insights to larger social, cultural, and political issues" (Poulos, 2021, p. 4) – Forlano outlines the tensions she encounters daily after *adopting* different medical devices for the management of Type 1 diabetes, highlighting the ways she disobeys them and vice versa, how they negotiate and collaborate, and the small invisible labour, "repairing, maintaining, fixing, adjusting and troubleshooting" (p. 7), they require. Despite the increasing attention on the development and improvement of medical technologies, companies' focus is techno-centric, on the transmission, measurement, and display of accurate data, rather than on the daily experience (Forlano, 2016), which translates in small hacking and medical disobedience acts. Acknowledging the pivotal role of technological devices in participating and negotiating the world, Forlano promotes a shift in the human-centred design perspective towards the "embodied practices and lived experience of everyday routines, habits and rituals through participation in socio-technical systems" (para. 9), considering the human/technology relationship as a hybrid stakeholder.

Conclusions

The analysis of kinship between humans and non-humans can play an increasingly central role in the design of technological artefacts. Therefore, the first task of the designer is to create awareness and critical consciousness towards this approach, which is already happening, informed by the communicative, interactive, and emotional capabilities of technology. Moreover, the fact that humans super-value the interactive and emotional capabilities of existing technological artefact indicates that future, more sophisticated technologies will be even more emotionally charged. The type of interaction and kinship that is created will vary depending on the capabilities of the non-humans, the condition and feelings of humans, and how humans and non-humans interact. It is important to analyse these elements considering not only the current level of interaction with technology, but also foreseeing possible future developments, in which technology will be increasingly symbiotic and less separable – physically, intellectually, and emotionally – from humans. Furthermore, knowing the new ways of interaction and kinship, not only from a design perspective but also, and above all, from an ethical and moral point of view, offers new insights, design opportunities, and questions that designers are called upon to anticipate and answer. This paper, through the analysis of the abovementioned examples, shows the position of designers who study posthumanism in various ways. Even if there is no explicit reference to the theme of posthuman kinship in their ideas, elements of reflection emerge that can be traced back to the evolution of the relationship with technological artefacts in the following ways:

- the importance, at the design level, of considering both the human perspective on how people interact with technological objects, as well as the sociological study on how these objects actively interact with humans, other entities, and the environment. Questioning existing relationships between designers, end-users, and technologies, leads to the need to redefine the activities of designing relationships of use of technological artefacts, overcoming HCD approaches;
- the importance, at the design level, of analysing and understanding how the interaction between individuals and technological objects occurs and is modified in spatiotemporal contexts. That is, how individuals and technologies act together in a context by modifying, changing, and co-evolving it over time. Posthuman kinship is fluid and changeable, and has its own temporal and spatial development;
- the importance, at the design level, to understand posthuman design as a form of responsible design, which aims to consider the social contexts where

technologies will act and, above all, the values, needs, and requirements of all posthuman entities not in terms of technological solutionism but in generative and collaborative terms;

» the importance, at the design level, to understand posthuman kinship as a way of defining posthuman networks, to which human and non-human entities belong. Technology could build different intimate, personal and daily relationships with each entity it interacts with, unravelling new posthuman familiar structures, in which each member has a role and establishes unique bonds with the others. The theme of 'familiarity' in posthuman kinship can be declined in two ways. First, it refers to the trust established between humans and non-human entities, considering the inherent power dynamics that exist between them. Second, it considers the possible hereditary character and content of this relationship, which evolves and is passed down over time;

» a reflection on the evolution of the concept of inclusiveness in the field of design. In posthuman design, an increased focus on the diversity of the users involved is inevitable. In addition to considering the variation in capabilities, needs, and aspirations of users, inclusive design is confronted with overcoming the diversity (and distinction/separation) between human and non-human entities. Each entity, with its own needs, relationships, modes of interaction, and roles is considered during each design phase;

» finally, the recognition and realisation (by human designers) that posthuman designers are a recognised set of human and non-human entities that activate, research, operate, and participate in design processes. Posthuman design already expresses increasingly intense forms of symbiosis and collaboration between humans and non-humans due to the increasingly common and inseparable ability to deal not only with problem-solving, but with problem-setting and problem-finding. Fostering collaboration is the real challenge between technicians and design technologies, and post-human designers and projects.

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Beyond empathy: how curiosity promotes to greater care

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Abstract

Empathy is widely revered as an essential mindset among designers. While beneficial to design practice, empathy has its problems. Consider studies that show: (1) We easily confuse and conflate empathy, sympathy, and compassion. The differences between these capacities are critically important. (2) Empathic resonance in the brain is highly biased. We find it hard to empathize with people unlike ourselves. (3) Having too much empathy may also be problematic and can be weaponized by bad actors. (4) We feel empathy only for humans and some animals — not for objects, spaces, places, or our planet.

If we can empathize with humans and only in limited ways, perhaps designers could benefit from an assemblage of emotive capacities beyond just empathy. This paper will trace the "edges of empathy" and argue that designers should cultivate two additional emotive capacities that complement empathy: curiosity and care. Because care is a linguistic ancestor to the English word curiosity, the paper will briefly trace the etymological roots of curiosity. It will argue that care and curiosity are inextricable: developing one can foster the other. The paper concludes that, unlike empathy, care and curiosity broadly apply to people, objects, places, systems, and ecologies situated around that which we build.

Author keywords

Curiosity; empathy; interaction design; designing for care

Introduction

Empathy is widely revered as an essential mindset for design practice. For good reasons: Empathy helps us take the perspective of other people (Maibom, 2022), identify with them (Spaulding, 2019), understand their emotional states, and build rapport (Maibom, 2019). Philosophers propose it as the basis for morality (Kauppinen, 2019) and one way we can actualize care and concern (Zaki, 2020). Design practitioners and academics have placed increasing importance on empathy. Cross (1982) listed empathy as one of the values that distinguished design from the long-established cultures of the sciences and humanities. IDEO and the Stanford d.school helped popularize design thinking as a way for organizations to scale design practices, beginning with an empathize phase. Dave Gray's original (May, 2021) and updated Empathy Map (2017) provide a template to capture empathy in design research.

While valuable to design practice, empathy has its problems. Having empathy does not necessarily make us better people. Empathy is not necessarily bad, but neither is it all good. Empathy has come under scrutiny recently. Psychologists, cognitive scientists, and philosophers are re-examining its place as a singular force for only good.

Designers are too. Heylighen and Dong's academic article in *Design Studies* (2019) stressed the importance of recognizing the limits of knowing the experiences of others. Anthropologist and design researcher Sekai Farai (2020) addressed design practitioners in her User Experience Researchers Conference (UXRC) talk by saying, "I'm here to call bullshit on empathy in user experience with love," noting that "there is less empathy in user research today than there should be." Even renowned, influential design icons are questioning the limits of empathy. Donald Norman's *Why I Don't Believe in Empathetic Design* (2019) challenges the notion that empathy can make us think we can comprehend how others feel and what they think.

In this paper, we will define empathy and explain its importance. We will then identify sixteen "edges" or limitations of empathy that extend from the individual to those with similar characteristics, those with dissimilar characteristics, and society. We will investigate how these limitations can be enhanced by two additional emotive capacities: care and curiosity. In short, this paper will address the question: Is empathy enough?

What is Empathy?

Coined over 100 years ago by Edward B. Titchener, the term "empathy" is used to refer to a range of feelings and phenomena. It is worth noting that there is no consensus on the term's definition in psychology and neuroscience. Cuff et al. (2014) list 43 discrete definitions of empathy. This definition diversity is not necessarily a problem, but a mismatch between the way empathy is researched and the way it is being practiced may lead to overall confusion about its efficacy. All definitions of empathy confirm the idea that it is other-oriented. Designers colloquially use the phrase "stepping into another's shoes" to describe it. This paper uses Goleman and Ekman's definition of empathy (2008), which delineates three types of empathy. Other researchers have adopted the Goleman and Ekman triadic model, such as Zaki (2020), who uses similar terms, as shown in Table 1.

Table 1. Three kinds of empathy

Goleman and Ekman (2008)	Zaki (2020)	Definition
Cognitive empathy	Cognitive empathy	Identifying what others feel and what they might be thinking
Affective empathy	Emotional empathy	Physically feeling what others feel
Compassionate empathy	Empathic concern	Understanding the situation and feeling of others and are moved to assist

Other kinds of empathies outside of these three may exist. Literature on autism, for example, describe *motor empathy*, where we mirror facial expressions, body language or speech of another (Silvertant, 2018). Depending on the situation, our past experiences, how well we know the person we are directing our empathy towards, and other factors, our empathy can take on different forms. Cognitive empathy, affective empathy, compassionate empathy, or some combination of all three are possible. This makes empathy elastic, as our capacity to empathize can stretch to any of these components.

The Influence of Proximity to Self on Empathy

Empathy is widely accepted as the basis of morality and moral values (Hoffman, 2001). Peter Singer (1981) introduced the concept of the moral circle to explore differences in moral judgments. The moral circle has the self at its center, with progressively larger circles for family, tribe, etc. Graham et al. (2017) adapted Singer's circle to propose the concept of centripetal and centrifugal forces within this moral circle (Figure 1).

Centrifugal Force Empathy pushes attention and concern away from the self. Centrifugal forces (centrum + fugio = "center-fleeing") push from the center of the moral circle (family, community) to the outermost circles (all humans, all living things). Graham et al. describe this force as in conflict with another powerful force in the moral circle, a centripetal (centrum + petere = "center-seeking") pulling inward to the concern of family and self.

We adapt Graham et al.'s forces on Singer's circle (Figure 2), simplifying their effects into four main categories: the self at the center, people familiar or similar to us (our in-group), others (out-group), and society. These concentric circles influence how we respond to the people we design for and with.

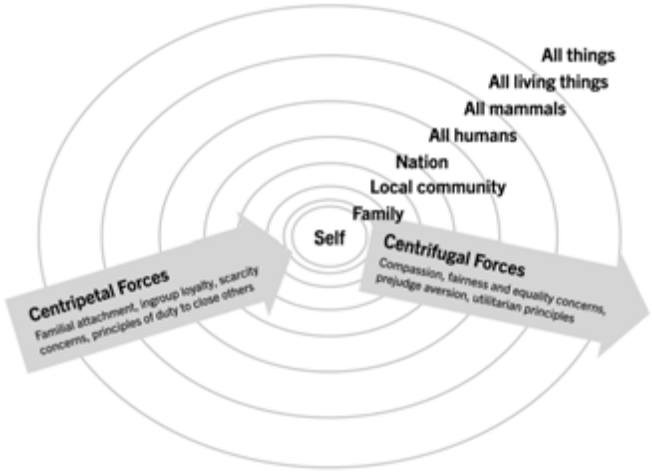

Figure 1. Graham et al.'s (2017) notion of centripetal and centrifugal forces in the moral circle

Figure 2. Sixteen limitations of empathy

We categorize these sixteen limitations of empathy into four categories. If mapped, they would form the boundaries of the empathy territory. This is not an exhaustive list and some items may fit into multiple categories. Many are situation dependent. Some limitations have a disproportionate impact, depending on the individual, situation, or context. How each limitation manifests is determined by the designer, as well as the processes and collective design decisions made. Where possible, attention is given to how each limitation is relevant to designers. More research is needed to better understand the effects and externalities of these limitations in design practice.

Limitations of Empathy Concerning the Self

Zaki (2020) argues that, rather than being an immutable and unchanging trait, empathy is a skill that can be improved over time. Empathy can thus be conceived of as a capacity, something that can be filled, expanded, or diminished. The following six items are a function of the designer's emotive capacity.

1.1 Empathy is often confused with other emotions. It can be challenging to define what empathy entails. The popularization of design thinking methods has caused empathy to become more elastic, taking on connotations and meanings beyond its scope. Designer Jason Mesut has created a map (2018) of concepts that are often mistaken for empathy, such as sympathy, pity, compassion, and ignorance. This map is a tool to explore which emotion should be expressed to whom (users, colleagues, stakeholders, the wider system). Mesut also points out that designers focus on empathizing with users while neglecting other actors and stakeholders. One could argue that this confusion has little effect, if a general effort is made to understand the emotions of others. However, it is important to note that understanding the feelings of others (sympathy) is quite different from being aware but detached from another's thoughts and feelings (pity) and leads to different understandings and insights.

1.2 Empathy can have negative consequences for those who experience it, such as burnout. Maslach and Jackson (1981) defined *burnout* as a psychological syndrome involving physical depletion, feelings of helplessness, negative self-concept, and negative attitudes towards work, life, and others. The Maslach Burnout Inventory (MBI) is considered the "gold standard" for measuring burnout in empirical research (Bradham, 2008; Lee & Ashforth, 1990) and has been applied to settings beyond healthcare. Burnout can significantly reduce the quality of care in professional medical settings. Likewise, it may make designers less likely to show concern in certain situations. However, more academic research is needed into the relationship between empathy and burnout for design professionals.

1.3 Exercising empathy exposes us to manipulation. Breithaupt (2012) notes that in the legal system, empathy can cloud judgment and cause jury members to side not with the morally correct party but with the one more adept at eliciting empathy. Similarly, designers who are not knowledgeable about the wider contexts of their products or services may be unaware of similar manipulative forces. Managers, stakeholders, consumers, or others involved in the design process may exert some form of manipulation through empathy. It is worth noting that designers may, conversely, use empathy to manipulate others.

1.4 We are unreliable narrators of our own situations. Norman (2019) strikes at the idea that empathy can lead us to believe that we are in another person's head and can understand how people feel and what they think. This is a fallacy: we often do not know or understand what we are feeling or why, let alone what those around us might be feeling. The narratives we create often portray our actions in a favorable light and can thus be inaccurate or incomplete.

1.5 Empathy can trap us in the emotions of others. According to Stern and Divecha (2017), when trying to understand the perspective of others, it is important to maintain a balance between our own emotions and those of the other person. Without this balance, we may feel like we are being held hostage by the emotions of others. They refer to this phenomenon as the "Empathy Trap", which works like a contagion, causing us to become overly invested in the feelings of others and neglecting our own. This is often seen in close personal relationships (such as between partners or spouses), but it can also occur in work relationships or during design research.

1.6 Recognizing the emotions of others may lead us to believe we understand when, we do not. This is one of the most dangerous limitations of empathy. Designers cannot be sure that they are feeling the same emotion as those with whom they empathize or that they understand or experience the emotion the same way. Even if designers correctly identify the emotions of others, they may not interpret the meaning, context, or implications accurately. Saying or thinking "I understand" too quickly can prevent further questioning in design research. Approaching the situation with the mindset of "I don't understand" or "I don't fully understand" can lead to a more thorough exploration.

Limitations of Empathy Concerning Similars

We tend to show the most empathy to those who are similar to us or familiar. This can lead to a series of biases that we may not be aware of on a conscious level.

2.1 The spotlight nature of empathy narrows, rather than widens, our view. Bloom (2016) describes empathy as a spotlight that allows us to focus on certain people in the present. This can be beneficial in fostering care for those under the spotlight, but it can also lead to insensitivity towards those outside of it. This myopic nature of empathy can have long-term consequences, such as designers neglecting certain types of user groups, stakeholders, or agents that are unlike themselves.

2.2 The snapshot effect of empathy locks people into a time and place. Bloom's spotlight only concerns the present moment. Brown and Kulik (1977) introduced the term "flashbulb memory," which describes highly vivid or salient moments that are "snapshotted" in time. This effect can be applied to how we experience people. Designers often create personas, journey maps, and other artifacts that snapshot individuals without also identifying ways that people will naturally change over time. Empathy has a limited lifespan.

2.3 Empathic reasoning is biased. We are not psychologically wired to feel the same way toward a stranger as we do toward someone we love (Scarry, 1998). We choose whom we want to show empathy toward, which reflects our biases. It is difficult for us to empathize with people who are very different from us. We tend to feel more empathy towards people who are attractive than those who are not. For those who disgust us, we generally feel no empathy at all. Designers may unconsciously select individuals who are similar to them to show empathy towards or implicitly extend empathy to those most like them. This phenomenon is more widely studied in the legal system than it is in design.

Limitations of Empathy Concerning Dissimilars

Empathy's weakest point is when it is extended to those too much unlike us. Because the products, services, and systems designers influence may have large or worldwide audiences (in the case of social media systems or applications), this can cause deleterious effects on users.

3.1 We are likely to take sides when observing conflict between two or more people. Unlike psychologists and counselors, who have received extensive training in remaining neutral and objective, most designers have not had this kind of training. Nevertheless, we often extend empathy to one side in a conflict to justify our own actions. Ethnographic research has demonstrated that taking a first-person-like perspective on other people's behavior is rarely seen as beneficial, as it can be prone to errors and can be used to both harm and help (Hollan, 2019).

3.2 Empathy can be filtered through mediators or helpers. Human beings often help each other in situations of need, and empathy is often cited as the likely motivator for this behavior (Brown, 2009). Breithaupt (2017) suggests an alternative explanation. Instead of direct empathy with the person in need, another mental act may motivate behavior: identification with the (real or imaginary) helper. Through identification (that is, seeing oneself as oneself in the situation of the other), the empathizer participates in the positive aura of the helper. Breithaupt refers to this form of empathy as filtered, which is indirect and mediated.

However, filtered empathy has its drawbacks. Additionally, when filtered empathy is used, the target of empathy only matters insofar as they fit the image of the filter. In the case of humanitarian aid, the target of empathy only matters as the victim, which can lead to a tendency to maintain or prolong the victim status.

3.3 Our imagination of those dissimilar to us is extremely limited. We have tremendous difficulty imagining and understanding the reasons and rationales behind the behaviors of those who are too dissimilar to us. Scarry (1998) argues that human imagination is relatively weak as a tool to offset our

immediate perceptions. We may instead rely on dangerous stereotypes or facile explanations without truly understanding individuals.

3.4 Empathy is often manifested differently between neurotypical and neurodiverse individuals. Milton's "double empathy problem" (2012) suggests that a mismatch between two people can lead to faulty communication. Milton argues that neurotypicals demonstrate empathy in ways that are distinct from those of neurodiverse individuals, such as those who identify on the autism spectrum. This disconnect can occur at many levels, from conversation styles to how people view the world. The greater the disconnect, the more difficulty the two will have interacting, leading to misunderstandings of reciprocity and mutuality.

For example, a study by Sheppard et al. (2016) reveals that non-autistic individuals struggle to accurately interpret the facial expressions of autistic people. Non-autistic individuals show difficulty in deciphering the mental states of those on the spectrum (Sasson, 2017). Empathy, as practiced by Design Thinking as popularized by IDEO, is generally presented as neurotypical.

Limitations of Empathy Concerning Society

4.1 Empathy tends to be human-centered. Gregory Currie (2011) makes the case that we may be able to empathize with objects, but his argument centers primarily around aesthetics, works of arts intended to elicit emotional response. We do not generally feel emotions for objects or mentally simulate emotions in our minds for human-made objects. For example, we do not, as a general rule, apologize to the chair before we sit in it.

Neither do we generally empathize with nature. We may be more likely to empathize with animals but in unequal ways. We have empathy for animals likely to be pets, such as dogs, cats, and birds. We have little to no empathy or concern for animals we consider nuisances, unwelcome predators, or spreaders of diseases.

In the Anthropocene, where human activity has a profound negative effect on the environment (Lewis & Maslin, 2015), empathy for the environment may make us more likely to consider the effects of collective human action upon it. Designers who create products do not often consider the effect of their products on the environment or understand how their creation may destabilize ecosystems.

4.2 In-group empathy can fuel division. While empathy creates connections with others, it can also fuel division. Bloom (2016) cites the Israel-Palestine conflict to show how individuals feel deeply about crimes done toward them or their families. Breithaupt (2018) notes that terrorists may feel such strong empathy for people in a conflict that they act violently against the other side.

Adam Smith's words, as cited by Bloom, are particularly poignant: "When we see one man oppressed or injured by another, the sympathy which we feel with the distress of the sufferer seems to serve only to animate our fellow-feeling with his resentment against the offender. We are rejoiced to see him attack his adversary in his turn, and are eager and ready to assist him." This encourages us to protect our in-group.

4.3 Empathy is culturally embedded. Empathy is a capacity that is shaped by and responsive to the cultural, moral, and political contexts in which it is embedded. Hollan (2019) points out that while recent ethnographic research suggests that many people around the world share concepts or terminology that may overlap with the Western notion of empathy, far fewer have ones that are identical to it. The vocabulary and conceptualization of empathic-like processes vary considerably through space and time. There seem to be many places in the world, for example in the Pacific region (Hollan & Throop, 2011a), where empathic-like sentiments shade much more closely, both semantically and behaviorally, to what English speakers would refer to as love, compassion, sympathy, concern, pity, or some hyphenated combination of these terms. In the eastern Indonesian society of Toraja, terms suggesting empathic-like awareness but translating more literally into English as "love-compassion-pity" often imply a strong sense of identification or merger with the subject of attention, such that one feels compelled to reach out and help, as if one had no other choice (Hollan, 2011).

The limitations of empathy identified above underscore the need for diverse design teams with varied backgrounds, ages, experiences, and perspectives.

Conclusion: The Case for Care and Curiosity

If we can empathize with only humans, and as demonstrated above, only in limited or biased ways, perhaps designers could benefit from an assemblage of emotive capacities beyond just empathy. Two of those emotive capacities are curiosity and care. Mayeroff (1971) defines caring as acting on empathy. Rodgers and Bremner (2016) identify care as an important part of the concept of the design discipline that points us toward larger contexts and concerns: "care refers to designing with the macro and micro social, technological, economic, environmental and political effects of design decision-making well in mind." Like empathy, care is other-centered but when used in design practice, care can attune us to the effects of design in the way we live.

Stepping into the shoes of others and understanding them requires an abiding curiosity about what life may be like outside of our own experiences. Voss (2013) describes curiosity as simply motivation to explore. Empathy can have the effect of shutting off question-asking. The explorative nature of curiosity opens us up to question-asking and necessitates further exploration.

The English word curiosity traces roots from Latin (*cūra*, meaning care, concern, or a means of healing) to early medieval Latin (*cūriōsus*, meaning full of care or pains, careful, assiduous) through Italian, French, and Middle English before entering our modern language ("Curiosity", n.d.). That curiosity is linguistically rooted in care has profound implications. It can be argued that demonstrating genuine curiosity toward someone is also a form of demonstrating that care. Both care and curiosity widen the circle of understanding in ways that empathy cannot. Empathy is primarily centered around humans (see Limitation 4.1 above). Wakkary (2021) argues for a rethinking of design that displaces humans at the center of thought and action.

Curiosity about the effects of what we design—not just to users, stakeholders, or other humans, but also to the environment, planet, and ecological systems—can also be a way of extending care beyond humans. Operationalizing curiosi-

ty in design requires designers to ask more questions, leave time to explore the answers, and engage more frequently in reflection. The cross-disciplinary, emerging field of curiosity studies, pioneered by Perry Zurn and Arjun Shankar (2020), may find contributions from designers valuable.

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Convention versus contemporaneity: the affordances of design-led mediation towards sustaining an ancestral cycle of linen making in Castelões, Portugal

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Abstract

This article discusses the emerging affordances of a research-led mediation process that is currently being developed in Castelões, a parish in the Viseu region of Central Portugal. The mediation, a part of an ongoing doctoral project in Design, focuses on creating a semantic framework for the resignification of the term "innovation", specifically in contexts of traditional making. Its objective is not to break with the past, but to extend its interpretation as a leverage for generating contemporarily relevant value and meaning – in this case, in and with vulnerable communities of practice.

The practice, popularly referred to as a "from seed to towel" production cycle is an ancient tradition kept alive in Castelões, which covers more than twenty manual stages of linen-making – from planting flax seeds to weaving fabric on handlooms. A distinguishing feature here is that unlike in other linen making cultures, the practitioners of Castelões are typically cognizant of, and adept in, each stage of the production cycle. This specialized knowhow is unique and has been passed through generations of predominantly women practitioners. Linen production once prevailed throughout the Portuguese territory, especially in the northern and central regions, however, in recent years, it has drastically declined due to a variety of unmitigated local and global factors, leaving Castelões as one of the few – if barely – remaining centres where artisanal linen-making is still in practice and can still be observed empirically.

The urgency for a multi-agent approach to mediation within this context is underlined by the fact that the practice base is critically low: four practitioners, each of an advanced age, who embody the knowledge of the process in its entirety, and are, therefore, both principal protagonists and veritable assets for restorative intervention. The study, therefore, finds further thematic alignment with the conference track's emphasis on care, wherein equal emphasis is laid on intangible human and social facets of heritage preservation as processual or material ones.

Correspondingly, the project argues that quid pro quo understanding between market forces and technology under premises of progress in the modern day has had a significant impact on the way objects are produced and consumed. In this regard, it agrees with the assessment that "programmed obsolescence is driving industrial growth", which is consequently putting constant and inordinate pressure on makers to keep reinventing themselves – in terms of identity and praxis.

For small-scale making, and especially in the case of traditional industries that depend on manual processes honed over centuries, a fundamental non-conformity with the underpinnings of such conditioned progress is a palpable point of conflict that is culminating in either the loss of authenticity or instigating suspension of practice altogether, due to consequent economic untenability. The paper accordingly discusses what would 'innovation' or 'newness' mean in such contexts where there is an obvious lack of congruence between local and global realities.

Author keywords

Design Research; Heritage preservation; Linen Cycle; Territory and Identity; Cultural Sustainability.

Introduction

This article presents a mediation process developed in Castelões - a parish in the municipality of Viseu, in central Portugal, - led by a PhD research project in Design that focuses on creating a semantic framework for understanding the concept of "innovation" within traditional cultures, specifically in contexts of artisanal production.

The aim of this approach is not to break with the past, but to propose a reconciliation between tradition and contemporaneity in Creative Cultural Industries (CCI), what is understood by this study is that often this relationship (tradition - contemporaneity) can be wrongly perceived and presented as antagonistic. In this sense, the project proposes to broad-

en the interpretation of 'new', and relatedly, 'innovation' as a basis for generating new meanings, relevance, and value - in this case, in and with communities of vulnerable practices.

The knowledge and practice of linen production in Castelões (1414 inhabitants, in 2021) (Portal Do INE, n.d.) are presently sustained by a small group of women practitioners carrying the legacy of centuries-old traditions of flax cultivation and processing, and correspondingly, artisanal manufacturing of linen fabric. Linen production was once prevalent throughout the Portuguese territory, especially in the northern and central regions, however, in recent years it has drastically declined due to a variety of unmitigated local and global factors, leaving Castelões as one of the few centers where handmade linen is still technically in practice, and can be observed empirically.

In this regard, the project has put emphasis on incorporating ethnographic techniques such as participant observation in its methodological approach to not only derive the required empirical data from a case study perspective, but also to foster a space of trust, bonding, and co-creation with the respective community of practice. The group, formally known as the Association of Women Agriculturists from Castelões (*Associação das Mulheres Agricultoras de Castelões*) is a non-profit institution founded in 1997 dedicated to the cultivation and processing of linseed into linen fabric. When the investigation began, the association was at risk of disappearing, mainly due to the advanced age of the artisans, but also because of the lack of apprentices from younger demographics in the region – who were generally disinterested in an activity that was perceptibly connected with the past and connoted more precarious times. In this context, the project recognized the criticality of preserving such a unique ecosystem of linen-making, to which it responded by initiating a series of design-led collaborative activities aimed at scaffolding community-driven reestablishment, and through developing research infrastructure for facilitating sustained social and cultural innovation.

The study component in this case, therefore, began by focusing on comprehending the various phases of the flax cycle, getting to know the main protagonists and the surrounding members of the community, observing the potential for development and exploration of the territory's identity, and by working to transform local needs into results that were concrete and relevant towards the continuity and permanence of the specialized know-how.

Contextual background: Linen-making in Castelões

Flax has traditionally been cultivated as a common food and fiber crop in Continental Portugal, with studies suggesting its prevalence in these regions since at least as far back as the pre-Roman period (Oliveira, Galhano & Pereira, 1991) when the industry was "organized in a predominantly rural system of production using rudimentary technical means" (Sequeira & Melo, 2012). Elsewhere in continental Portugal and the Iberian Peninsula, historical evidence points to an even earlier occurrence, such as in Algarve (2000 BC) and in the province of Almeria in southeastern Spain (2500 BC), establishing an indivisible provenance between the practice and the territory (Oliveira, Galhano & Pereira 1991).

In keeping with tradition, the cycle of linen making in Castelões is a fully manual and artisanal process that imbibes empirical systems of knowledge developed over centuries and passed down through generations as both heritage and a life skill. The artisans recall that in their childhood, flax was still a regular aspect of everyday life: a significant portion of the surrounding lands was used in its cultivation, and most families kept a bit of the produce for their own consumption. Each village also had at least one designated weaver who would transform yarn to fabric. The artisans remember their mothers and grandmothers weaving flax, while they would help around with auxiliary tasks such as splitting the husk from the seeds using their teeth. In this way, the working of flax often involved the entire family.

With wide scale shifts in agricultural technologies coming into effect during the 20th Century, alongside correspondingly evolving consumer preferences and sectoral outlooks, the preference of linen as an essential crop abated, bringing with it a gradual decline in both production and the practice base. The Association of Women Agriculturists from Castelões was, therefore, founded in 1997 with a mission to preserve and reinstate the traditional process of linen making in the region. The initiative was put in motion by a course on family farming organized by the Municipality for Castelões residents, which reintroduced predominantly the women members of the community to growing, spinning, and weaving flax. The association began with 30 members on board, all women, and was centered in a facility owned by *Santa Casa de Misericórdia*, a non-governmental organization, with minimal resources and little or no access to electricity, water, or heating. Conditions had barely improved since, and the association lost a significant majority of its members over the years to death or ill health.

When the doctoral project made its initial approaches to the community, the number of practicing members had reduced to four, aged between 69 and 88, however, despite the perceivable complexities faced over the years, these four artisans showcased remarkable resilience towards keeping the practice and the knowledge system alive.

At that moment the research became acutely aware that the ongoing depopulation in the region along with a general apathy of younger community members towards the traditional practice presented a critical and untenable situation, the resolution of which would require a sensitive prospection of opportunities towards a dignified reinstatement. This premise oriented the corresponding research actions, emplacing the protagonists as anchors of restorative intervention, and as critical assets to the process of heritage management.

On convention versus contemporaneity

A theoretical objective of the doctoral research in question is to examine the constructs of the terms, 'innovation' and 'newness', and their interpretation from distinctive perspectives. It argues that such phenomenographic approach may be required to bring focus to the inherent polysemantic nature of the terms, and thereby, critique their reductive use in common parlance, specifically in contexts of industry – which the project posits is mandating inflated and unsustainable cyclical relationships between production and consumption, and normalizing damaging practices such as planned obsolescence which are then being deemed necessary for further innovation. The study, accordingly, subscribes to Lipovetsky's observation that the society today has become "hyper-consumerist", entailing a "multiplication of experience" driven by "the intoxication of new sensations and emotions" (Lipovet-

sky, 2007) – which may actively marginalize social, cultural, and human values accrued in ecosystems of traditional making, thereby, affecting their relevance to modern economy and industry.

Therefore, the exploration and documentation of tangible and intangible wealth residing within the linen making culture at Castelões became a key aspect of mediation for the study, towards securing a future for the practice and its practitioners. It sought to foreground the atemporal character of the craft, its contributions to industrial, material, and cultural heritage, and the durability of its offerings, as a means to defend its significance to related contemporary discourses, and to sustain its agency towards affecting and informing change.

Elsewhere in the world, comparable efforts are in motion to bring back public attention to nuance and human values. There is indication of a growing appreciation for handmade produce as campaigns like the maker movement in the UK, and DIY in the USA suggest (Borges 2011). Slow movement spin-offs such as slow fashion (Fletcher, 2010), especially in the UK, are taking root in popular culture and consumption. Slow design (Strauss & Fuad-Luke, 2008), similarly, makes a call to action for design to refocus on the "trinity of individual, socio-cultural, and environmental well-being", citing the importance of "slower human, economic, and resource flow metabolisms" to personal and environmental health. The manual process of linen-making at Castelões is a natural example of such reflective stances. The depth of its history, the exclusivity of its outcomes, and an obvious human connect are all attributes that instead of being feted, are earnestly working against the best interests of the community. In order to push for reconciliation, thus, the project had to reframe its standpoint, from top-down to bottom-up, that would allow the context instead to shape its own perception.

Borges (2011) in denouncing the conception that the ability to think creatively is exclusive to individuals with formal education, makes a note of how for communities of traditional practice, especially for those belonging to economically and/or socially marginalized sections, the desire to project their legacy is not driven by regressive nostalgia, but by the conviction that the knowledge that they imbibe is valuable heritage, and can drive fairer and more equitable development. The possibility of finding voice and representation, in this case, would constitute a sufficient interpretation of innovation – as an opportunity for renewal and continuity. In conjunction, Davis (1979) points out that "the public appetite for nostalgia can be considered as a socially adaptive mechanism which helps recover from sociocultural discontinuities and imbalances caused by radical social changes", however, the study from the position of a design research intervention maintains its skepticism of nostalgia as becoming a definitive resolution to the occurring conflict between convention and contemporaneity in Castelões.

Xue and Woolley (2013) define nostalgia as "links with past memories or experiences, which seem to be in opposition to being innovative – a characteristic usually associated with good design," however, they also acknowledge that nostalgia can make it easier for individuals and societies to retain identities in the aftermath of paradigm shifts. The research, respectively, principally agrees with their assessment that nostalgia is primarily a memory-based experience, and in the case of people who do not share a certain memory, they do not always have the need for (or are themselves) an effective source of nostalgia, and consequently cannot fully feel the effects of change or recognize correlations with their own history. This is a major reason for the dissociation of the younger generations in the community with the craft, and that is why, the research argues that humanizing technology and recovering valuable cultural and emotional aspects of the past can offer better prospects for traditions to continue into modernity.

Methodological Approach

As iterated, it was important for the research, from the perspective of design, to assume a reflective stance that was expressly non-coercive and non-imposing, and which scaffolded a variety of exploratory actions pertaining the re-signification of identity. Co-creation led methods were strategically implemented for meeting specific community needs, for instance, towards establishing a common space where the artisans alongside other local actors and stakeholders such as farmers, administrators, commercial entities, and students could freely discuss and work together to identify, and subsequently, address challenges and opportunities.

In retrospection, the ethnographic component of the study can be seen as divided between two key phases. This division was unplanned and the transition between the two was organic. The research perspective at the beginning of the intervention, during the first phase, was primarily etic – corresponding to developing a general understanding of the context and involving non-participatory observation, informal and semi-structured collection of oral histories, and photographic documentation of tools and processes. In the course of this phase, a number of intermediary measures were considered, such as the integration of traditional weaving into contemporary design and fashion as a basis for articulating tradition with modernity. However, during such deliberations, it became clear that the cultural and historical aspects of flax production in the region needed to be comprehended and contextualized in order to safeguard the practice's authenticity and potentially generate further, and even unexpected value propositions. Hence, a more hands-on approach was required, that imbibed the perspective of the research subjects – an outlook which consequently led to the researcher actively learning and participating in all stages of linen production as a member of the community, which eventually helped nurture an emic perspective. In this period of three years, the researcher made contact and collaborated extensively with the wider community in Castelões, including local inhabitants and figures of authority, and was able to create a space of mutual trust and confidence.

Ongoing actions, results, and findings

A key milestone for the mediation process has been the possibility to acquire and establish a new association headquarters. Housed at a former primary school belonging to the municipality, the space is bigger, with significantly better amenities, organization, and working conditions. It can not only accommodate processual tools and equipment such as handlooms, but it also serves as an environment for learning and connecting. A series of strategic intra and inter community meetings, for instance, has been organized in the location for purposes of networking and conceptualization.

The second important development emerging from the mediation is the co-design of a visual identity (branding) for the community of artisans (Figure 1). Named AmaCastelões

Figure 1. Branding related materials co-developed with the practice community.

(Love Castelões), the identity is designed to reflect a deep semantic connection with its territory and provenance and has been created with the intention to generate social, symbolic, and economic value for the local community. Upon launch, it was observed that the branding exercise soon evolved into a localized movement, driven by an intensely positive response from the wider community, which became a moment of catharsis for the artisans. Reflections gathered correspondingly, indicate a sense of empowerment derived from the greater acknowledgement of their work as professionals, and their contribution towards safeguarding (and now, projecting) the cultural and industrial legacies of the village and the region.

Respectively, the gains from the above two milestones paved the way for the third, and arguably, the most significant accomplishment for the research. With burgeoning public interest in the practice, the project found it opportune to shift focus to a critical need – expanding the practice base. A series of workshops and open days were organized at the new association headquarters, which brought in a surprisingly high number of younger community members willing to learn from the old masters about their craft, and who were driven not as much by nostalgia but by a sense of association, structure, and personal responsibility towards perpetuating the underlying empirical wisdom.

At present, the number of practicing members has increased from four to seventeen. The new headquarters are serving well as a space of active learning and exploration pertaining to the production of linen; weaving and embroidery techniques; and new product development for expanding outreach to newer potential markets. A further number of exploratory activities are in motion that are dedicated to process optimization and the integration of new tools. The space also regularly hosts meetings and workshops on the theme, and the project in the coming months is scheduled to organize lectures and visits by international entities connected with traditional making, and pedagogic workshops with university students in conjunction with the practice community.

Discussion

Bringing together different perspectives on innovation is critical to inform related public discourse and policy on the effects of a generalized outlook, such as direct and spillover implications to economy, culture, and the environment. Only by taking differing views of innovation into account is it possible to formulate theoretical frameworks that genuinely support sustainable and inclusive development. It is important for the practice of design to be sensitive to the polysemic nature of concepts such as innovation, wealth, and value, and to consider how interpretations can be used strategically to maximize one set of gains (for example, processual or economic) without compromising another (social or environmental).

The project, additionally, posits that while enshrining traditional artefacts and passive depictions of past activities in museums may help preserve the memory of traditional practices, channeling research towards understanding and activating the underlying values can help retain their relevance to contemporaneity; and provide the associated maker communities a sustainable basis to continue building on their contributions to economy, culture, territory, and identity.

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Enforced distance as catalyst and creative disruptor of heritage narrations. Caring for people, culture and planet through inclusive storytelling

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Abstract

Concerns about stubbornly prevailing systems of design production and consumption that negatively impact people and planet have never been more prominent than during the past two decades, with a marked increase in industry, consumer and academic interest in narratives (if not necessarily action) around sustainable design practices laying claim to handling the environment with care. On a similar trajectory, but surprisingly infrequently connected, academic and institutional endeavours to give voice to makers and their culture in the wake of the 2003 Convention for the Safeguarding of the Intangible Cultural Heritage. (https://ich.unesco.org/en/convention)

Cumulus Antwerp 2023's paper track *'Handle with care'* is a welcome platform to report on a project that connected these two pressing challenges of the 21st century, to elevate care in design beyond its human (and planetary) focus. This paper shares insights from a funded research project that allowed academics, technical specialists and makers in Scotland and India to consider digital entrepreneurship opportunities around heritage to benefit environments, makers, users and craft practices. The 'Covid lockdown impact on craft capacity' (CLICC) project started at the height of the COVID 19 disruption to supply chains and travel and explored how new realities around digital engagement could shock a languishing sustainability agenda into the mainstream of production, consumption and protection of heritage crafts, therein exploring how *technology, culture and design might be harnessed in a way that embodies kindness and concern for people, for objects and for the planet*. The team used an inclusive ethnological approach by enlisting potential consumers to shape broad content parameters for what digital making narratives might constitute and who the target audience might be, before employing artisans to produce moving image pilots around their craft. It brought together stakeholders in NGOs, academia and cultural industries to use design thinking and co-design practices to determine hardware, technical skills and content guidance needs if digitisation of intangible heritage were to help realise an inclusive preferred future of making. The emphasis was on futures for everyone and everywhere, with design in a pivotal role to help take care of past objects and practices as well as meeting future production and consumer demands; a multi-lingual production guide for filming heritage processes now exists as a free and highly visual resource to reach many artisan communities. The project tested digital technologies to enable direct collaborations between makers and consumers at a distance, through circular design paradigms, and for an evolution of practice that is dedicated to simultaneous care for human, planetary and cultural resources. By sharing our findings we seek dialogue with the CUMULUS crowd to formulate new agendas that further advance truly inclusive co-design practices towards sustainability, *acknowledging the fact that our natural environment (...) and cultural inspirations and practices are forced to adapt to current and future global challenges, with heritage* having an untapped potential to *being a guiding resource in this transformation*.

Author keywords

Inclusive co-design; digital engagement; heritage informed circular making; care for culture and people and planet.
Enforced distance as catalyst and creative disruptor of heritage narrations

The differing motivations for provenance narratives

Mounting ethical and environmental concerns about the prevailing systems of consumer goods production (e.g. Payne 2019) have led to ever increasing purchaser (and of course marketing) interest in provenance narratives, and since the *2003 Convention for the Safeguarding of the Intangible Cultural Heritage* origin accounts and certifications have frequently been enlisted to help protect maker communities against cultural loss and misuse. The respective motivations behind such narratives are expressing care for potentially conflicting actors, with the former arguably focused on engaging (or informing) consumers, aide business or make it more ethical, and the latter attempting to safeguard culture or afford a competitive advantage to makers. The 'Covid lockdown impact on craft capacity' (CLICC) project harnessed COVID 19 disruption to supply chains and travel to explore how new

realities around digital engagement could shock a languishing sustainability agenda into the mainstream of production, consumption and protection of heritage crafts, therein exploring how *technology, culture and design might be harnessed in a way that embodies kindness and concern for everyone, for objects and for the planet*.

Adaptation to online living - virtual consumption and a new appetite for visual narration, but not inclusively

As high streets across the world were shuttered and more than half of all workers in the UK arts and entertainment industries were on furlough by the end of the year, members of societies where economic support for pandemic-stricken sectors was strong are reported to have taken to new digital engagements in a lasting way (McKinsey 2020), but the loss of analogue working opportunities was felt most harshly in the global south (World Bank 2020).

Analogue craft in lockdown crisis - the need for creative rethinking of product consumption.

The Indian craft sector offers often precarious employment for up to 200 million people, with significant numbers being de facto employees of international brands, as many studies have traced (Edwards 2016, Greru and Kalkreuter 2017, Kalkreuter 2020). Accordingly, the sector suffered considerably under COVID 19 lockdown as an international crash in fashion consumption badly impacted textiles and related crafts sectors with orders being cancelled en masse. At the same time tourism was virtually brought to a standstill overnight by travel bans, and with little state support available, NGOs, national craft networks and international academe raced to explore alternative ways of income generation for traditional makers in crisis. The disruptive urgency that the unexpected lockdown brought to many traditional making communities allowed for some free thinking that brought creative ideas around narration of craft, with makers at the centre of an inclusive agenda for change in the face of conflict.

CLICC, the 'COVID Lockdown Impact on Craft Capacity' Project

The Global Challenges Research funded project CLICC thus started out as an emergency initiative to provide immediate income for Indian artisans during lockdown while keeping artisanal activity in the paying public's mind during travel bans, but we recount here how the existential challenges that COVID disruption had brought to artisans showed new potential for harnessing digital technologies in order to extend care for craft beyond the usual protection of ancient practices.

Heritage in the digital sphere - for marketing and collaboration

Digital opportunities for the crafts have been globally harnessed since the start of the 21st century at least, initially often with a marketing focus, but more recently also as a tool for user collaboration. In India, thanks to the relatively wide reach of smartphone ownership and a concerted drive by NGOs and craft organisations to empower entrepreneurial activity in craft individuals and communities, a solid proportion of artisans are already digital natives who seek to advertise and sell products on social media platforms. What is much less prevalent, however, is digital recording of the making of craft as a tool for engaging paying customers, a cultural good in itself, or towards a shared sustainability agenda.

To scope this field of new craft narrative potential, CLICC sought to investigate how perceptions of what constitutes the cultural value of making heritage might vary between maker and audience, and what questions of intangible heritage ownership and innovation potential its digitisation might bring with it, especially when traditional making processes were transmitted, as a temporary or permanent record, to paying customers from outside traditional communities.

The collateral of exclusion in top-down narratives

Chandan Bose offers a dispassionate account of how the hallmark of Geographical Indication, promotes a consumption of craft that is laced with a moral participation in the "lived tradition" (Nash 1993), whereby Westeners "consume the region" (Chiarappa 1997) as they purchase goods (2016). In India, GI can be traced back to a colonial historiography informed by surveys and exhibitions of crafts by region, and such "colonial fixing of artisanal products to discrete localities" (Kawlra 2014, 6) affords the intended protection to those living in the designated areas.

It remains a powerful marketing tool as discerning consumers are willing to pay for the narrative of authenticity, but it is necessarily contested by those outside the narrow geography and tradition that has been linked to a product in this way, especially where those outside the geography might have a legitimate claim to be alternative experts in a making practice. In his study into Cheriyal paintings, Bose has been able to show how "GI has come to re/construct the history of practice" as he cites master artisan Vaikuntam's welcoming of the certification as affording the protection once given by caste and a mindset of community shielded from outsiders (2016, 124-27), a reading of GI's societal origins previously confirmed also by Roy (2008, 118).

In that sense the GI's promotion of authenticity is not just literally exclusive, but also highly political and a source of conflict: when seen through the modern desirable of social mobility, authenticity narratives that aim to gatekeep the agency of some might then conflict with emerging cultural narratives that seek to empower others or all (Willner and Ghassan 2017).

It is in this context that CLICC sought to investigate the inclusive opportunities that new digital media can bring to the not already protected actors of narratives around making, and what agencial, financial and cultural resources they might be able to harness through such practice.

Varied actors of heritage narration and documentation

Much literature on the digitisation of heritage currently concentrates on tangible heritage and visitor interaction with museum collections of historic artefacts created by makers of the past. While such interaction with artefacts in which the producer or "owner" is no longer alive is fundamentally different to digital narratives created by makers, such literature shares CLICC's central concern about the roles of "user communities" in selecting "their method, extent, and form of engagement with heritage" (King et al 2016, 93). User communities and research team for CLICC consisted of international craft enthusiasts, cultural tourists and heritage scholars.

The digitisation of a process narrative was approached by the project as an opportunity best explored with and amongst artisans so that they might build capability long term and increase communication of making heritage, in line with similar developments in other heritage industries (e.g. Rahaman 2018), and in the spirit of inclusiveness.

However, since the project was keen to find economic opportunities during an acute financial crisis for artisans, and informed as it was by research recognising that much traditional craft identity is actively "formed and negotiated (...) with specific design scenarios and actors" (Greru and Kalkreuter 2017, 137), the team first sought to identify consumer expectations of craft process narrations with two small focus groups of experienced cultural tourists and design collaborators around craft from the UK and India, whom we called superusers:

What superusers expect from digital heritage narration

Having had considerable pre-lockdown exposure to in-person artisan process and product experience in the Indian craft field, the CLICC superusers highlighted three key concerns for any external interventions aimed at harnessing digital craft narration for a multiple care agenda:

Visibility and quality

Brand identity and a virtual home for accessing craft narration were recommended so that films would stand out amongst the growing number of free-to-air offerings by amateur enthusiasts aimed at simple make instruction. Heritage makers cannot be presumed to be capable demonstrators of making, and against professional and able amateur competition the filmic and technical quality of digitised narration appears key and problematic at the same time.

Content and format

Outsourcing any editing of content beyond heritage communities raised concerns over authorship and boundaries between helpful advice and undue prescription of content by outsiders, and the superusers cautioned respect so as not to 'insult' artisans by suggesting that complex and ancient craft knowledge could be packaged into a short instructional video. CLICC's technical team produced a step-by-step guide on how to shoot and do basic edits of film footage of a craft process. The guide is richly illustrated with photographs and diagrams and has been translated into Hindi and several vernacular languages of India to capture different cognitive preferences and have a wide geographical reach. It covers: Introduction to various social media platforms; Video shooting with specific good frame criteria for various platforms; Transfer of files from camera to card; Setting up a tripod amongst other things.

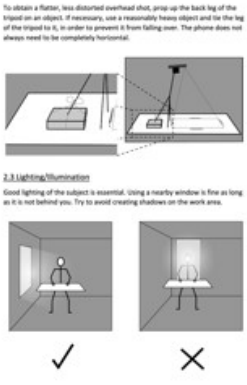

Figure 1. CLICC Craft Video Guide 2020.

Benefit for artisans and for craft

Beyond CLICC's immediate goal of empowering artisans economically during lockdown disruption, the benefits of digital craft narrative were seen to include: Keeping artisans in the eye of the public with a view to future sales and visits; forming the beginning of a repository of craft skills; paving the way for digital collaborations by upskilling craft communities.

What artisans consider the story of craft to be

As soon as the team approached artisans, it became apparent that preferences on making narratives might be more easily formulated by consumers than by craft practitioners themselves, raising once more questions of craft narrative authenticity and indeed its raison d'être between marketing tool, knowledge repository or genuinely welcomed channel for dissemination of a maker's knowledge. CLICC's sample of collaborating artists was determined by the network connections of the project researchers, thereby favouring artisans already connected to academia and NGOs. While not representative of an estimated 200 million artisans in India, the strategy promised a realistic prospect of communication during COVID and included material crafts from weaving to woodcarving to basketry.

Field researcher and artisan decisions on making process

Bead artisan Sitaben was designated 'Super Artisan' as she was local, professionally known to the project's Indian field researcher and could be reached during the height of the Indian lockdown. An image of the artisan at work in her home and a short pilot video that Sitaben shot early on for the project are analysed here in turn to explain the disparities of expectations on craft narratives. A teenage neighbour assisted the artisan with the technical realisation of filming guidance offered by the team.

Sitaben seated on a bedstead in her home in Ahmedabad shows a pragmatic and process-focused setup, with the maker dressed in clothing that favours comfort over tradition, wearing plain bead jewellery that does not begin to showcase her extraordinary skills, and making heritage objects in a rather eclectic interior setting that mixes modern prints with traditional mirror-work embroidery. We are witnessing here an unselfconscious scene of craft, one unpretentiously focused on the process in that it does not put heritage content centre-stage other than in the made objects themselves. This focus on practice rather than a wider contextual narrative of craft heritage was further evidenced when CLICC asked Sitaben to document her bead craft in a pilot video:

Figure 2. Sitaben at work in Ahmedabad. Photograph taken by field researcher Amisha Bajpai in June 2020..

Figure 3. Still from Sitaben's pilot narrative of her bead craft. Filmed by Sitaben in the summer of 2020.

Cultural probes with artisans

Competitive day rate stipends were provided to allow for collaborations with artisans that valued them as co-researchers rather than mere participants, and Sitaben was commissioned thus commissioned to document her making practice, initially with very little additional information other than the broad aims of CLICC. This approach resembled a cultural probe as its wide brief allowed for agency to be transferred from project team to maker, and provided with a basic smartphone and tripod, Sitaben focused her craft narration on the production of a beaded object. In just over 2 minutes of footage, we can make out the fingertips of the artisan working on an already advanced piece of a colourful beaded rectangle above a copper bowl full of assorted beads. She adds a few rows of beads before finishing off the piece by producing a loop as for a pendant and moving the completed object around to find different camera angles.

Sitaben submitted this first short video film just days after she had been provided with a basic smartphone and interestingly she chose to focus her short video on an unnarrated angle on her hands as they thread beads from a large copper tray. Much emphasis is on the counting of the beads, while the technique of how shapes are formed by threading complicated stitches through the bead formations is made less clear. There is an accidental soundtrack of urban background noises, reminding us of the workshop location in busy downtown Ahmedabad. The camera angle shows little regard beyond the materials and hands of the artisan, so the narrative of craft is here understood as one that is manual and material based, in contrast to the much wider angle photo by the CLICC researcher that including the workshop surroundings as desirable.

Conclusions on inclusive care narratives

The parallel narratives of craft

Against the backdrop of urgent Global Challenges for craft during COVID lockdown, CLICC explored questions around creating digital narratives of craft. Initial findings from this ongoing project point towards a wide range of possible narratives around craft, the usefulness and appropriateness of which depend very much on the expectation and relationship each actor has with the craft thus narrated. The bringing together of UK and Indian expertise in craft, heritage studies, digital technologies, pedagogy and entrepreneurship, has proven central to the aim to co-characterise the challenges and opportunities of heritage narratives for a wide care agenda.

Technology capabilities matter

The project highlighted issues of hierarchy and agency around digital access and identified the importance of determining who benefits when heritage process is shared digitally via different models (Miller 2020), as mobile phone and online capability varies generationally and culturally, as Sitaben's example of accepting technology help from a young neighbour evidenced.

An inclusive approach to heritage narratives focuses on communities more than agendas

- Narration can portray a physical making space, highlight a local or geographical context, focus on practice or objects, as long as ultimate control remains with owner communities.
- The definition of "ownership" must be reflected upon to be flexible, fair and inclusive.
- To afford "owners" inclusive access to expression, footage might be silent at point of capture, but it can be narrated synchronously or voiced over later in vernacular language; to open up any spoken narration to wider audiences and causes, agreed subtitles may be added.
- Expert editing and marketing should be weighed up with the threat for the agency of narrative owners, with an emphasis on digital capacity building preferable for the agenda of inclusivity.
- Virtuality as a green alternative to cultural tourism, as cultural repository or as research into heritage for current agendas emerges as more inclusive and conducive to a wide ranging care plan than digital clips aimed solely at the experience economy.

Wider implications from CLICC as heritage narratives become instruments of care

CLICC's central idea of supporting artisans and users of crafted goods to move from being traditional 'makers and consumers of product' to 'keepers and seekers of skills' links with a number of current design themes that have gathered pace in the face of the COVID disruption:

Moving image as much more than narration of process

The project was able to position filmed narration of craft as spanning all usually cited categories from representing chiefly the filmed actor (Brun-Cottan & Wall 1995, Suchman & Trigg 1991) to offering consumers fragments of practice to engage with (Buur & Soendergaard 2000), to wider evidence of cultural practice (Blomberg, Giacomi, Mosher, Swenton-Wall 1993) and documentation of design scenarios (Halse, Brandt, Clark & Binder 2010). This well-documented flexibility of filmed narration is mirrored in the myriad debated opportunities and filmed or photographed pilots that the researchers, superusers and artisans of this project generated so far, and offers a wide portfolio of care scenarios.

Digitisation as a move for democratic access and against climate emergency

More analysis into the possible format and potential impact of each of these content varieties of narration is under way, with many lateral applications in the digitised heritage field also already indicated by the project discussion. Amongst these are augmented reality opportunities and prospects of connecting distant skill keepers and seekers in a burgeoning repair economy. A current cultural transformation in design and the arts is widely believed to go hand in hand with the disruption of modes of production and consumption (Diez 2019), and new forms of communication, such as CLICC's artisan-generated craft narrations, can be seen in this context of systemic change. Diez (2012) has asserted that digital revolutions in computing, communications and manufacturing are personal, global and local respectively and while his focus is on new physical spaces for shared production such as Fab Labs and Makerspaces, he emphasises the digital opportunities for peer-to-peer learning and the improvement of the quality of life of communities with the development of interventions in the real world. Just as in this context of collaboration in shared maker spaces, the production and commercialisation of making narratives should be understood not just as a technologi-

cal challenge, but also a socio-cultural discourse (Diez 2019). Artisan-generated narratives that can disseminate and monetise craft knowledge through digital means can in this context be seen as a potential tool for democratisation of access to both consumption and production of cultural knowledge.

Disruption as catalyst towards increasing resilience of craft through digitised narratives

The need for increasing digital capacity and skills to respond to disruption to our normal ways of consumption and production seems evermore important post COVID while remaining a significant factor also in the much-needed change of our relationship with planet Earth, its resources and inhabitants. Democratising tools for digital documentation and distribution through the key activities of heritage narratives should be part of a disruptive attempt towards reducing global hierarchies of empowerment, and towards futures that are desirable and prosperous for all.

CLICC has highlighted matters of power balances and agency that require careful consideration to counteract potential for digital heritage narratives to "lead us to repeat (...) extractivist and colonialist logics (...) that extract personal data and commercialize with them merchandise for product positioning through personalized marketing strategies" (Diez 2019). CLICC has now co-produced a highly visual guide on the techniques of shooting craft narratives with input from mainly technical and artisanal stakeholders in India and the UK, and it has collaborated with NGOs and the wider arts community in India on translating the written instructions of the guide into as many vernacular languages as possible before distributing it as a free open-source material amongst craft communities and arts networks.

As far as content is concerned, the team recognises that its early and continued engagement with artisans can only be seen as the beginning of an empowerment of those actors who need to be in charge of the well-documented tensions between an almost nostalgic promotion of craft heritage (Greru and Kalkreuter 2017) in pursuit of the UN's Sustainable Development Goal #8 (decent work and economic growth) and the modernizing forces of SDGs #9, 12 and 13 (relating to technology, innovation and sustainable production and consumption). The project's networks have contributed to dialogue with established and emerging action groups for craft in India, and the team continue to be deeply engaged with local and global crafts and academic communities.

The methodology employed in this project has facilitated impact on a wide scale: the project now works with two leading NGOs in reaching craft communities, with further footage received by artisan *Sahil* on Felting in Himachal Pradesh, by *Zafar bhai* on Glass blowing in Firozabad, by *Shakil bhai* on Batik printing in Mundra, by *Raju bhai* on Wood carving in Idar, by *Palden* on Basketry in Sikkim and Weaving from Kutch, with some 8 local languages projected to be covered in addition to Hindi and English. The pool of artisans who might participate now exceeds 50 and covers more than a dozen very distinct disciplines and even more localities across India. The initial project investigators and the wider project team are aiming at longevity as footage from artisans is being received beyond the finish date of the funded project, and the work has become a new, artisan driven facet of well-established and regular engagement with heritage communities by Universities Srishti and NID, and NGOs 200millionartisans and Dastkar. In that sense, CLICC hopes to have contributed to another dimension of inclusive outreach from academia to craft communities beyond the customary relationships of design championing craft in order to reach new markets and customers. Interest from heritage organisations and artisans is currently moving towards repair agendas, perhaps suggesting that empowerment of marginalised actors is being achieved, and certainly showing potential for reaching towards a new multifaceted understanding of what inclusive care for all and everything in the heritage sector may mean and can achieve. With that, the project is well placed to explore opportunities beyond its initial regional and material focus to find further heritage-driven disruptive interventions in a continued difficult economic climate and amidst societal conflict.

Approaches from other research teams and individuals are actively encouraged.

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Media art creation process using digitized archetype of Korean traditional dance movement

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Abstract

Cultural heritage is a product of history and culture that contains traces and memories of humanity. Therefore, various kinds of effort are needed to care and spread its value. However, young people's interest in cultural heritage remains shallow due to the strong perception or bias that it cannot be reconciled with modern culture. Intangible cultural properties are thus held and passed down by a relatively small population, which often carries the risk of losing or damaging its original form. Thus, establishing measures to pass down intangible cultural heritage (ICH) is a crucial challenge. In addition to the safeguarding of ICH, there is also a need to increase the younger generation's interest in traditional Korean cultural heritage and encourage them to participate in various activities in order to slowly expose them to the various dimensions of cultural heritage.

The purpose of this study is to propose and demonstrate a new media art creation process through the case of the 'Dongnae Crane Dance', one of the most prominent aspects within the local cultural heritage of Busan. This study was conducted in using the following process: 1) The archetype data of the 'Dongnae Crane Dance' was extracted using motion recognition technology to recognize the dancer's body movements. 2) The displacement difference (difference in the changing position) of the 3D data was calculated, and the trajectory distance of the motion was derived from the accumulative data calculated above. 3) Based on the data acquired, this study proposes a media art creation process applying various practical contents, focusing on the detailed elements included in digitalized archetype data.

Through this process, this study aims to enhance the interest of young people in ICH and contributes to the cultural transmission and safeguarding of its original form. Furthermore, it is expected that the creative activity of modern artworks based on archetype data, not on reinterpretation from the artist's point of view, can provide an opportunity to recognize and convey the value of Korean cultural heritage once again and to have this cultural heritage further disseminate throughout the world.

Author keywords

Korean Culture; Traditional Dance Movement; Use of Archetype; Media Art Creation Process

Introduction

Cultural uniformity has deepened as the integration of economy, politics and culture has accelerated internationally in the era of globalization. Accordingly, maintaining cultural diversity and national identity has become an important research issue. Culture is formed through the lifestyle, behavior, belief, and faith of a particular community (Yoon, Kim, & Chang, 2022), and this becomes a key foundation for shaping new values, creativity, knowledge, and traditions (Herrow & Azraai, 2021; Chang, 2020). Cultural heritage is formed, shared and handed down from generation to generation. The diversity of culture and heritage is an irreplaceable asset for the spiritual and intellectual enrichment of all mankind (UNESCO, 2021). Therefore, various efforts are needed to safeguard cultural heritage and spread its value.

Folk dance is an important part of Intangible Cultural Heritage (ICH) and one of the diverse cultural foundations that shape a particular social context (Stavrakis, Aristidou, Savva, Himona, & Chrysanthou, 2012). However, unlike tangible cultural heritage, which has a relatively clear substance, ICH has some problems involving care and succession because it is handed down mainly by a small number of heritage holders and bearers. In other words, if there is a problem with the personal safety of the bearers, the original form may be damaged or, in severe cases, may not be able to pass down. Therefore, in the transmission of ICH, it is necessary to break away with traditional methods, and seek new ways that can assist or replace them (Kim, 2018). In this respect, the rapid development of 3D technology has become a great turning point in the safeguarding of cultural heritage. Through this, various means and options have been obtained for recording, restoring, and harnessing the elements of ICH, escaping from the limited means of recording such as video recordings and images (Skublewska-Paszkowska, Milosz, Powroznik, & Lukasik, 2022).

Korea has a long history and rich tangible and ICH. However, it was found that 50.9% or merely half of Korean people have interest in traditional culture, and the lower the age, the lower the interest. Notably, the proportion of the population with no experience of enjoying traditional culture was higher in the younger age group (Ministry of Culture, Sports and Tourism, Republic of Korea, 2019). Although multifaceted efforts are being made to care cultural heritage in various fields, the departure

of young generation's cultural interest has become a new challenge. As such, there is a need to respond to the problems with ICH transmission and at the same time seek ways to enhance interest of the younger generation in the Korean traditional cultural heritage. This research project started from such context and problems.

Therefore, this study aims to propose the incorporation of cutting-edge technology through various means and options as a measure for ICH transmission, and increases the interest of the younger generation in ICH through the development of a creation process that uses media technology. In this vein, this study selects Dongnae Crane Dance, a local ICH in Korea, as a research subject, and records and cares the archetype data of the dance movements by using the sophisticated motion recognition technology to try out a new transmission method. In addition, as a way to raise the interest in local ICH and the production of content that incorporates the recorded archetype data, this study will develop and propose a media art creation process with a communication method of participation and experience of the audience.

This study largely consists of prior research review, the extraction and conversion of dance movement data, and the development and proposal of a media art creation process using data. (1) In the stage of prior research review, the study looked into related prior researches, and described the overall outline of this project. By doing so, the necessity and direction of the study was explored. (2) Data extraction on dance movements was conducted using motion capture technology, and movements were recorded for each body part, such as the torso, hands, and legs, centered on the body of the performer of Dongnae Crane Dance. Moreover, this study constructed the archetype data of the dance movements in Dongnae Crane Dance through the moving distance according to the movement after calculating the displacement difference in the recorded 3D coordinates. (3) In the proposal of media art creation process, this study attempted to identify the flow of media art, which has recently drawn a high interest, and propose a process for media art creators to realize creations by harnessing the archetype data of local ICH that they secured earlier. This study corresponds to the basic research part of the entire project, and includes the details of the prior research review stage.

Related Studies

This section briefly reviewed recent research related to the safeguarding of ICH and folk dance.

Tangible cultural heritage with a physical substance has the characteristic that its original form is relatively well maintained for a longer period of time than ICH. Accordingly, it can be said that the majority of studies related to the safeguarding and utilization of cultural heritage in the past were focused on tangible cultural heritage (Pistola, et al, 2021). With the development of 3D and digital media technology, it has become possible to study the care of the archetype of ICH in more effective and diversified ways, breaking with the limitations of relying on traditional recording methods (illustrations, photos, videos, Labanotation, etc.) and observation and recording of heritage (Skublewska-Paszkowska, et al, 2022). Accordingly, research related to the ICH safeguarding has recently become a major topic of cultural heritage research internationally (Jing, Tan, & Zhang, 2021), and various technologies such as 3D modeling, motion capture, 3D visualization, VR, and AR have been used in related studies. Furthermore, there have been various attempts to safeguard heritage and add new value, such as building an Internet public database using digitized ICH, experiencing museum AR, and developing a platform that promotes ICH-based creative activities (Hou, Kenderdine, Picca, Egloff, & Adamou, 2021; Pistola, et al, 2021; Kim, Im, Lee, & Choi, 2019; Xue, Li, & Meng, 2019; Kim, 2018).

Most of the studies related to the safeguarding of traditional dance movements show awareness of the problem involving effective safeguarding and recording, and raising interest of the younger generation or the general public (Stavrakis, et al, 2012; Zhanna, 2020). Discussions are also underway to develop games, interaction programs, learning games and animations using digitized data, including care through digital technology (Herrow, et al, 2021). In this regard, the study by Hajdin, et al (2018) developed and presented a visualized interaction application that can learn through the digitized traditional dance of Slovakia. This showed the potential that 3D and media technologies could be useful options for learning traditional dance movements.

It was found that related recent studies have a tendency to build digitized data by using advanced technology and based on this, seek a direction to create new value, while evolving from the perspective of mere recording and safeguarding. This seems to have been an important global issue.

To create such new value, this study attempted to design a media art creation process based on the archetype data of digitized ICH. The expected contributions to the media art creation process are as follows. (1) It proposes various methods by providing a reference based on the archetype data extracted through advanced technology, and thus expanding the archetype record of Dongnae Crane Dance, an ICH. Through this, it is expected to contribute to the transmission of local ICH and safeguarding of its original form. (2) It promotes interaction, participation, and cultural experience with visitors by presenting a media art creation process using ICH. In this process, the familiarity and interest in cultural heritage are expected to grow.

Digital data recording of traditional dance movements

Introduction to the dance movement of Dongnae Crane Dance

Dongnae Crane Dance, designated as Intangible Cultural Property No. 3 by Busan City, is said to have been expressed based on the Deotbaegi Dance that started extemporaneously in Nori Madang, the areas for traditional outdoor performances. This is an unstructured dance that is improvised to the Gutgeory jangdan (rhythm) or Deotbaegi jangdan (rhythm) through Nori Madang, including Dongnae Yaryu or tug-of-war that have been passed down in the Dongnae area of Busan. It developed from the Deotbaegi Dance performed in a fixed frame but unfixed freedom. In particular, Dongnae Crane Dance has larger movements than the Deotbaegi Dance, and the dance moves, such as connecting between motions through abundant breathing or moving forward, are expressed in a dynamic yet round manner. The name of the Crane Dance originated from dance movements that resemble those of a crane when a man donning a white robe and a black hat, the daily style at the time, danced merrily. Dongnae Crane Dance was created by adding the movements

of the crane according to the flow of time, and is currently taught with arbitrary names based on the form of 16 dances. Among them, the nine movements presented in Table 1 represent the shape of a crane (Busan, 2012).

Table 1. Movement Description and Symbolism of Dongnae Crane Dance

#	↓Image of Dance Movements	*Name (the original language) and ↑Description	↑Symbolism
1		Hwalkaetjit Ttwim (활갯짓 뜀) Running around the dance floor while fluttering the left and right arms in turn	The image of a crane flying merrily
2		Jwawoo Hwalkae (좌우활개) Opening both arms and raising and lowering them on the shoul-ders in turn	The image of a crane flapping its wings in place
3		Dolim (돌림) A slow, spinning movement with both arms open to the side and stepping out once in a while	The image of meandering as if looking for food with wings wide open
4		Somae Keoteum (소매걷음) Rolling up the sleeve of the other arm with one arm	The image of opening and folding the wings one by one
5		Baegim (배김) Jumping big	The image of a crane spreading its wings wide to jump and sit down

Methods and results of recording traditional dance movements

The subject of the dance movements recorded in this study is Mr. Lee Seonghune, the bearer of Dongnae Crane Dance. He is a person who can acquire, safeguard, and reproduce the art of Dongnae Crane Dance designated by the country in its original form. Lee is capable of succession activities and has a succession system. Moreover, he plans and conducts Dongnae Crane Dance performances every year, and operates classes and training at training centers. Centering on him as a subject, the following techniques were used to record the dance movements of Dongnae Crane Dance, and extract data accordingly (Kim, 2006).

First, the Primex camera of the motion capture system OptiTrack was used to measure the movements of the dance. To accurately measure body movements, 24 cameras were installed around the subject, and 180 frames of data were acquired per second. Motive software was used for the editing of the acquired data. The dance movements were extracted through the moving distance of 26 markers attached to each joint, and the movements were recorded for each body part, such as head, torso, hands, and legs of the subject. In addition, archetype data of the movement trajectory of the Dongnae Crane Dance was constructed by calculating the displacement difference of the recorded 3D coordinates.

Figure 1. Preparation for the motion capture of the crane dance movements (first and second from left). Input (second from right) and output (first from right) of the motion capture

Media art using local intangible cultural heritage

ICH is a cultural art in a special field of folk culture, and it is possible to naturally approach the perception of existence of people living in the present through folk culture. Unlike other traditional dances, the dance movements of Dongnae Crane Dance have the characteristics of the regional specificity and uniqueness of Busan, which makes the safeguarding and utilization all the more valuable. Despite its value, however, local ICH is often latent only within the region, and interest is low, especially among the younger generation. Therefore, to increase interest in local ICH, content creators in various fields should try an approach to media art creation using new technologies (Choi, 2016). In this section, this study proposes a process through which creators can realize various creative works related to media art by harnessing digital data and technology of Dongnae Crane Dance, a local ICH.

Cultural heritage and media art

Recently, smart interactive media art that stimulates the emotions of the younger generation is gaining popularity (Gong, 2021). Using advanced technologies such as virtual reality (VR), augmented reality (AR), mixed reality (MR), high-resolution video images, holograms, and projection mapping, the work is expressed through a communication method called user participation and experience. Notably, immersive content that has recently attracted attention, is a type of media art that stimulates the five senses to enhances immersion. It is used as exhibition content at the National Research Institute of Cultural Heritage or National Museum of Korea to create new values for the safeguarding and utilization of cultural heritage.

Proposal of media art creation process

In this study, the process by which creators attempt to create media art using the archetype data of local ICH will be designed as follows.

1. Apply skeleton properties to 3D characters through motion data conversion by using the archetype dance movement data extracted from the motion capture system.
2. Correct the part where the actual volume of the bearer and the volume of the virtual character do not match by using a layer in the next step of creating an animation key and designing a character.
3. Select a high-poly or low-poly rendering method according to the device to implement the content, and perform modeling in the 3D design process,
4. After setting the modeled character, save the file in the format of the set device environment, and derive the final content by setting the user manipulation interface.

Using the final content derived from the above process, construct a spatial structure of the environment in which the audience can immerse. In addition, create media art in which

Figure 2. The Concept map of the Media Art Creation Process

the audience plays a main role and an important medium by forming the environment that induces interaction with the audience through harmony and experience between the video and the audience.

Conclusion

This study examined the contents corresponding to the basic research among the entire research projects that digitize Dongnae Crane Dance, an ICH in Korea, and develop a media art creation process based on it. Literature on the safeguarding and utilization of ICH and traditional dance movements was briefly reviewed, and the general context of this research field and the position of this study were explored. Moreover, this study introduced Dongnae Crane Dance, the main subject of the study, and presented an outline for future research projects.

Based on this, this study conducted digital data recording of Dongnae Crane Dance in the next stage, and attempted to convert the invisible content called intangible cultural heritage into visible content through digital data recording and extraction. This study also proposed a process of media art creation by harnessing extracted digital data to derive visualized content.

By attempting to develop a new creation process using the digitized archetype data of ICH, this study is expected to have a positive effect on the perception of the younger generation about the value of ICH. Last but not least, this study is expected to make a significant contribution in terms of a modern reinterpretation and utilization of cultural heritage through the creation process based on the archetype data.

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Envisioning design strategies for intangible cultural heritage activation

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Abstract

This paper aims at presenting innovative design strategies for the Intangible Cultural Heritage (ICH) 'activation' in the age of 'heritage continuum'. The principal claim is that, in response to an age of crisis and turbulence (climate change, conflicts, post-pandemic recovery) and to the nowadays scenario of digital transformation (metaverse and phygital and smart reality) "caring ICH" means, more than a simple revitalisation, making it sustainably practiced or, rather, 'activated' to bring value, creativity and innovation, being a guiding resource for promoting social and economic development, more inclusive societies and intercultural understanding and collaboration, and new cultural production and co-creation. For doing this, ICH needs to be approached 'designerly' as a cultural ecosystem that binds together cultural contents, museums, cultural institutions, archives and digital repository, territory, communities, users and stakeholders. Moreover it is crucial pushing creatively forward beyond stereotypes the concept of valorization from mere conservation to an updated idea of safeguarding and taking care, addressing the lively and evolving nature of ICT, namely its adaptation and transformation, in order to allow for ICH to be re-enacted and brought back into use and meaning for contemporary society.

After a critical literature review on design for Cultural Heritage, the essay focuses on the potentialities of the actual scenario of ICH valorisation, and then, identifying and analysing interesting case studies and using theoretical reflection, presents some strategies to sustainably address the global challenges of the ICH activation (experience, interpretation, practice and re-use) to come.

Author keywords

heritage continuum; design-driven valorisation; activation strategies; Intangible Cultural Heritage; innovation.

Defining Intangible Cultural Heritage (ICH) in a Contemporary Way: the 'Heritage Continuum'

Understanding Intangible Cultural Heritage (ICH) in a new way addresses the need to innovatively represent the immaterial forms of contemporary culture, that is increasingly dematerialised and incorporating a growing number of born-digital or digitalised objects of nowadays cultural production. In comparison to traditional monuments or works of art, the acknowledged forms of ICH (UNESCO, 2003) have some specific features: ICH is a form of distributed knowledge, often not manifested in distinctive forms, but can be considered a valuable expression of typical creativity embodied in people, rooted in activities and places. ICH is at once traditional and contemporary; it is a community's living expression of identity, diversity, inclusion and belonging; it is locally-based, because it originated and is situated in a specific context and condition.

Due to its process nature of performance embodied in people (Kishenblatt Gimblett, 2004), in order to be preserved, this knowledge must be continuously practiced, taught and incorporated into society: in other words, 'activated' (Lupo et al., 2011). It is a social construct that can adapt time by time because is informed by contextual values that vary over time: 'close' values are those which must be understood against the cultural background of their context; 'remote' values, meanwhile, refer to meanings, uses, functions and aesthetics of the original context subsequently lost in the ICH's displacement from its original conditions (Campione, 2007).

This complex immaterial dimension challenges the traditional strategies for conservation and access favoured by museums and archives. In order to allow for ICH to be reenacted and brought back into use as living heritage, more open, easily-updated systems for its documentation and access are required.

At the same time, the cultural institutions are characterized by changes: following the so-called 'museum effect' (Putnam, 2011) the recently approved definition of Museum by the International Council of Museums (ICOM) is broadening the concept, shifting it from an 'institution' towards a knowledge production model which permeates the aesthetics and imaginary of everyday life. The concept of the 'archive' too has become a conceptual category with a generative value that examines and reinvents knowledge, creating new meanings (Maart, 2013). Consequently, boundaries between archives, collections and exhibitions are blurred not only within cultural institutions, with their functions, mechanisms and structures (Ozdil, 2014), but also in the personal and collective understanding and experience of cultural heritage.

To further complicate the matter, the increasing spread and adoption of digital and mobile technologies in the field of heritage demands an overhaul of the strategies for the management, collection, exploitation and reuse of cultural heritage by institutional bodies and potential end users; additionally, these new technologies profoundly affect the production and reproduction of cultural heritage within the owners' communities themselves. In the era of 'new heritage' (Kalay, Kvan, Affleck, 2008), technology enables different dynamics for the use, spread and accessibility of culture possible remotely

in space and time in a 'smart heritage'. Hence the idea of 'phygital': a blend of the physical and digital worlds. Applied to the field of cultural heritage, this leads to a meta-materiality that integrates tangible and intangible assets in a fluid, hybridised space and experience.

As a result, we define this complex cultural context as the 'heritage continuum': an ecosystem of cultural content that closely connects the collections of museums, cultural institutions, archives and digital repositories, territories, the keepers of heritage (and therefore their ICH) and users in a fluid, stratified space between the physical and virtual worlds which is ever-expanding and ever-enriched thanks to the digital dimension. This circulation of heritage can have a social, political and economic impact beyond the merely cultural dimension, bringing innovation in community or neighbourhood advocacy, sustainable development or new professional and creative practices (European Commission, 2018a, 2018b; Sonkoly, Vahtikari, 2018).

This represents the main challenge of today's cultural institutions: combining the intersections between heritage, technology and experience with social, political and developmental issues: and this is relevant for ICH too, that is a paradigmatic field for exploring the potential of an approach that goes beyond documentation and exhibition (Meissner, 2021). In this regard, design can be a crucial player.

Design for Cultural Heritage (CH): a brief literature review

The value of design's contribution to the field of heritage has been acknowledged internationally by design scholars since the early 2000s: on one hand a systematic overview was carried out to bridge design's role in sustainable local development (Maffei, Villari, 2006) and cultural heritage (Corte-Real et al., 2005); on the other hand technology have acquired a crucial role within the field of heritage (Allen, Lupo, 2012): with the raise of the digital age of museums (Parry, 2013), technologies are used to design narrative museums (Studio Azzurro, 2011) and simulated experiences and performative spaces (Dernie, 2006) by virtual, augmented and mixed-reality design (Kidd 2014) as well as tangible interaction design (Shaer, O., Hornecker, 2010; Hornecker Ciolfi, 2019).

To increase digital engagement (Visser, Richardson, 2013), mobile technology and social media have also become a focus of design (Spallazzo, 2012) in the sphere of inclusive and dialogic museums (Affleck, Kvan, 2008; Kuo Wai Tchen, Ševcenko, 2011; Salgado, Marttila, 2013). Many authors particularly emphasise the participatory turn in museum by co-design and co-creation approach to CH (Simon, 2010; Giaccardi, 2012; Arnaboldi, Diaz Lema, 2021).

In this rich context, the Italian academic design community has reframed the issue of 'Design for Cultural Heritage', placing it at the intersection between heritage, technologies, local development, and social and cultural innovation (Lupo, 2014; Irace et al., 2013; Capurro, Lupo 2016; Ceconello, Spallazzo 2011).

The Current Scenario of ICH Valorisation: Critical Issues and Research Questions

The UNESCO List of Intangible Cultural Heritage and Register of Good Safeguarding Practices provide an official index of all ICH, including 470 elements from 117 countries which can be browsed by year, safeguarding status (with three grades: 'in need of urgent safeguarding', 'representative list of ICH of humanity' and 'good safeguarding practices'), country or keyword (https://ich.unesco.org/en/lists). Almost every entry includes a short video and a photo gallery.

ICH is usually documented at an institutional level and transmitted using photographic or film documentaries and exhibitions, with little discussion of issues such as the self-representation of ICH or strengthening the impact of ICH in real life and contemporary society. Local projects eventually evolve into digital exhibitions or online repositories (Dai, Zhang, 2016; Li, 2022), but only few studies discuss the consequences of using technologies in documenting intangible knowledge (Graham, 2009; Rodil, 2017). Another common approach, especially towards minorities and native cultures, is based on the musealisation of their ICH, thus promoting postcolonial perspectives (Alivizatou, 2012).

At the opposite there are examples of first-hand experience and appropriation of ICH, whether through public festivals (promoted at institutional levels by cultural institutions or museums) or through events in which people can watch live performances or learn traditional skills and techniques first-hand: these experiences, with their ephemeral nature, often lack the continuity that would allow for an in-depth understanding of ICH, dynamics of change, and the potential of intercultural reproduction.

It is also interesting to note that some forms of CH which are not on the official list of ICH are characterised by more experimental attempts at promotion, leveraging technologies and participatory approaches in museums and temporary exhibitions: recent studies on the use of innovative technologies in ICH include Apps and Artificial intelligence (Li, Li, 2021; Xie, 2022). Some museums of cultures - which represent an evolution of ethnographic museums from a postcolonial perspective (Pagani, 2013) - are transforming their traditional approaches to exhibitions into more co-curatorial processes that offer a participatory and performative approach to ICH (Salvesen, Keithsch, 2021); however, these often focus on preservation (Papangelis, Chamberlain, Hai-Ning, 2016; Rodil, 2017) and don't consider ICH's potential for reuse and the consequences in terms of ownership and impact.

As a result, the current ICH valorization don't cover the entire chain from safeguarding to innovation, with the generation of social, cultural and economic impacts. This may perhaps be rooted in the compartmentalisation of the disciplines and approaches to ICH, as well as the difficulty - typical of social and cultural innovation - of scaling up (theorisation and regulation) and out (replication) effective yet specific projects (Moore et al., 2015).

Therefore, our research question is: how can ICH be valorized by design in a comprehensive activation strategy that preserve, document and promote it in a contemporary and engaging way, also facilitating ownership, practice and reproduction in order to support adaptation, development and innovation?

In the following parts, starting with some inspiring projects and critical considerations, we envision some insights, suggesting possible strategies and digital techniques for activating ICH by design.

A phenomenology of design strategies for the activation of ICH

As starting point for our envisioning, we looked for some inspiring projects of ICH valorization, which show an exem-

plar and emblematic approach on two peculiar dimensions, selected accordingly our initial hypothesis: the fact that the activation strategies should focus on appropriation and practices, in order to make ICH accessible in a participative experience, being also possible interpreting, acting and transforming it.

- The first dimension expresses the objective with which the ICH is approached by the project in order to pursue different goals: it spans from knowledge to reproduction of ICH, with various forms of promotion in-between (from musealisation to utilisation to reuse).
- the second dimension shows the cultural permeability and openness through which ICH undergoes in the project, which runs from continuity (less open to change) to evolution (more open and permeable).

The intersection of these two axes generates four quadrants in which the examples are clustered providing four possible scenarios of activation, here discussed, with reference to the literature, in the following paragraphs.

The examples don't belong to the institutional domain of ICH listed in Unesco List, but can be assimilated to forms of ICH, for their immaterial and identity nature: history and memories of places and people, ethnographic heritage, cultural expressions of communities (art, languages, music) and so on.

Amplifying and Enriching the Narration and Experience of ICH

Combining continuity and knowledge there is the basic understanding of any ICH, gained by experiencing it. To supplement the existing traditional forms of photographic/film exhibitions, design applies various technologies to create amplified narratives which magnify, share, stage and dramatise ICH content in exhibitions and installations, up to immersive exhibitions (Pistola et al., 2021) or olfactory experiences (Miotto, 2016). Whilst the narrative approach appears to be merely contemplative, visitors have an active role in exploring the space, choosing their path and interacting with the content. This approach has clear potential if applied to institutional forms of ICH such as oral traditions, performing arts and social practices, improving their comprehension.

Figure 1. To the East (by www.studioazzurro.com).

Some iconic examples are offered by the works of Studio Azzurro, whose temporary exhibitions or permanent installations are conceived as 'museums of narration'. Starting from the concept of sensitive environments, they create interactive spaces in which the content is activated by the (deliberate or unconscious) movements and actions of visitors in the space; a projects is 'To the East. People and Gods on the Silk Routes', Rome, 2011 a temporary exhibition which engage visitors with performative approaches involving objects, surfaces, screens and floors which activate sounds and projections.

This kind of strategy is also applicable outside museum spaces and contexts, through online systems (e.g. 'City of Memory' by Local Project, 2003) or via mobile applications that support augmented reality ('Explore 9/11' by Local Project, 2010).

Figure 2. Explore 9/11 (by www. localprojects.com).

Connecting Different Interpretations and Exchanges of ICH

In the space between knowledge and permeability, there is opportunity to better understand ICH by facilitating different interpretations. Instead of a monolithic vision, multiple perspectives can trigger an active interpretative approach. Design's potential role here is to connect and allow for the comparison - technological or otherwise - of different points of view to foster a deeper level of interpretation, thus promoting mutual understanding and respect. In this way, ICH also catalyses social relations and exchange between people, possibly sparking intercultural dialogue and providing an insight into the 'other'. This approach can be particularly relevant if applied to institutional forms of ICH, where it promotes self-representation by indigenous curation processes (Kreps, 2009) and supports the building of bridges between communities.
One authoritative historical example refers to the concept of the dialogic museum (Kuo Wei Tchen, Ševcenko, 2011): the former Chinatown History Museum (now the Museum of Chinese in America) is pioneering 'dialogue-driven' practices and their implications for museums and cultural institutions (McCarthy, Ciolfi, 2008). This experiment started in 1990 with the dialogic stations of the exhibition 'Memories of New York Chinatown', in which people could contribute with their personal memories and reflections to construct a collective database of timelines and biographies using a very low-tech system.

Figure 3. StoryCorps (by www. localprojects.com).

This kind of strategy can also be applied outside museums and cultural institutions, in public spaces featuring simple interactive installations to both tell oral stories and collect them from people (e.g. 'StoryCorps' by Local Project, 2003).

Performing and Practicing ICH

In the space between continuity and reproduction lies the option of practicing and performing ICH in an active physical experience. The assumption is that bodily, multisensory engagement facilitates a greater sense of ownership and a deeper understanding of cultural heritage (Petrelli et al., 2013): an idea that is even truer of ICH, thanks to the embodiment it offers (Ruggles and Silverman, 2009; Marshall, Hornecker, 2013). Performance, a strategy that is already employed in museums and cultural sites (Jackson and Kidd, 2011), here consists in allowing users to literally perform and practice ICH first-hand: design can enable a visitor to perform a cultural practice or ritual, but in a controlled setting using an actorial approach or a more practical one: for instance a responsive environment in which the cultural content is activated not by stereotypical digital interactions, but using culturally consistent gestures coherent with those that normally bring the ICH (such as a ritual) to life in its original context (these are carefully explained to visitors to avoid misunderstandings about this simulated reenactment). Or, engaging users in learning activities with the heritage-bearers' community, for examples by training them with traditional handicrafts.

We are aware that gestures have the potential to create spectacularization or misunderstandings rather than conveying the ICH respectfully, especially in a transcultural experience, therefore these kinds of experiences need to be carefully designed. In addition, since the direct engagement often don't occurs in the context where the ICH originated, the spatial experience must always be set within a framework of staged authenticity (MacCannell, 1976) or low fidelity (Kidd, 2011) in relation to the ICH's native context, to avoid a simplistically folkloric reenactment of the past (Haldrup and Bærenholdt, 2015).

Good examples that avoid trivialising ICH into mundane fairs and shows, or extemporaneous workshops, are rare; some fairly engaging projects are aimed at younger audiences, but the experience of ICH (and the richness of its content) is obviously often oversimplified. Interesting examples can stem from the concept of tangible interaction (Shaer, O., Hornecker, 2010), which denotes systems in which the experience relies on materiality, bodily/embodied interaction, and eventually physical representations of data. 'Whispering Table', an interactive installation designed by Studio TheGreenEyl in 2009 for the Jüdisches Museum of Berlin, is based on tangible user interfaces (TUI) in an accurate cultural and behavioural setting, namely a communal dinner.

Figure 4. Whispering table (by www.thegreeneyl.com).

This kind of strategy should be implemented in permanent museum display, as well as in cultural and educational activities within a museum setting. Outside museums, any such approach should carefully consider the adequacy of the accuracy or approximation of the performance offered to the public.

Transforming, Rewriting and Reusing ICH

Finally, in the area between permeability and reproduction lies the potential for the continuous adaptation, transformation and evolution of ICH. Whereas strict cultural conservation sometimes approaches fundamentalism, cultural heritage is naturally subject to cyclical processes of selection, reproduction, oblivion and rescue. In particular, as a living heritage, ICH is even more subject to dynamic changes and negotiation and adaptation processes influenced by time and context: it is continuously 'rewritten' and adjusted by its bearers in its socialisation and transmission from generation to generation, or in the relocation of a culture or a community (e.g. migration) in order to remain meaningful and functional to the community. Here, design can help by multiplying and stratifying new meanings of ICH, supporting its rewriting and reuse with participatory approaches, including from a transcultural perspective, i.e. the contributory approach enabled by museums and exhibitions which involve visitors adding personal content through digital and social media technologies.

In the field of cultural heritage, this can lead to the co-creation of cultural content and co-curation strategies. Some crucial issues here include the production of relevant, culturally-consistent content (authoritativeness) and the recognisability of the author (authorship and intellectual property) to ensure the overall quality of the ICH experience, selecting and labelling museum-authored content, expert-generated content and generic UGC via a system of moderation (Ridge, 2007 and 2014).

One example is a pilot application developed in 2014-2015, within the framework of the Europen project Mela- mu-

Figure 5. Museo Diocesano, Milano: app development (by the Author).

seums in the age of migration, for the Diocesan Museum of Milano by the Design for Cultural Heritage group at the Design Department of Politecnico di Milano. A mobile application has been designed with an intercultural (and interreligious) aim in the field of religious heritage. In the initial stage, it stimulated and gathered commentary from experts of different cultures and religions about certain paintings in the museums; in a second stage a digital app was designed consisting of a layered narration of culturally significant religious content and perspectives, addressing a general public from different religious backgrounds.

Design can also implement this approach for the practical and material reuse and reapplication of ICH knowledge, in new, culturally-intensive artefacts (Lupo, 2012). This can be sponsored by museums and cultural institutions, such as in the 'Inspired by China' project at the Peabody Essex Museum, which in 2006 organised an experiment with furniture makers who designed some new pieces inspired by the traditional furniture on show at the museum; alternatively, at a policy level by promoting adequate cultural and developmental frameworks, as well as collaborative actions between heritage owners and social, educational and economic stakeholders at governmental levels.

Critical considerations: Design-Driven Valorisation Chain of ICH from Safeguarding to Activation

The innovative design approach for activating ICH understands heritage as a process in which every phase of the chain of promotion, from safeguarding to use to reproduction, should be designed in an interconnected model.

According to some scholars (van Zanten, 2004), 'active safeguarding' is the appropriate terminology for ICH as it encompasses conservation, preservation and protection, whilst also addressing knowledge and transmission. In this regard, a fundamental revision of the hierarchies and authorities involved in the production, interpretation and representation of heritage is required. Indigenous curation (Kreps, 2009) is often used to promote self-representation, but this must also go hand-in-hand with co-curation strategies (Capurro, Lupo, 2016) to maximise people's engagement and contribution, even in the early stages of the process.

Similarly, the potential re-use of ICH needs to be enabled, ensuring that certain social practices and representations are maintained and practiced in the owners' community, and made accessible for other communities, or 'interpretive communities' (Hooper-Greenhill, 2003), using interactive, narrative, participatory and performative approaches to magnify its potentially endless multi-vocality and emphasizing it as a source for territorial development and community empowerment (Bandarin et al., 2011; Labadi, 2011). Furthermore, the reuse of ICH can support creativity and innovation, such as new cultural production (Comineli, Greffe, 2012; Sedita, 2012).

Within these processes, some issues are critical: Intellectual property right of ICH should rest to the heritage owners (Wendland, 2004): they should be considered producers (Shankar, 2010), and should thus be trained as managers and decision-makers for their CH, facilitating its capacity to reproduce, perform, transform and reuse the ICH, under three factors: ownership, control and impact of their heritage.

Conclusions

The four strategies presented above are conceived as not sequential, but rather complementary to one another: a strategy for 'activating' ICH should cover the various stages in the ICH chain of value, considering the four models as synergistic. However, coming to the practical side, whilst some strategies fit together more intuitively (enriching the narration of ICH by expanding it with multiple interpretations; alternatively, reproducing, reusing and transforming ICH by practicing and performing it), it can prove challenging to develop the four models together at once. Currently, the most important action for extending the chain of promotion for ICH is linking safeguarding with the most appropriate form of reproduction of the heritage at the earliest possible stages; this can use any combination of augmented narrations, multiple interpretations, embodied performances and transformative reuse. As such, we would argue that by using an incremental approach that blends together interpretations, practice and reuse to different degrees, it is possible to reconcile practical applications with long-term visions. The future development of this study will involve testing this theory with real projects and assessing the design-driven added value provided to ICH by this activation strategy, lending more solidity to the theory.

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Craft for care, design for life. Heritage contemporary enhancement and communication design tools as a resource for social changes, fostering diversity and inclusion

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Abstract

Local identity vs global standardization, participatory vs authorial, kairos vs chronos, dichotomies that global change has brought to the reality we live in today, are emerging strongly both on a national (Italian Recovery and Resilience Plan PNRR, 2021) and on a European level (European framework for action on cultural heritage, 2019). The world we live in and how we relate to it is changing by those categories, both individually and synergistically.

Within the framework of enabling and inclusive design tools to fight stereotypes, social exclusion and loss of cultural treasures, craft could be intended as a lever for inclusion, care for the social environment and a key asset to guide heritage to contemporary goals. Reading those topics under the craft lens means relaunching local economies by enhancing the territory's products, knowledge and techniques, putting craft at the centre of the contemporary social debate.

Global challenges, such as the UN 2030 Agenda for Sustainable Development, massively stimulate the cultures of the project, the design for the real world (Papanek, 2019), in which design moves to foster social innovation (Manzini, 2015), but perhaps there is still too little craft exploited in order to have the strategic capacity to narrate local territories, including different identities and excellences that characterize them.

As the main attitude of design is to guide behaviours, objectify tastes, through the concretization of images capable of synthesizing form, function, meaning and value (Celaschi, 2016), also the craft can take on a new value linked to global challenges, by stimulating its inner relational attitude. This could be determined by embracing a flexible approach to the contemporary culture by making adaptations to other disciplines, as the design has done so deftly (Rawsthorn, 2022).

In recent times, craft has benefited from the injection of modern thinking driven by technology or by the support of design thinking and social innovation purposes. This crossing of knowledge is detectable, for example, in the work of Iris van Herpen, the first fashion designer to incorporate 3D printing technology into the fashion industry, mixing them with traditional handmade methods such as embroidery, knitting and spinning. Also, the enabling co-design and participatory methodologies can witness how craft can be supported by design thinking and social innovation methodologies, as in the work of the collective Droog Design or the duo Formafantasma, both recognized for a desire to incorporate the design methods with craft symbolism and techniques into their work.

Instead, it is debatable whether there has been the same experimentation in the more established craft practice, traditional by definition, that can suffer from its being strongly tied to work done to perfection and strictly close to its context of belonging. The aim of this paper is therefore to investigate, through the description of cases and polar comparisons, forays into adjacent worlds as art or design shifting into social, economic and cultural areas of interest, what is contemporary craft, what happens when new technologies and contemporary expressive methods are associated with it and how it can act as a guiding resource for a sustainable and inclusive transformation concerning global challenges.

Author keywords

Contemporary Craft; Communication Design; Attitudinal design; Social Inclusion; Local enhancement.

Introduction. Craft for care: heritage contemporary enhancement and social sustainability, between artifice and nature.

Our identity is defined in our relationship with others, in how we show and tell ourselves verbally, but also through the objects we use, or with which we dress and surround ourselves. Deyan Sudjic, in his essay "The language of things", talks about objects as elements through which we define ourselves to understand who we were and who we were not, to measure the passing of our lives. Things allow us to observe the quantitative flow of time (*Cronos*), but also to indicate its qualitative nature (*Kairos*): an indefinite period in which "something" special happens and, by happening it modifies the context, the places and the people. And things.

Design is the language with which we give shape to those objects and with which we model the messages they bring with them. The role of the designer, in addition to solving formal and functional problems, is that of a storyteller: to shape objects to communicate messages effectively and engagingly (Sudjic, 2008).

The contemporary debate about the sustainability of the Western lifestyle has favoured the acquisition of awareness

by consumers. People have learned to purchase more consciously and to be more demanding with the market, to obtain products that reflect ethical principles. Initiatives such as the Fashion Revolution, whose slogan is *"who made my clothes?"*, demonstrate the need for consumers to know the production process, expecting sustainability from both environmental and social points of view. From this perspective, the craft practice stands as one of the possible alternatives to trigger virtuous processes of social sustainability which, in parallel with ecological, is inserted within the environmental debate with a specific focus on human beings and the relationships between communities, and therefore on sustainable relationships, as well as on resources: *"a life-enhancing condition within communities, and a process within communities that can achieve that condition"* (McKenzie, 2004). This definition of social sustainability suggests an interpretation of how the process of contemporary heritage enhancement should be centred on local communities and the relationships between them.

The fifty-seventh International Art Exhibition, *Viva Arte Viva*, curated by Christine Macel and organized by the Venice Biennale in 2017, addressed the theme of the individual responsibility of the artist in contemporary debates, reaffirmed the growing importance of the craft within the visual arts. The words of the curator Christine Macel are a call to reconsider a "new humanism" that can stimulate a worthwhile debate in terms of social change, inclusion and care: *"A humanism not focused on an artistic ideal to pursue, nor characterized by the celebration of man as a being capable of dominating his surroundings; if anything, a humanism that celebrates man's ability, through art, not to be dominated by the forces that govern what happens in the world, forces that if left alone can greatly condition the human dimension in a reductive sense. It is a humanism in which the artistic act is a gesture of resistance, liberation and generosity."*

Even Michelangelo Pistoletto, with the project "The Third Paradise", imagines a *"third phase of humanity, realized as a balanced connection between artifice and nature. The Third Paradise is the passage to a new level of planetary civilization, essential to ensure the survival of humanity. To this purpose, we first need to re-form the principles and the ethical behaviours guiding our common life. The Third Paradise is the great myth that leads everyone to take personal responsibility for the global vision. The term "paradise" comes from the Ancient Persian and means "protected garden". We are the gardeners who must protect this planet and heal the human society inhabiting it."* (Pistoletto, 2003)

Figure 1. Third Paradise, Michelangelo Pistoletto (2003). The symbol of the Third Paradise, a reconfiguration of the mathematical infinity sign, is made of three consecutive circles. The two external circles represent all the diversities and antinomies, among which nature and artifice. The central one is given by compenetrating the opposite circles and represents the generative womb of a new humanity.

Background. Design for life: relations between art, craft and design.

While it is true that from prehistory to the industrial revolution all manufacturing processes took place through manual processes, it is equally true that the crafter barely attracted any attention for a long time. Only starting from the Late Middle Ages, the crafts-practitioner has come to represent the economic backbone of European society. In the Renaissance, Italian craft *ateliers* enjoyed great fame, and it is precisely in these places that the greatest artists were trained. Over the years, and thanks to the gradual industrialization, the two worlds separated clearly, with the consequent differences between hand-made and industrial products. In the 19th century, the idea of *art pour l'art* began to spread: a theory attributed to the French philosopher Victor Cousin, based on the assumption that art, visual or literary, is self-sustaining and does not need a moral or social purpose. It was the Bauhaus movement that restored importance to the craft sector. Walter Gropius in 1919 stated that there is no essential difference between the artist and the crafter, but that the artist is an elevation of the crafter. Artists are also technicians and technicians are artists because in both cases their actions involve a method. Laszlo Moholy-Nagy, another great exponent of the Bauhaus, theorized the attitudinal design, untying it from the discipline and open to everyone. The essay "Vision in Motion" (1947) proposes a democratic vision of self-expression, that emphasizes the necessity of integrating art with life. His proposal that we learn to utilize all our sensory capacities and to see everything in a relationship, emphasizes simultaneity and motion through the interconnection of space and time. In doing so, Moholy-Nagy proposes a theory of perception and change, which is dynamic and fitting for the modern age.

In the contemporary era, characterized by the rediscovery of doing it yourself, we have entered a new phase, in which craft is compared with digital technology. From the pages of the US magazine "Make", in 2006 the "makers" defined themselves for the first time as digital artisans: sharing processes, resources, means and costs on the web, based on an open-source sharing logic where products are developed by a community by adding spontaneous contributions, in a free and participatory way, contrary to the innovation model of traditional companies which envisages industrial secrecy, copyright and patents.

Just as there is a craft defined as creative (Micelli, 2011), there is a design that has an artisanal expressiveness (Micelli, 2016). In the twentieth century, it was found in Ugo La Pietra, who managed to intersect the world of art with artistic craft, or Piero Fornasetti, who had the typical Italian mindset for integrating the arts: artist's head, the eye of a designer and hands of a crafter. In the contemporary panorama, we observe designers who make the material and technical research as one of the main characteristics of their work, with a marked artisan aptitude: from experimentation between industrial design, craft work, self-production, social design, limited editions for galleries of the Italian designer Francesco Faccin, up to the also Italian Formafantasma design studio, which bases its research on the ecological, historical, political and social forces shaping the discipline of design today. Max Lamb and Martino Gamper carried out experimental studies on the concept of seating, with the projects at *Garage Sanremo* during the Milan Design Week in 2015 (Faccin) and the *100 Chairs in 100 Days* project, started in 2009 by Gamper. He made a new chair a day, for a

hundred days, by collaging together bits of chairs that he found discarded on the street or in friends' homes. Blending found stylistic and structural elements, he generated perverse, poetic, and humorous hybrids. The project combined formal and functional questions with sociological and semiotic ones. The Dutch collective Droog Design, since the early nineties, shows a critical approach towards consumerism, with particular attention to the reuse of material for the creation of unique pieces, among which emerge the *Chest of Drawers* (1991) and the *Rag chair* (1991) by Tejo Remy. Interaction is at the heart of the work of the Droog collective, as well as the use of unusual materials and different types of craft practices and material experimentation, to synthesize the dilemma between industrial production and art.

The evolution of post-industrial culture has brought advantages to both design and craft, which in some cases has acquired expert methods and techniques typical of design, showing itself in a new guise. As in the Renaissance an interesting dialogue between art and craft practice was observed, today we notice the artisan profession dealing with design, a production method that does not only look at the industry but which develops an intermediate production scale between the one-of-a-kind and the large-scale industrial projects. The creations of the fashion stylist Antonio Marras, made of a deep connection with the Sardinian manufacturing tradition, his homeland, as much as the experiments of the Dutch fashion designer Iris Van Herpen, who was the first to combine 3D printing with traditional manual processes, are further examples of how artisanal experimentation, with both traditional or digital methods, often crosses the methodologies and practices of design. Not just experiments by individuals: the demand for professionals in the handmade sector is increasingly high even in the big luxury *maisons*, which have set up various training courses dedicated to manufacturing talents. They range from the LVMH group, which in 2014 founded the IME (*Institut des Métiers d'Excellence*) to various initiatives such as the *Brioni Haute Couture School* and the *Gucci Haute Couture Leather School*.

Recently, *Making Knowing: Craft in Art, 1950–2019*, an exhibition held at the Whitney Museum of American Art in New York between 2019 and 2022, has unequivocally established the great importance of the relationship between art and artifice. The works selected by curators Jennie Goldstein and Elisabeth Sherman demonstrate that crafts practices, which have long been defined in opposition to the "fine arts" can be, like art and design, also conceptual in their forms of expression, and strategic in a vision of promoting new perspectives on topics that have been central to artists, including abstraction, popular culture, feminist aesthetics and recent explorations of identity and relationships.

The reasons for the recent craft revival (Rawsthorn, 2022) are many and could be read as a response to the consequences of the leap that cultures have made from a local to a global scale, from a dimension of adaptation to expansion. First, today we are better acquainted with the dark side of globalization: we are aware of its possible consequences and therefore more inclined to make purchases whose we know the origin and actual quality. A second reason arises from the fascination with matter and the spontaneity of craft -frequently made up of small imperfections- which contrasts with the rigidity and perfection of industrial products or digital screens. Furthermore, the evolution of 3D printing systems has facilitated and made cheaper the prototyping, and therefore the experimentation, of new objects or the repair of old ones, in a circular economy framework of recycling and upcycling practices. Finally, craft endorses participatory processes, it has a long tradition of handing down knowledge behind it. Allowing these traditional techniques to be shared, with a design-driven approach where narration and storytelling are central, is proving to be a lever of success for the entire craft sector (Rawsthorn, 2022).

Contrary to what is claimed by the posthuman thought (Hayles, 1999), which eliminates sharp demarcations and essential differences between humans and machines, between cybernetic mechanisms and biological organisms, contemporary craft endorses the words used by Lazlo Moholy-Nagy to describe his point of view on design. *"The idea of design and the profession of the designer must be transformed from the notion of a specialist function into a generally valid attitude of resourcefulness and inventiveness which allows projects to be seen not in isolation but in relationship with the need of the individual, and the community. Ultimately all problems of design merge into one great problem: a design for life. In a healthy society, this design for life will encourage every profession and vocation to play its part since the degree of relatedness to all their work gives to any civilization its quality"* (Moholy-Nagy, 1947).

Argument. Storytelling and communication design tools for heritage enhancement: key resources for social change.

To correctly frame which resources are used to promote and enhance heritage today, and how to interpret in an interdisciplinary way and under the synergistic lens of contemporary design key concepts (once faced only by the humanities) such as identity, belonging and authenticity, it is important to observe the evolution of the global social context, the current situation of the economic crisis that began in the first decade of the twenty-first century then resulted in the pandemic crisis of 2019, and the global consequences of the Russian-Ukrainian conflict in the recent 2022. Among the goals of the Italian Recovery Plan presented in January 2021, is explicit the focus on the enhancement of the identity of places. The text reads as follows: *"Increasing the attractiveness of the country's tourist and cultural system through the modernization of tangible and intangible infrastructures, the formation and strengthening of accommodation facilities through investments in infrastructures and strategic tourist services and the financing of municipal projects for investments on identifying places in one's territory"* (PNRR, National Recovery and Resilience Plan, Component M1C3: Tourism and Culture 4.0, 2021). Already since the 2008 recession we have become more attentive to the quality, sustainability, and origin of products. The crisis has forced many countries, after years of relocation, to reflect on the future of manufacturing and the importance of keeping production processes on the national territory. With the first lockdown of 2020, there was a strong increase not only in the use of technologies but also in growth in a feeling of belonging, an identification within a group. The web has brought out a new culture of consumption, which asks to know the history of who manufactured the products. For example, in the luxury sector, an important shift in purchase motivation has been noticed: customers have begun to seek more authenticity in the objects purchased. While on the one hand neighbourhood life in cities has been reborn assuming new value, on the other the daily home-alone practices as remote working, streaming, and online shopping, continue to be very topical. Social rela-

tionships and urban collective actions have also moved online through neighbourhood initiatives on social media. The confinement within our cities has given a boost to the rediscovery of a new type of living, made up of strengthened community relationships and proximity consumption in local shops, but either in a physical and digital way.

Throughout history, human beings have always communicated, conveyed ideas and opinions, and have told stories. The art of storytelling was born almost simultaneously with the appearance of man on earth and has been an important tool for sharing social values (Salmon, 2007). Communication design tools today make use of new methods of participatory communication, essential to guarantee content fruition and sharing without geographical or cultural boundaries.

In this context, the most used communication design tools are user-generated content, or the UX design (Norman, 1990) to outline the man-machine experience which today extends to all aspects of the product or service perceived by users; also, the new transmedia storytelling techniques (Jenkins, 2006) for audience engagement, which use different types of media, to refine and integrate the user experience with new and distinct information not openly connected but in narrative synchrony between them.

These tools are essential to ensure the use of authentic and local content, but projected towards open sharing, without geographical or cultural boundaries. Territories are not only a source of original and authentic raw materials but also a network of human and professional relationships, which can positively influence those who live or work in a place. Concepts such as tangible and intangible are inextricably linked and dealing with what is not physically visible such as belonging, cultural identity and authenticity is essential to support and promote even the most material activities such as crafts.

"The 2019 Future Brand Index reveals that individuals are more likely to buy products or services Made In a specific country are also more likely to recommend that country to visit, would consider it for business, and also consider living in or studying there." (Future Brand Country Index, 2019, pag.42)

The intangible dimension of cultural heritage provides unique identities to objects produced in a specific place; authenticity, as the quality of not being imitable, draws on and expresses the tradition of a city, a region, or a cultural asset. Culture acts here as a key element, a connection engine, and a key point for complex processes, relationships between different actors, industrial processes and cognitive paths.

The protagonists of the story of contemporary craft are designers and producers; sometimes these two figures are the same person, and sometimes instead work together, in symbiosis. But not only the creators, the creatives, also the users, the users, but the consumers are also central figures. It is precisely the exchange, the participatory and inclusive dialogue between producer and client/consumer that set the limits of a handcrafted object. Frequently the artisans are unable to promote themselves correctly due to lack of time, will or ability, therefore, it is increasingly evident how fundamental the role of communication designers is. With a participatory and effective narration, the places of production become the places of the story, opening to the public and thus creating direct contact, a relational, individual, cultural exchange: this approach leads to the birth of a new form of tourism based on knowledge, experience, and relationships.

Conclusion. The relevance of provenance and the role of communication designer.

Contemporary craft is innovative but does not forget tradition. Quite the opposite, it understands it and translates it into something new. Contemporary craft creates connections, and brings different people together, materials, places, and design fields, giving life to communities, groups of creatives and producers who collaborate directly or indirectly and influence each other.

Contemporary craft has many hallmarks, sustainability is one of the first but not merely environmental and economic, though above all social, fuelled by cultural awareness and driven by the need to know and understand the deep heritage that adds value to a handcrafted product.

In 2010 Prada launched the "made in" project to tell the origin of four of its productions from as many parts of the world. Thus, Prada is no longer only made in Italy but also made in Scotland, India, Japan and Peru. It's not (just) about social responsibility, but rather about enhancing the authenticity and provenance of superior skills, as the value of a resource depends on its use and the benefits it can generate. The role of communication design, at this stage of the enhancement process, is overriding for its intrinsic attitude to listen as a preparatory requirement for any design activity, in so far as it acts as a tool for dialogue between people, things, companies, users and between public and private (Piscitelli, 2018).

New technologies are certainly essential tools to improve fruition both from a qualitative and quantitative point of view. Contents and ideas travel horizontally in the virtual and global space of the internet and thus become accessible to many people: participation and knowledge sharing require a balance between the different stakeholders and this balance is made possible by many digital platforms which allow people and places to be connected. The rediscovery of interest in handmade is due to people who fully share the values of craft and making, such as uniqueness and attention to detail. This behavioural change, in addition to an innovative boost towards new methods of communication and digital marketing, has transformed products into experiences that combine the knowledge of places with the discovery of quality manufacturing. As for the design discipline, craft today can no longer be defined only as a profession, but also as an open and inclusive attitude, a renewed approach to everyday life.

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Embroidered heritage: a design-led visual ethnography of traditional Palestinian motifs

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Abstract

This paper presents a research approach toward the motifs of traditional iconography in contemporary discourses of graphic design in Palestine. The investigation is being undertaken within the scope of a doctoral project in design at the Faculty of Fine Arts, University of Porto. It focuses on the visual and semantical deconstruction of traditional motifs that are particular to Palestinian *Tartreez* (hand embroidery) and typically applied in ethnic clothing.

The research fully acknowledges the challenges to, and correspondingly the urgency of, conserving such unique heritage assets in light of ongoing circumstances of strife and uncertainty in the region. It also observes the impact of rapidly shifting technological and consumption paradigms as compounding factors actively marginalising localised traditional enterprises, including manual arts and crafts.

The paper, accordingly, examines the role of design as an essential but often neglected aspect of heritage preservation, management, and activation. It discusses how the general perception of 'graphic design' in Palestine, which inextricably links the practice to cutting-edge newness, can prospectively disregard its agency towards involving in and contributing to more retrospective exercises of meaning-making - specifically in contexts such as historical iconographies residing within unique semiotic ecosystems.

A key area of inquiry for the project, which the paper details, is thus a thorough exploration of the semantic underpinnings present in these traditional motifs and, consequently, mapping emerging affordances of contemporary Palestinian visual culture. The corresponding aim is to articulate prospective methodologies and resources that can be introduced in local academic and occupational pedagogies, which can promote the consultation of cultural inheritance as a more meaningful alternative to arbitrary extra-cultural appropriation in graphic and communication design.

The narrative fundamentally aligns with the third thematic track of the conference, "Handle with care/Inclusivity," as the basic premise of the research is to develop and validate means that enable current and future Palestinian designers to address both emic and etic stereotyping, and critically, prevent the loss of unique heritage assets while carrying forward their visual/material legacies through newer forms of creative expression.

Author keywords

Heritage Preservation; Design Research; Visual Ethnography; Palestinian Tartreez; Graphic Design

Introduction

Embroidery is a fundamental craft form etched in Palestinian culture and has been practised by the community and its diaspora as a means of creative expression for centuries. The corresponding iconography, comprising a diverse assemblage of motifs closely linked to Palestinian land and culture, is an essential pillar in the construction of visual and cultural identity, which the community seeks to preserve in the face of compounding dimensions of conflict. Traditional Palestinian attire (Thoub) is the typical medium of motifs for this unique iconography, wherein the motifs can be grouped within different genres – revealing layers of history and cues to civilizations that presided. The research, therefore, investigates the contributions of contemporaneity towards extending this narrative and, conversely, the iconography's value to modern-day precepts of Palestinian visual culture. The latter is of particular importance as a means to identity-building in the context of heritage preservation since the implications are not only socio-economic but are also critically socio-political.

The research identifies key threats to the continuity of the craft: a diminishing practice base abetted by progressively weakening intergenerational transmission of expertise, rapidly shifting manufacturing paradigms, and cultural appropriation by external entities. The effects of these factors are amplified by the occurring instability in the region, therefore, presenting a situation of untenability that warrants the concerted intervention of multilateral and multi-sectoral nature towards the preservation and promulgation of the craft form. The study responds to this call for action by mediating across three key axes of intervention: documentation, design, and dissemination.

Design's role in the continuity of historically significant but antiquated traditional practices involves gaining greater visibility of emerging strategies for addressing real-world issues concerning heritage management (Brandão Pereira et al., 2019). Accordingly, the paper discusses the viability of one particular aspect of design-led mediation – the integration of such traditional iconography in modern Palestinian graphic design, which the project posits can create more meaningful and mutually advantageous synergies between convention and contemporaneity lead to self-innovation for the respective communities of practice.

Research objectives

The research in question is in its initial phase of implementation, wherein the current focus is on deconstructing the semiotic underpinnings of the traditional Palestinian motifs. The aim is to comprehend the associated visual culture from various perspectives, including graphic, semantic, and taxonomic, which may allow a balanced assessment of affordances, opportunities, and interplays in relation to modern-day design praxis. Additionally, the project observes that such analysis may also be relevant for heritage management initiatives – since it is based on source material accrued from a diverse set of references that have emerged from the ongoing primary and secondary inquiry.

The corresponding course of action for the project is to identify contexts where the iconography and/or its specific aspects can be dynamically interpreted, keeping in view contemporary tools, trends, and approaches to graphic design. The research, in this case, acknowledges the criticality of new media towards furthering the inscription of traditional iconography in present-day visual culture and towards its greater reinstatement in public awareness.

The paper, therefore, examines the role of design as an essential but often neglected aspect of heritage preservation, management, and activation. It discusses how the general perception of 'graphic design' in Palestine, which inextricably links the practice to cutting-edge newness, can prospectively disregard its agency towards involving in and contributing to more retrospective exercises of meaning-making - specifically in contexts such as historical iconographies residing within unique but vulnerable semiotic ecosystems.

Context of intervention

Palestine, also known as Canaan in ancient times, has long established textile production and trade history. Embroidery, in particular, is a craft form that has been passed down as an essential skill between generations of mothers and daughters. The craft epitomises Palestinian rural culture, and girls in the past would typically start learning techniques and styles unique to their village from the age of ten. The embroidery, as stated earlier, was primarily used to embellish traditional Palestinian women's attire called a thobe. The motifs and the patterns reflected elements of daily life and the surrounding environment. Garments for special occasions such as marriages and festivals were more richly ornamented, incorporating a greater diversity of designs (Figure 1).

Figure 1. A Palestinian woman practising hand embroidery.
Copyright Sunbula Organisation.

According to a study conducted by Nasir et al. (2019), "embroidery played an essential part in village life and was thought to reveal a woman's personality. The motifs contained an intricate communication system expressing the wearer's status, wealth, and geographic origin through their style and decorative elements. In addition to geometric, arabesque, and abstract patterns, embroidery motifs and colour combinations sometimes symbolised the surrounding flora and fauna, literally and metaphorically. There were subtle similarities between the works of neighbouring practice communities. However, differences increased with social and geographical distance (Figure 2).

Figure 2. Various motifs and styles from different cities.
Copyright Katie Murdoch, 2022.

In conjunction, Allenby (2011) notes:

> "Embroidered motifs also reflected the political environment of the time. For example, the Pasha's Tent pattern first appeared when the Ottoman Court ruled the region. In contrast, the Officer's Pips pattern was adopted during the British Mandate, imitating British military symbols of rank. Thus, embroidery acted as a symbol of evolving Palestinian identity by historically recording individual interpretations of the political and cultural events that touched the lives of Palestinian rural folk.

Before 1948, the traditional attire of women in rural Palestine was regionally and stylistically diverse, with great emphasis on ornamentation, and fashioned from the finest local and imported fabrics. (Kiwar, 2011) observes that each garment from the era could be considered an individual work of art.

With the outset of *Nakba*, or the Palestinian catastrophe, in 1948, many fundamental facets of daily living changed. A significant section of the population became internally or externally displaced. Severe financial difficulties supervened, as did settling for subsistence in refugee camps, which made it harder for embroidery to remain an active part of daily routines. However, against all odds, the craft survived. Palestinian embroidery after 1948 became a symbol of Palestinian identity and a declaration of provenance. In the coming decades, it

would regain its premise as a means for Palestinian women to sustain themselves and contribute towards local economies.

Despite this, the project comprehends that present-day complications facing the craft form are unprecedented in lieu of the sheer scale of cultural impressions effectuating from the transition to globally connected digital realities. The key challenge for Palestinian embroidery, respectively, has not been the loss of authenticity from a compulsion to reinvent, as is the likely scenario for other localised craft cultures facing a similar conundrum, but the inability to detach itself from what the research argues as veering narratives of visual mimesis. Such circumstances breed indifference towards nuance, which forms a key value proposition for the craft.

The threat of dissipation with regard to indigenous practices has been noted by authors like Ghnaim (2018). In her book documenting" tartreez" motifs and practices from her own family, the author states that after being dispersed into the diaspora, "the number of women who were experts and experienced in embroidery began to decrease", leading to it being considered "an endangered Art." Correspondingly, the author notes, "Our diaspora history is over 60 years old. Before this time, everyone could embroider, but Now, almost three generations since, almost all of them do not know how to embroider. If we don't continue to help the new generations do this, it will fade (Ulloa,2020).

Therefore, unlike in the past when the craft's rootedness in Palestinian identity was enough to sustain social and economic relevance, there is a real possibility that unless sustained cultural mediation is instituted, its historical legacy and material intricacies may further recede in the public consciousness – with prejudicial socioeconomic and sociocultural implications for the craft and its tapering practice community. In response, the investigation seeks to explore and build upon potential complementarities with contemporary graphic design practice as a supportable framework for reinscription.

Issues surrounding remediation

During the first phase of the research, a number of systemic issues were noted regarding previous and ongoing remediation initiatives. A significant issue, as discussed earlier, pertains to a general lack of awareness about the meaning of many symbols and motifs constituting the iconography, despite the existence of courses and programs related to embroidery in public and private institutions. A manifestation of the same can be gauged from a recent but rampant permeation of 'intrusive inscriptions' into the craft from non-native cultures/cultural productions. The craft has historically imbibed influences from external cultures and civilizations; however, the process of reinterpretation was previously gradual and, importantly, dialogic, wherein the corresponding production was a tribute to the original idea rather than emulation.

Similarly, the introduction of computerised embroidery over the past decade has presented another challenge to the craft's individuality; however, the implementation has faced firm resistance from the practice community who have insisted on the exclusivity of the practice as a manual craft form, arguing that the motion is entirely unacceptable since it works to destroy the very foundation of the practice in furtherance of innovation.

Correspondingly, the lack of precise framing of the ambit of the associated iconography and limited interpretative taxonomy of the visual system (and corresponding sub-systems) are also causes of concern since it exposes the craft to the risk of cultural appropriation.

In lieu of its disposition as a design-led strategic intervention aimed at cultural sustainability, the project effectively falls into the remediation category; however, the standpoint of 'design' here is reflective. By building a holistic comprehension of the attached sensitivities through in-depth on-ground research, it seeks to address some of the concerns identified above and avoid the obvious pitfalls that have afflicted previous initiatives. Its central mission is, therefore, to develop articulation strategies and generative resources that secure continuity for the tradition without undermining the ipseity of the craft or the representation of its practice community.

Methodological approach

Primary research is being developed in close proximity with several communities of practice, particularly within the context of workshops and training centres run by state and non-profit organisations for purposes of expanding the practice base. A key collaborator in this regard has been the Inash Al-Usra Association which has been supporting the upkeep of the craft since 1965 and whose main motive is to preserve Palestinian identity and heritage by empowering women, who form its central pillar.

During the research process, the archives of the Palestinian Museum and the Birzeit University Museum have also been consulted, which include rare collections of traditional garments dating back to the mid-1800s. Another collaborator and a key source of information for the study has been the Palestinian Heritage Center, a hub for the embroidery industry before 1948, which currently possesses an extensive collection of handmade Palestinian dresses. Fieldwork with and within the mentioned entities is ongoing, and a further set of collaborators is under consideration. The main aims of the fieldwork are to create an image bank for visual analysis and gather information on semiotic and semantic derivations of the motifs and patterns represented in the iconography.

The project also emphasises sharing and discussing research findings with practising designers, which at present is an exploratory exercise towards generating ideas for implementation scenarios. In future phases, such interactions are expected to be more focused, especially taking into consideration the possibility of interpreting iconography as a situated system of visual identity in contemporary Palestinian graphic design.

Visual research, therefore, is an imperative component of the analysis and will be instrumental towards a number of corresponding research actions, such as deconstructing compositional elements and determining the levels of taxonomic hierarchy that can then inform the prospected construction of the visual identity system, and subsequently, integration of the craft form into graphic design practice and pedagogy.

Expected outcomes

The prospective outcomes include a visual archive bringing together imagery from a diverse group of primary and secondary sources consulted during the period of research. The project will correspondingly seek the possibility of making

the archives open access and expandable towards integrating further contributions from the community. The analysis of these visual resources, as described above, is expected to lead to an inferential understanding of the taxonomic structure of the craft and, subsequently, a proposal for considering iconography as a unique visual identity system. Finally, the study's main findings will inform and be disseminated through curricular resources developed and contextualised individually for graphic design education and industry in Palestine.

Discussion

Palestinian history is rich in detail. Symbols and traditions extend to past civilizations spanning hundreds of years. Many different societies ruled Palestine, and it has been a region of permanent conflict, provoking countless narratives of hope, grace, and glory that have enriched the culture and are reflected in its motifs and customs.

Restricting Palestinian embroidery and iconography to clothing or tourism products may be an economically viable practice for now. However, the role of embroidery as a way of life in Palestine needs further attention and activation, even in the face of the challenges posed by globalisation. The adaptability of these patterns within localised and outward-facing discourses can be enhanced by strategic integration in everyday graphic design practice. It would help internal audiences to re-acknowledge the provenance of these motifs and their significance to Palestinian heritage and provide further visibility to the craft and its practitioners as knowledge and heritage assets.

Explaining and interpreting these symbols will encourage workers and youth to enter and learn the craft form while fostering a mutually advantageous dialogue between traditional and contemporary creative practices.

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Design for Ukraine's heritage: engaging international students during times of war through design activism

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Abstract

The Russian invasion of Ukraine - which began in February 2022 - has caused, and continues to inflict, a substantial number of deaths and destruction of buildings, including museums, cultural institutions, and heritage. Despite the instruments of international law put in place to protect cultural heritage, alarming reports of the removal and displacement of museums' collections from occupied areas continue to emerge.

In the amid of this complex context, how can design researchers and educators prompt students towards the development of contributions for emergencies such as war? Can digital platforms be used to support such development? And how can these technologies be employed to safeguard and raise awareness about at-risk heritage?

Drawing from the legacy of design activism and socially responsible design, the research aims to provide an answer to these questions, presenting the results of the Design for Ukraine's Heritage (D4UH) experience. D4UH is an educational project, the first step of a broader strategy that has the goal of creating a network of European institutions and NGOs to envision and develop possible solutions to safeguard the Ukrainian museums' heritage during and after times of war. D4UH pairs 20 Ukrainian museums with 20 international students from architecture and design schools, united by the desire to give support to the Ukrainian heritage. Partners, students and museums are asked to collaborate in the collection of videos, pictures and interviews to design the Virtual Museum of Ukrainian Museums, which acts as a statement of Ukrainian museums' current situation. Offering the chance of engaging, researching, curating and designing the virtual exhibition's narrative space, students and design educators can directly experience how the action of designing can tackle intricate cultural, social and political issues. The expected results of the project are, in fact, not merely to exhibit Ukrainian cultural heritage, but also to consider the relevance of museum institutions themselves as guardians of temporality to be interpreted and protected, especially in times of war, because of their contribution to the community's progress.

Author keywords

Cultural heritage; digital museums; design activism; design education; design in emergency.

Introduction

The Russian invasion of Ukraine - which began in February 2022 and is still ongoing- continues to result in losses on both sides (MacFarquhar, 2022) and among civilians (Office of the High Commissioner for Human Rights [OHCHR], 2023).

Attempts to protect and enhance the Ukrainian cultural heritage have overall been timely and effective, although some worrying news regarding the territories still under Russian control has come to us (Spinney, 2022). Many projects have sprung up to help the cause: Save Ukrainian Cultural Heritage Online (https://www.sucho.org/) — coordinated by an international team and managed by over 1500 volunteers (Majstorovic, 2022) —, Skrynia — a cultural heritage protection programme run by Shadows Project (https://saveua.art/) —, the initiatives from the International Council of Museums (ICOM) (*Solidarity Projects Ukraine, 2022*), and the partnership between the International Alliance for the Protection of Heritage in Conflict Areas (ALIPH) and Getty (*ALIPH and Getty Partner to Protect Cultural Heritage in Ukraine, 2022*).

Among these initiatives there is the European Nonviolent Action Movement (MEAN, 2022). After a visit Kyiv in July 2022, MEAN volunteers — including a representative of our design university — received and helped promote support requests from 20 Ukrainian museums to Italian institutions. The idea of involving our students to help raise awareness about the current Ukrainian crisis and the protection of cultural heritage took shape: the Design for Ukrainian Heritage (D4UH) initiative was born.

In the first part of this paper, we will briefly discuss the three main themes around which the D4UH educational initiative has been developed: the protection of cultural heritage, the transformations of museum institutions in recent years, and the role of design activism. The second section will describe the initiative itself through the analysis of students' work, together with a reflection on its relevance and efficacy and the subsequent steps for spreading the results.

Background

The Protection of Cultural Properties as Common Heritage

As a reaction to the destruction inflicted by the Second World War, the Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict was adopted in 1954 under the auspices of UNESCO. It is the first and most significant treaty devoted to the protection of cultural property, which is defined in the same document as:

"(a) Movable or immovable property of great importance to the cultural heritage of every people [...]; (b) Buildings whose main and effective purpose is to preserve or exhibit the movable cultural property defined in sub-paragraph (a) [...]; (c) Centers containing a large amount of cultural property as defined in sub-paragraphs (a) and (b), to be known as centers containing monuments" (*Convention for the Protection of Cultural Property in the Event of Armed Conflict, 1954*).

The most significant aspect of the Convention is its definition of cultural property as universal heritage, rather than national heritage, "since each people makes its contribution to the culture of the world". Gradually, the concept has been expanded to include intangible cultural heritage, which is of particular significance in armed situations. In fact, one of the goals of wars is frequently the elimination of the historical-cultural identity of the enemy, beginning with questioning those identities while simultaneously establishing new ones and eliminating as rapidly as possible any evidence that may undermine the strategy (Chiodi, 2018, p. 46).

A second important aspect that emerged concerns the need to build respect for heritage. The Second Protocol to the Hague Convention of 1954 (1999) encourages the enhancement of the cultural legacy of the territory during times of peace through educational and informational initiatives directed at the civilian population. Nonetheless, as suggested by Chiodi (2018, p. 48), raising awareness of different cultures through the inclusion of propaedeutic subjects for inter- and infra-culturality related to cultural heritage in education programs would be especially crucial for cultivating respect for cultural properties as a common heritage.

The Museum: from object-oriented institution to polyphonic (virtual) space of memory

Historically, museums have centered their interest on the past: their focus on ancient artifacts has made them object-oriented (MacDonald & Alsford, 2009, p. 72) and this viewpoint has been prevalent for a long time.

In recent years though, the definition of museum has been revised to acknowledge, first and foremost, the significance of museum institutions as "democratising, inclusive, and polyphonic spaces for critical dialogue about the past and the future" (Lehmannová, 2020) as well as the relevance of community participation and the provision of "varied experiences for education, enjoyment, reflection and knowledge sharing" (ICOM, 2022).

The new kind of audience that the technologies' appearance has shaped over the 20th century has unquestionably played a crucial part in the evolution of the museum institution and in the birth of virtual museums, necessitating a shift in how knowledge is presented to the public (Williams, 2009, p. 16) through different media.

Experiments in the field of memorialization forms, which underwent several alterations in the last century, are of special relevance to this study. While monuments and memorials appear to lose their value with time and become lifeless replicas of a memory they can no longer revive or preserve (Bassanelli, 2014, p. 11), new physical and virtual forms of commemoration have recently emerged. All of them share, albeit in varying manifestations, the desire to engage people by offering chances for intercultural interchange, eradicating national barriers, and facilitating both geographical and political permeability (Bassanelli, 2013, pp. 27-28).

This change in the field of curation, which aims to build a link between the past and the present and start a conversation about current social issues, shows that institutions want to change how they contribute to a better future for society (Janes & Sandell, 2019). An example of the use of this approach can be found in Holocaust museums: they do not merely seek to stimulate visitors' interest in the subject from a purely historical knowledge perspective, but they propose activities, albeit sometimes with questionable outcomes (Popescu, 2019, p. 344), and invite visitors to *actively engage* in political and social actions, connecting past, present, and future not to let certain atrocities occur again.

The Potential Role of Design Activism

The shifts towards digitalization (Bekele et al., 2018) and activism (Janes & Sandell, 2019) happening in the museum field open new possibilities for design and designers. Specifically, starting to collaborate with museums keen to engage with social and political issues - exploring alternative routes beyond their historical (supposed) neutrality (Brekke, 2019, p. 268) - could be an area of interest for design activism and design activists.

With the term "design activism", we indicate a miscellaneous design movement acting on environmental, social, and/or political issues. Born in the '70s from the seminal work of Victor Papanek — *Design for the Real World* (1972) — and drawn from the Italian radical design movement — such as Superstudio and Archizoom — instances (Julier, 2013b), design activism can be nowadays understood as "[..] representing design's central role in (1) promoting social change, (2) raising awareness about values and beliefs (e.g., in relation to climate change, sustainability, etc.), or (3) questioning the constraints that mass production and consumerism place on people's everyday life" (Markussen, 2013). Sprouting from the need for disruption and injustice-revealing activism advocates for (Thorpe, 2011), design activism frames issues and generates better alternatives by "[..] a *designerly* way of intervening in people's lives" (Markussen, 2013), putting at the service of a community its aesthetic practice, its tools and its methods.

The range of action, within the design field, design activism can engage varies from fashion design to urbanism, from service design to architecture, covering different scales and types of projects. The wide in-the-making definition of design activ-

ism and its positioning as a relatively new subject of discussion still make scholars in the field debate about its inner nature, its relationships to design and its limits (Faud Luke, 2009; Julier, 2013b; Markussen, 2013; Thorpe, 2011).

To evaluate, reflect upon and understand the relationships between design and activism Thorpe (2011) proposed four open criteria:

- It publicly reveals or frames a problem or challenging issue.
- It makes a contentious claim for change (it calls for change) based on that problem or issue.
- It works on behalf of a neglected, excluded or disadvantaged group.
- It disrupts routine practices, or systems of authority, which gives it the characteristic of being unconventional or unorthodox—outside traditional channels of change.

Against these criteria and through the discussion of the D4UH initiative, the next section of this paper tries to reflect on and discuss the role of design researchers and educators in prompting students towards the development of design activism contributions.

Design for Ukraine's Heritage (D4UH)

D4UH is the first step of a long-term plan by MEAN to protect and digitalize the collections of 20 Ukrainian museums, by gathering basic information about their current state. To achieve this goal, an open call has been launched to students of architecture and design schools from different universities. The results of the initiative will give birth to the Virtual Museum of Ukrainian Museums, with the broadened aim of increasing awareness of the situation in which these cultural institutions find themselves, attracting the attention of the public as well as private institutions and individual citizens, and inviting them to an active engagement.

Method

The project adopted a Participatory Action Research (PAR) approach, following the definition given by Reason and Bradbury: "action research is a participatory process concerned with developing practical knowing in the pursuit of [...] practical solutions to issues of pressing concern to people [...]" (2007, p. 4). Specifically, the initiative used a PAR strategy with the two goals of encouraging student engagement in socio-political concerns and fostering activist participation in emergency situations.

D4UH involved different types of actors: museum directors and their collaborators - partnering since previous months through the coordination of the National Museum of the History of Ukraine-, students, volunteer linguistic mediators, MEAN, researchers and professors from the hosting university and a national council of research.

The initiative engaged 20 students of different nationalities and universities, including two Ukrainian students. Each of them has been assigned to one of the 20 already-mentioned museums, the majority of which are small local history museums that lack the resources to protect their artefacts and disseminate information about their condition to a large audience outside their own country.

The characteristics of the museums and their staff, as well as the unique circumstances, necessitated a heightened level of commitment from the Ukrainian students and other native-speaking volunteers, who worked as cultural mediators and tried to foster an atmosphere of mutual trust.

The initiative evolved through four online workshops and reviews with the students: an introductory presentation of the project and participating museums, two meetings to verify the work's progress, and one final presentation. It was determined that a digital whiteboard was used so that students could share material and discuss their various research strategies even remotely.

Insights and outputs from students' research

The students' research was organized with a time frame: the past, the present, and the future. Regarding the past, they focused on the museum's history, museological characteristics, permanent collections, and significant temporary exhibitions. The most essential component of the investigation, however, was the analysis of the current situation, from mapping the military condition of the museums' areas to determining whether the museums were currently open and with what activities. The information collected was pivotal to understanding what similar initiatives and strategies were already put in place, and to building a comprehensive picture of how the museums are using their spaces to serve the local communities in the emergency.

The students constantly monitored the state of the museums using social media news and direct connections with collaborators, when possible. Thus, they were able to determine if and when museums were harmed, as well as the extent of the damage and the condition of their permanent collections.

Challenged with the question of the museums' future at the end of their research, students displayed, on the one hand, great respect and sensitivity for the current situation and, on the other, an innovative spirit, insisting on the need for the digitalization of the collections and the creation of virtual educational paths also accessible to foreign audiences. The interaction with the museum directors helped establish actual action steps, beginning with the short-term demand for the conservation of the works and moving to the long-term improvement of museum itineraries.

The narration of the war period has become a focal point of interest, especially in damaged museums. For example, when talking about the renovation of a local history museum that had been badly damaged by bombing, a student suggested "keeping the remnants and mixing them with new pieces as a reminder of the aftermath of the war and how the museum recovers." This shows the importance of including the traces of the war in the narrative space of the museum.

One of the participating students began to reflect on the second phase of the strategy: the design of the Virtual Museum of Ukrainian Institutions, which would store the results of the PAR undertaken in collaboration with students and museums. The virtual museum — the subject of his degree thesis — will be "set up" within the National Museum of the History of Ukraine. The tour will start at the museum's entry with an explanation of the project's goals and instructions on how to explore the virtual space. Each room will be devoted to a specific museum, turning the museum institution into a subject to be narrated and experienced through the storytelling of its past, present, and future. The exhibition will employ the Kintsugi concept and interactive elements to depict the general condition of Ukrainian history and the specific conditions of each museum. The overall installation atmosphere will try to foster a positive attitude towards the future.

Discussion

Using the criteria developed by Thorpe (2011) as guidelines, in this section, we discuss the project results, their relevance, potential and limits. Firstly, the issue D4UH reveals and tries to frame regards the protection of cultural heritage in war zones and/or in countries at war. Through the engagement of local actors and the desk research carried out by participating students, investigations around the 20 museums' situations highlight how — in times of emergency — it is hard to distribute and properly direct resources, both in terms of skills and financial aid. We noticed how small and rural museums struggle more to access support and, despite being guardians of traditions, stories and identities of a piece of territory, make their voices heard by the broader international community. We experienced challenges in getting and keeping in touch with some of the above-mentioned museums: trust issues due to the little time at our disposal to "set the scene" of the project, communication barriers such as language and operational problems as the difficult access to broadband and electricity were just some of the limits we have had to face.

Reporting and researching that specific situation, D4UH tried also to make a claim for change: raising awareness, giving visibility and supporting (less renowned) museums in times of war is a chance to safeguard the tangible and intangible cultural heritage of a population. The "neglected, excluded or disadvantaged group" (Thorpe, 2011) the project aimed to work for/on behalf of was, in fact, the broader community of people who identify themselves or feel close to Ukrainian history and culture.

Lastly, we can see how this project can be considered a design activism action as — with its use of digital platforms and by being carried out in an educational environment — it moved "outside traditional channels of change" (Thorpe, 2011). In the emergency caused by the war, digital tools had been vital to engage with local stakeholders, collecting, elaborating and disseminating precious information: all communications and material exchange had been made possible mainly via the web (for e.g.: via e-mails, social networks, instant messages apps..); students gathered, analyzed, synthesized and systemically presented all found data on a digital collaborative platform; the final output itself is going to be a digital experience in the shape of a virtual museum. The important use of digital technologies provided us as well with the opportunity of bringing together international students from different universities, giving us the chance to experiment with a sort of remote activism through design research in an educational context. Of course, if on one hand 'digital' makes D4UH possible, on the other it underlined some criticalities such as trust development between stakeholders, and the dependence on broadband and power lines which are at stake in territories in war.

Conclusion

The purpose of D4UH was to include students in the creation of a design activism contribution. The PAR, on which students, volunteers, and museum staff collaborated, demonstrated and made visible the war's impact on Ukrainian museum institutions.

In the week following the conclusion of the initiative, one of the partner museums was bombed, and only a part of its collection was preserved. In light of this last event, it is essential to continue documenting what is happening to preserve the identity of the Ukrainian people and their cultural legacy for the benefit of society as a whole.

The research results will be shared with a wider audience through the implementation of the current Virtual Museum of Ukrainian Museums because, in the words of one of the participating students, museums' "role in preserving and narrating the [...] culture, history, and stories, despite the suffering and danger in which they found themselves, showed to us how that despite perils, there are always stories that must be narrated".

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The impact of vertical greening on local microclimate: preliminary results of field monitoring in Ghent, Belgium

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Abstract

Urban environments, especially city centres, are subjected to higher temperatures and higher pollution levels relative to their less dense surroundings due to the urban heat island effect. The key factor to mitigate those drastic consequences for human and natural environments is implementing green initiatives. Despite the abundance of built heritage in city centres, they are often excluded from the mitigation strategies of cities due to several reasons such as concerns about their impact on materials and structural integrity. The uncertain impact of vertical greening on the built heritage can be investigated in different ways, such as monitoring case studies, laboratory studies, analysing literature and additional simulations, which are complementary in order to understand the real impact. This paper scopes the preliminary results of a case study in Ghent where vertical greening is able to reduce the amount of incoming solar irradiation and the amplitude of the temperature and relative humidity fluctuations on a wall.

Author keywords

Vertical greening; Built heritage; Monitoring case studies; Microclimate; Urban heat island

Introduction

Historic buildings determine the landscape and identity of cities, which makes them an essential part of the urban environment. Due to its cultural and economic values, it is necessary to preserve and maintain our built heritage. Current global challenges such as climate change and the urban heat island effect, where city centres experience higher temperatures and higher pollution levels relative to their less dense surroundings, complicate heritage preservation (Huerto-Cardenas et al., 2021; Oke, 1982). Due to their location in city centres where the urban heat island effect is strongest, and their associated cultural and economic value, built heritage must be included in the urban mitigation strategies to enable sustainable conservation. While urban environments are implementing green initiatives such as green walls, green roofs or street trees, the built heritage is excluded from the mitigation due to the limitation of a dense urban fabric (especially in city centres), the conservation rules and the uncertainty about the structural integrity and the consequences of this implementation on the historic building materials.

Research context

This research scopes the impact of vertical greening on the local microclimate and the corresponding impact on the common forms of degradation of historic building materials caused by salts, frost, bio-activity and air pollution. Vertical greening in this research represents plants, rooted in the ground, and climbing up the façade by either attaching themselves to the surface or trellising (Dover, 2015). Vertical greening is seen as one of the green initiatives with great potential in dense historic environments due to their limited footprint while still being able to cover a large area of greening (Norton et al., 2015; Ottelé, 2011).

By monitoring case studies, analysing literature, performing experiments and additional simulations, we aim to understand the impact of an implementation of vertical greening on built heritage. In order to understand the complex impact of vertical greening on the local microclimate which determines the risk of weathering of historic building materials, we try to combine the different approaches. The monitoring of the case studies will determine the impact of vertical greening in the urban environment of Antwerp, which is subjected to an urban heat island effect and thus the focus in this research.

This paper will discuss the case study's setting, findings, and the environmental parameters that the monitoring focuses on. The results of the bare wall and the wall with vertical greening in front are compared with each other to illustrate the impact of vertical greening on the local microclimate.

Preliminary data

This paper scope the test case study in Destelbergen, Ghent (Belgium). Destelbergen is a submunicipality of Ghent and rather a rural environment. This case study was undertaken to establish the mounting requirements for measurement instruments and their monitoring capabilities and settings.

Monitoring environmental parameters

The main focus of monitoring this case study is on how the implementation of vertical greening can affect the local microclimate. Therefore, the environmental parameters are measured in front of both walls – the wall with and without vertical greening – and compared with each other. In literature, the most frequently discussed environmental parameters affected by vertical greening are air temperature, surface temperature and relative humidity. These parameters are also significantly impacted by the urban heat island effect. Air temperature and relative humidity are responsible for the comfort of people in the city, while the surface temperature is seen as the energy balance centre of urban surface and as the most important factor affecting the urban climate (Yang et al., 2016). Additional, solar irradiation is strongly connected with the temperature and relative humidity values which makes this parameter as important as the others.

This case study explores the impact of vertical greening on the air temperature, surface temperature, relative humidity and solar irradiation nearby or on the wall. Each parameter has its significant impact on the four aforementioned degradation of historic building materials. For example, freeze-thaw weathering needs low temperatures and high moisture levels to occur. A change in those environmental parameters due to the implementation of vertical greening can have, beneficial or adverse, impacts on the degradation of historic building materials (Baer et al., 2009; Camuffo, 2014; Godts et al., 2021; Moncmanová, 2007; Siegesmund & Snethlage, 2014).

Case study features

The case study wall is located in a test centrum PCS (Proefcentrum voor Sierteelt) in Destelbergen (Ghent). PCS is an independent knowledge centre for floriculture and greenery in Flanders, Belgium (PCS, n.d.). This wall exists of different types of mature ivy and is facing a north orientation. Our case study was only a part of this wall and was performed on the part with Hedera *Helix* 'Glacier'. The measurement devices were installed in the vertical greening and at the bare wall on the same height and recorded environmental conditions from 21 September 2022 until 23 December 2022.

Figure 1. Set-up of monitoring devices on the wall of the case study in Destelbergen with a set-up on the bare wall and a set-up in the vertical greening (Hedera Helix 'Glacier').

Methodology

In order to make a good comparison between the environmental conditions surrounding the bare wall and the green wall, the same monitoring devices are installed on both parts of the wall (Figure 1). The air temperature and relative humidity are measured together with a HOBO S-THC-M002 smart sensor which is covered by a solar radiation shield (HOBO RS3-B) to prevent the measurements from being affected by the solar irradiation. This device is installed at a distance of 10 cm away from the wall surface. The surface temperature is measured with a HOBO TMC6-HE temperature sensor, which is mounted against the wall. The amount of solar irradiation is measured with a silicon pyranometer sensor (HOBO S-LIB-M003) covered by an light sensor level (HOBO MLLA) to receive accurate measurement and is mounted as close as possible against the wall.

The sensors for air temperature, relative humidity and solar irradiation are connected to a HOBO USB Micro station data logger, which collects their data at a frequency of 15 minutes. The surface temperature is connected to a 4-Channel Analog Data Logger, HOBO UX120-006M, and provides measurements at a frequency of 15 minutes.

Results and discussion

By analysing the data of the test case study, it is clear that vertical greening has a significant impact on the environmental parameters.

First of all, vertical greening is able to lower the amplitude of fluctuations of the surface temperature significantly over the whole monitoring period. More specifically, vertical greening is able to reduce the maximum surface temperature by up to -1.12°C while the minimum surface temperature increases by +1.88°C. The average surface temperature of a wall with vertical greening is 0.57°C lower relative to the corresponding bare wall.

Secondly, the effect of vertical greening over three months of monitoring is less pronounced in the air temperature, probably due to the positioning of the measurement device at a distance of 10 cm from the wall surface. Vertical greening causes a negligible difference in the average air temperature relative to the corresponding bare wall. Similar to the surface temperature, the fluctuations of the air temperature are smaller due to an implementation of vertical greening. The maximum air temperature is 0.16°C lower in front of a green wall compared to the bare wall and the minimum air temperature is 0.13°C higher.

Thirdly, the relative humidity is measured with the same measurement device as the air temperature and is therefore also installed on a distance of 10 cm relative to the wall. By comparing the two walls to each other, there is only a small difference noticeable in the relative humidity due to the implementation of vertical greening. Over the whole monitoring period, the relative humidity of the green wall is on average +1.07% higher relative to the corresponding bare wall. Due to

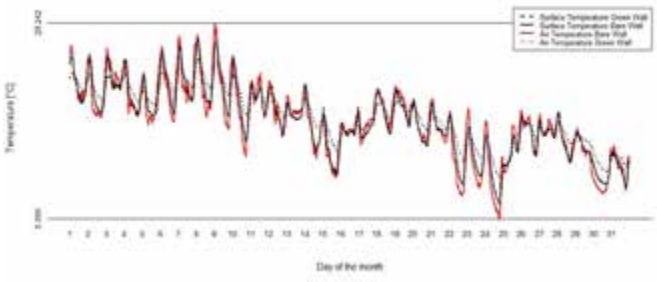

Figure 2. This graph is a subset of the whole measuring period and illustrates the surface (black) and air temperature (red) of the wall behind vertical greening and the corresponding bare wall during the month October 2022.

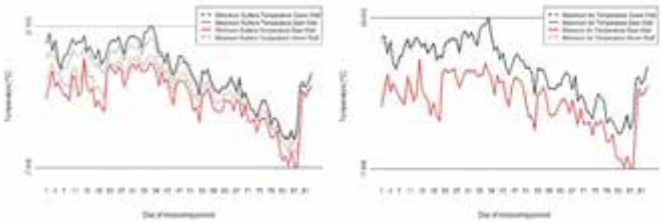

Figure 3. The graphs illustrate the maximum (black) and minimum (red) values of the surface temperature (left) and air temperature (right) of the wall behind the vertical greening compared to the corresponding the bare wall (red) during the whole measuring period.

the low amount of solar irradiation in the north orientation, it is likely to have a lower amount of evaporation which contributes in rising the relative humidity in front of a green wall.

Lastly, the amount of incoming solar irradiation is affected significantly by an implementation of vertical greening. The average amount of incoming solar irradiation is lowered with 76.88% while the maximum values of the incoming solar irradiation are lowered with 79.70% relative to the bare wall. Those results can have a significant impact on the aforementioned degradation types of historic building materials.

The results of this paper represent already a clear impact of vertical greening on the local environment, even though this case study was located in a rather rural environment. In order to have more extensive results, a longer measuring time and a larger amount of walls with different orientations and a location in the city centre should be taking into consideration for the monitoring of future case studies. The more data available, the more interesting connections that can be made between the impact of vertical greening on the local microclimate and different variables such as seasons, orientations and climate types and the more it can be understood how vertical greening can have an impact on the most common degradation types of historic building materials, especially in an dense urban environment.

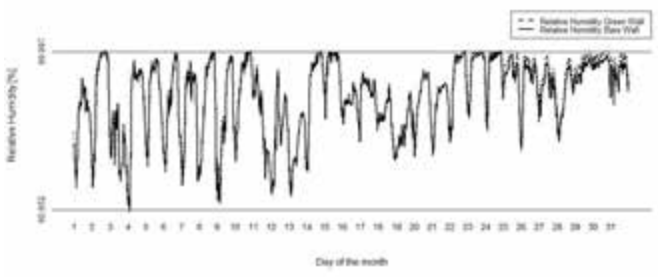

Figure 4. The graph is a subset of the whole measuring period and illustrates the relative humidity of a wall behind the vertical greening and a wall without vertical greening during the month October 2022.

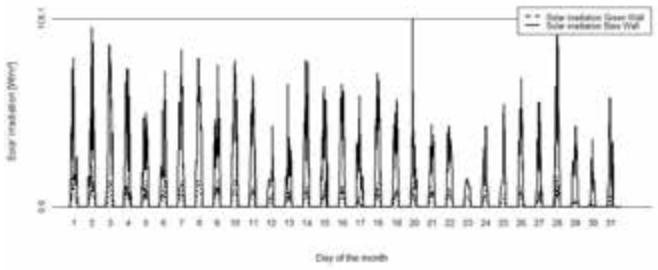

Figure 5. The graph is a subset of the whole measuring period and illustrates the incoming solar irradiation on a wall behind the vertical greening and on a wall without vertical greening during the month October 2022.

Conclusion

This case study performed in Ghent illustrates the beneficial impact of vertical greening on the local microclimate. In general, the environmental conditions of the wall will be less extreme and therefore more likely to have a beneficial impact on the degradation of historic building materials. This means that vertical greening is able to reduce the urban heat island effect on a local scale while it only needs a small footprint to cover a large surface area of greening. First, the surface temperature, which is an indicator for the urban climate, is reduced significantly. Further, the impact of vertical greening on the air temperature and relative humidity is smaller but the reduction in air temperature is still beneficial for the comfort of the residents. Last, vertical greening is able to reduce the amount of incoming solar irradiation significantly, which is beneficial for the degradation of historic building materials but also for the comfort and energy efficiency in buildings.

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New design models for proximity retail and senior inclusion

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Abstract

According to the world health organization (WHO) the impact of the pandemic on the population aged 60 years or over still need further assessment. Besides biological and physiological risk factors, indirect risk factors derived from loneliness and exclusion must be considered. When asked about the impact of social distancing and isolation over the course of the lockdowns, many seniors reported a degree of physical and mental deterioration. The prolonged restriction of mobility caused a lack of confidence in their walking ability and less motivation to spend time outside, leading to sedentary behavior. In some cases, the pandemic increased awareness about ageing itself, but this was often perceived as a negative rather than positive life transition (Phillipson et al., 2021). Mobility is generally associated with active ageing and has several benefits on the individual's quality of life, whereas a sedentary lifestyle amplifies age related conditions. Studies have shown that the most ordinary everyday activities, such as shopping, can have long-term health benefits. As a matter of fact, this simple daily activity can stimulate cognitive processes and provide physical benefits while promoting social engagement. Older adults who preserve social interactions are proved to have 50% increased chance of living longer than the isolated ones (Holt-Lunstad et al., 2010). Going out of home and interact with public spaces such as supermarkets, is therefore essential to seniors as they allow them to feel connected with the local community maintaining their identity favoring the process of active ageing. In the given context a strategic design approach can help shaping a different proximity retail format which can enable "time-rich" senior users to engage in a unique form of "convenience-shopping" revolving around social interaction and convivial relationship, rather than on a time-saving and automated experience. The research aims to examine new functional configurations for proximity retail with particular attention to promoting the social networking of elderly people.

Author keywords

Active ageing; Isolation; Public spaces; Proximity retail; Social interactions

Ageing population and social exclusion, the effects of the lockdowns

The progressive ageing of the population in western developed economies must be dealt with as one of the main challenges to maintain a healthy social interaction in future cities. The unprecedent life condition of the pandemic with its social isolation, could easier make evident that people aged 80 or over were 5 times more at risk of death than before due to the additional indirect risk factors derived from loniless and social isolation as they are more likely to face lone life, loss of family members and friends, chronic illness, and hearing loss. (Loneliness and Social Isolation LInked to Serious Health Conditions, 2022). Despite them being strongly subjective factors, social isolation and loneliness were proven linked to (*Social Isolation and Loneliness in Older Adults*, 2020)

- Increased risk of premature death from all causes, a risk that may rival those of smoking, obesity, and physical inactivity.
- 50% increased risk of dementia.
- 29% increased risk of heart disease and a 32% increased risk of stroke.
- Higher rates of depression, anxiety, and suicide.
- 4 times higher risk of death, 68% increased risk of hospitalization, and 57% increased risk of emergency department visits in isolated patients with heart related conditions.

The segregation of already marginalized subjects such as isolated seniors or other not self-sufficient individuals can therefore effectively be considered a form of abandonment (Armitage & Nellums, 2020; Han & Mosqueda, 2020) to the extent that it does not only affect the physical wellbeing of the isolated individuals, but it prevents them to access primary services and goods while eventually resulting in age–based discrimination, so called ageism. According to the World Health organization "WHO" the term ageism refers to "the stereotypes (how we think), prejudice (how we feel) and discrimination (how we act) towards others or oneself based on age" (WHO). It is reported that elders are typically associated with negative physical to mental condition which make them essentially uninteresting and unattractive for the community. As a result, the older person who has unwillingly internalized these clichés just accepts them as representative of his/her condition. Unlike other forms of discrimination, ageism is often normalized and even disregarded, hence, not considered as a task in urban development.

Over the course of the COVID lockdowns many seniors experienced an important "degree of physical and mental de-

terioration" (Phillipson et al., 2021). The prolonged restriction of mobility particularly concerned those with already existing mobility problems as the home confinement induced a lack in motivation to simply leave the house, encouraging the sedentary behavior of many elderlies. Evidence suggest that the pandemic may have caused "significant changes to the "relationship of groups and individuals with public spaces, reducing the possibility of spontaneous or casual relationships. This is indicated by the extent to which the two activities which bring people into public space - shopping and socializing - are precisely those most affected by the pandemic" (Phillipson et al., 2021).

Mobility and wellbeing

Bringing it to the point, it can be stated that "mobility, locality and social networks influence the perceived quality of life, and this perception or wellbeing can be reconstructed in terms of six main "building blocks" (Banister, 2004; Bricocoli et al., 2018):

- Peoples' standards of social comparison and expectations of life.
- A sense of optimism and belief that "all will be well in the end".
- Having good health and physical functioning.
- Engaging in many social activities and feeling supported.
- Living in a neighbourhood with good community facilities and services (including transport).
- Feeling safe in one's neighborhood.

These subjective and social factors seemed to contribute far more to the perceived quality of life than indicators of material circumstance, such as actual levels of income, education, home ownership or social class (Bowling et al., 2002). It is important to state however that these qualities are different from one individual to another and will always keep being subjective matters even if generally suggested for a healthy life style. "Profiles of ageing mobilities are defined considering the interplay of mobility and movement. Mobility is the ability to move through space and overcome spatial friction, while movement consists of putting mobility into practice" (Akhavan & Vecchio, 2018). A priority target in building neighborhood communities is the availability of worth-to-reach public spaces that trigger the mobility of elder people in order to overcome individual hurdles.

Walking has always been promoted as a good practice among older adults due to its many health benefits, ranging from lower risk of cardiovascular conditions, obesity, diabetes, and lower mortality in general. It is useful however to distinguish between recreational and utilitarian walking "Utilitarian walking can be defined as walking to shop and do other necessary errands or tasks of daily life". While recreational walking is considered optional and "not necessary", utilitarian walking become crucial to keep their independence. By being often the only physical activity, it plays a crucial importance of providing with opportunities to shop inside the neighbourhood, to reach places of social contact and interaction, and health services such as general doctors and pharmacies. These spaces contribute in the sense of belonging to a place, constitute the imageability of the place (Lynch, 1960) in order to keep stable the understanding of one self's location inside a larger community space which centre is the own dwelling (Paradisi, 2017). This sense of belonging and attribution to one's environment as an integrated living space mitigates and overcomes a series of physical and psychological barriers, that occur more often in aging people. That affects positively the social engagement by feeling part of a place. Because otherwise, it's not rare for elderly with hearing impairments to decide not to engage in communication in the first place, as they might feel embarrassed by their condition. Vision impairments can cause the elderly to have hard times reading instructions, signs, or spot other people around them, also poor vision can even trouble listening and comprehension.

The importance of daily shopping activity

The impact of these issues is huge and avoids leading the elderly to reconsider their habits and downgrade their lifestyle choices essentially resulting in an unhappy life characterised by apathy and personal devaluation ultimately leading to self-isolation and exclusion. Recent studies suggest that it might be the most ordinary everyday activities, such as shopping which can have the biggest impact on health and wellbeing on the long run. Among 1800 individuals aged 65 or over, those who shopped every day, have been observed to have 27 % lower risk of death than those who did not (Chang et al., 2012). Shopping stimulates cognitive processes as the shopper must identify the items they need, compare different products, and determine whether an item is indeed worth being purchased based on a value to cost assessment. These kinds of task are stimulating those areas of the brain in charge of the decision-making process. Other benefits stem from the opportunity to make buying decisions that could positively affect their health in the long term together with the physical activity, typically walking, involved in everyday shopping. The last component is social interaction, which might be the most significant one as it has been shown that socially invested elderly are 50% more likely to live longer than isolated ones (Holt-Lunstad et al., 2010). Shopping is in fact for many an actual way to leave their home and meet or interact with people such as neighbours or casually bump into friends and acquaintances. Shopping places are therefore essential to seniors as they allow them to feel connected with the community and express their identity in a social context, Generally, shopping centres and supermarkets are regarded as "public yet non-civil space" on behalf of their consumerist nature. "Such spaces encourage action, not inter-action. Any interaction between the actors would, however, keep them away from the actions in which they are individually engaged and would be a liability to each, not an asset The task is consumption." It is even fair to say shopping centres and supermarkets are conceived as "non-places" which "accept the inevitability of a protracted, sometimes very long sojourn of strangers, and so do all they can to make their presence 'merely physical' while socially little different, preferably indistinguishable altogether" (Bauman, 2000). Despite discouraging "the thought of 'settling in', making colonization or domestication of the space all but impossible"(Bauman, 2000) shopping centres and supermarkets have become important community meeting places for a wide range of users from different age groups and financial backgrounds (White et al., 2013). Together with parks, gardens, and squares, "commercial spaces" are not a less popular nodal point for elderly communities. It is therefore time to investigate the senior's experience of community spaces, particularly in relation to their sense of inclusion in, or exclusion from,

consumptive spaces. However, as various research studies have demonstrated, the meaning of 'shopping' varies greatly in terms of motivation, experience, emotion and satisfaction (Tauber, 1972). Indeed, going to the commercial area does not necessarily mean the pursuit of shopping at all; it can be an activity of pure leisure that does not require purchasing anything except a cup of coffee perhaps (Novak, 2006; Weinblatt et al., 2000). Part of what makes such public spaces so attractive is the sheer diversity of people, and activities, within them (White et al., 2013). Many seniors therefore gladly engage in "People watching", that is the act of observing of people. Sharing this "activity" with peers is one way how seniors can effectively create social networks by spontaneous and casual encounters in public spaces as well as consumption sites. For their characteristics we can suitably define seniors as "time-rich" users, which in opposition to their "time-poor" younger counterpart, are prone to a different and unique form of "convenience shopping" revolving around social interaction and convivial relationship, rather than on time saving and automated processes.

Proximity retail, convenience shopping: innovation and trajectories

The gradual shift in consumer habits, the effects of inflation together with the rise of digital economy and e-commerce are the main reason behind what has been called "retail apocalypse" which determined the closing of numerous brick-and-mortar retail stores. Thanks to accurate inventory control, special seasonal discount (i.e., black Friday/ cyber-Monday) and constant attention to innovation and customer experience, digital platforms outperformed conventional physical stores. The COVID-19 outbreak just added to the ongoing crisis as many storeowners were forced to shut down as non-essential business, effectively marking their definitive expiration. For physical stores to stay relevant and keep up with their digital counterparts, the brick-and-mortar format had to be updated in the fashion of an experiential retail which could make use of the physical retail space to offer additional experiences beyond conventional shopping. Since time, this strategy of exploring new retail formats led to the appearance of numerous temporary stores, pop up shops and concept store which in many cases use digital technologies as a mean to effectively enhance the experience of shopping in person. However, that is not the case for the traditional local business and proximity retail shops/corner shops which inevitably lost the competition with big retailers, department stores and their digital stores. As small corner shops and family businesses began disappearing, big retailers gained traction and started expanding their presence in the proximity retail market and the central areas of the city. According to large retail chains the small format store is ideally the best format to try out new marketing approach and solutions to later adopt on a bigger scale. The proximity retail format assumed the traits of the convenience store and quick shopping. If departments stores and supermarkets can offer a wide and localized assortment, small format proximity stores are an answer the on-demand shopping and impulsive buying. In 2016 the leading e-commerce platform Amazon opened its own chain of convenience store for grocery and daily shopping. "Amazon Go" stores are tight and hyper technological spaces which aim to offer the ultimate time saving, seamless approach to daily shopping rather than an experience. The fact alone, that the most renowned e-commerce platform and tech operator in the world decided to open a chain of physical shop should be enough to grasp the unexpressed potential of physical stores and proximity retail. Italian retail store chain Esselunga, is not new to innovation as it was the first retailer in Italy to introduce customer fidelity program (1995) and experiment e-commerce with the launch of their website (2001). Proximity retail stores "LaEsse" by Esselunga are the latest evolution of the Italian brand introduced to intercept new consumer behaviour shifting to daily and impulsive shopping while expanding the brand presence to the city center and neighborhoods. Esselunga has intended these stores as modern and premium reinterpretation of local convenience stores, which provides for two different shopping experience: one concept points on a "gourmet" like shopping with exclusive product categories like wine cellar, related to impulsive purchase while allocating daily products to a more automated platform. The more recent "iteration" of the "laEsse Hop" format is the most disruptive one as the store is meant to act both as a delivery hub and corner shop at the same time. Customers can order their groceries online and pick them up in person or have them sent home straight from their local store. Like in a conventional convenience store customers can shop in person at the store but all they must do is place their order through the tablet at the storefront as goods are only accessible by the staff "behind the scenes".

User interviews

In this context a series of qualitative user interview were conducted among the older customer of 4 different markets/ supermarkets asking their experience about social isolation, everyday routines and lastly about shopping to get some user insights on their experience.

4 different areas of the city of Bologna, Italy were purposefully chosen to investigate each kind of "ageing neighborhood": Bologna city center, S. Donato and Pilastro neighborhood at the first periphery and Osteria Grande at approximately 28 km from Bologna. The participants who trusted taking part in the survey ranged in age from 60 to 87. They were interviewed while standing or sitting nearby the shopping place. People aged 60 to 70 years, who just retired from work, are glad to finally spend time at home. This attitude however changes as they grow older as older participants referred, they liked spending much time at home at first, but soon started miss their past busier life as it felt more self-fulfilling. In the city center it is more likely to meet a person who happened to keep in touch with long-time friends of the same neighborhood. It is possible to identify 4 recurring themes in their experience: they were characterized by a decent level of mobility nevertheless they complained about their lack of autonomy which eventually made them homebound. Following the death of a significant other, most of the elderly who live alone won't be able to reach valuable opportunities. Many shared a relevant degree of insecurity and mistrust. Except for younger individuals (60-70 years old) the others clearly stated they would like to spend more time out; hence they preferred walking to the store rather than get their groceries delivered. However, there was a general desire for companion. That is particularly the case for all those who had experienced a fall and now lost confidence in their own physical ability. The interviews confirmed the central role of supermarkets and shopping spaces to replace (missing) recreational places in order to interact with peers.

Findings for a design concept

Throughout the research emerges the necessity of "upgrading" proximity retail for daily necessities with opportunities of social encounter for elderly people. Later years of life can be characterized by physical and mental decline, which can be contrasted by moving and social interaction, as well as mental activities such as choosing products. In an age where digital technology eliminates and replaces physical meeting places, necessity-based shopping is an essential activity which motivates people into public space, helping shape their sense of identity and belonging. Alongside the current phenomenon of e-commerce and delivery services this research stresses the important role of physical retail and suggests exploring the idea of an extended form of "convenience shopping" that offers additional services and community spaces for elder people and which aims to stimulate human interaction. Latest retail trend consisting in dematerialization, virtual showroom, and the implementation of state-of-the-art logistics for home delivery, aimed to the ultimate user experience needs to be eventually matched by a tangible equivalent, able to properly fulfil the growing need of inclusion and participation of the elderly population, avoiding isolation and all related conditions. Instead of claiming for returning of a traditional proximity retail that has already been replaced, the concepts want to gain benefit from up-to-date technology to diversify services, grasp best practices of delivery and shopping experience, eventually integrate marketing strategies of cashback and token in order to create a lively environment that is integrated with chat corners, newspaper readings and simple consumer offer. Return of Investment strategies for economical rentability have to be consider in order to create a sustainable retail format that might be also integrated in existing spaces as extended services.

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Investigating spatial patterns of green infrastructure at built heritage sites in Antwerp, Belgium

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Abstract

Green infrastructure has become a favourable solution to mitigate the effects of climate change, rapid urbanisation and the loss of biodiversity. However, historic buildings at the core of the urban fabric are often excluded from GI for reasons of conservation and the fear of plant species damaging the historic structure. There is little research and, therefore, evidence on the successful use of GI in historical contexts. This study addresses this gap by investigating different types of GI found in historical contexts. Spatial patterns found in the city centre of Antwerp in Belgium are analysed through the lens of architectural design theories and traditional heritage value assessment. This is the first step in creating an evidence base for best practices of GI in association with built heritage.

Author keywords

NbS, Heritage Value, Sustainable Development, Urban Heritage, Biophilic Design, Architecture

Introduction

In response to rapid urbanisation and global challenges like climate change and loss of biodiversity, cities are increasingly adopting nature-based solutions, which include Green Infrastructure (GI) like green open spaces, trees, green roofs and vertical greening systems. GI are strategically planned green spaces that provide numerous benefits, so-called ecosystem services (Norton et al., 2015; Tzoulas et al., 2007; Sharifi, 2021; Sturiale & Scuderi, 2019). Known benefits include improved air quality, reducing the temperature and overall urban heat island effect, contributing to (storm)water management, and increasing urban biodiversity and ecosystem health (Abdo & Huynh, 2021; Selbig et al., 2022; Ysebaert et al., 2021). In addition, GI has positive impacts on psychological and physical well-being, like reducing stress and improving attention (Kaplan & Kaplan, 1989; Ulrich, 1983). In this green transition, many historic cities have become pioneers of sustainable development and the willingness to adopt GI due to the societal and governmental acceptance of these projects (Beatley, 2012). Despite this, the compatibility of GI with historic built heritage has received little attention.

There is a common belief that GI is incompatible with built heritage as it can potentially alter the aesthetic values and physical integrity of building materials through biodegradation, plant-induced explosions, and cracks. In addition, there is a concern that integrating GI into built heritage may obstruct conservation practices by requiring additional management and maintenance activities (Ashurst & Ashurst, 1988; Coombes & Viles, 2021). However, these concerns are largely based on studies focusing on neglected and abandoned historical buildings or archaeological sites rather than representative built heritage contexts (Celesti-Grapow & Ricotta, 2021).

From a social perspective, individuals' negative perceptions of green layers on historic buildings are primarily associated with their physical and biological connections to natural and built environments (Kellert, 2008). Researches suggest that being disconnected from nature can build biphobia in the built environment (Ulrich, 1993), therefore, creating a bias against invasive and pest-attracting vegetation in public areas (Coombes & Viles, 2021). As a result, people tend to prefer manicured landscapes in urban settings because they are associated with maintenance (Hoyle et al., 2017), which could even lead to gentrification (Moore & Cooper Marcus, 2008). However, it is important to note that people may require genuine contact with nature rather than just superficial "greenwashing" (Browning et al., 2014).

To leverage the full potential of historic buildings in the greening of our cities, there is a need for evidence-based research analysing the successful and deliberate examples of GI in the context of built heritage within a framework of heritage values and spatial attributes. In this study, we focus on GI in a close relationship with historic buildings (vertical green, green roofs, and trees).

Methodology

The research uses a mixed approach involving a literature review and a field study. The literature review focuses on identifying the spatial attributes of built heritage values that can be used to analyse the compatibility of GI with built heritage. This involves reviewing cross-scale studies on urban planning, heritage value assessment, and architectural design and perception. The field study collects examples of GI applied to built heritage in Antwerp and categorises them based on their physical and perceptual attributes.

Built Heritage Value and Spatial Patterns of Urban Fabric

Determining the value of historic buildings is a central focus of many conservation doctrines and charters (de la Torre, 2013). The Nara Grid distinguishes the value and authenticity of heritage sites through different aspects, such as form and design, materials, use and function, traditions and techniques, location, and spirit and feeling, that can help to understand the artistic, historical, social, and scientific dimensions of a heritage site. Additionally, value assessment is shifting towards considering communities' involvement with heritage assets with socio-cultural associations, such as the collective memory, the spirit of the place and the identity of the place (Doğan, 2021; Kellert, 2008).

Theorists of architecture and urban planning have various approaches when it comes to determining spatial forms and elements. This involves considering various attributes, including ordering principles and qualities of space (such as texture, colour, and size) (Ching, 2014), categorising elements based on their form, function, and construction (Krier, 1991), creating an "urban vocabulary" based on a mental map (Lynch, 1960), and studying spatial patterns of built environments across scales (Alexander et al., 1977).

Field Study

The field study carried out in Antwerp aimed to establish a framework for subsequent research stages by conducting a preliminary analysis of several case studies where GI was implemented on built heritage sites. Antwerp was selected as the case study location because of the presence of projects that support the integration of GI into the built environment and the historical context. The study was conducted during the spring and summer seasons in 2022. The data collected through photo documentation of evergreen and deciduous GI was analysed qualitatively to investigate the spatial relationship between architectural patterns and GI using a set of attributes based on the built heritage values and spatial patterns of the urban fabric (Table 1). The attributes were grouped into three scales: building scale, neighbourhood scale, and city scale. The building scale analysis focused on the direct impact of GI on the historic building. Neighbourhood scale analysis examined the spatial relationships within building blocks and streets, which shape the collective identity of the built environment. Finally, the city scale analysis involved the examination of different districts with different historical and social characteristics.

Table 1. The attributes used for analysing perceptual and spatial attributes of GI in a built heritage context.

Scale	Attributes	Description
Building	Heritage Status	It encompasses the features that define buildings' identity, such as function, uniqueness, age and condition and historical value.
	Form and design	Analyses the spatial and physical elements of buildings where GI is applied, such as the façade, roof, and courtyard.
	Materials	Examines the visual impact of GI on the surface qualities of building materials.
	Support structures	Refers to the support structures used to maintain and guide the growth of GI, such as planters, wire structures, and trellises.
Neighbourhood	Street Morphology	Examines the physical characteristics of the street and building facades, including the height-to-width ratio of buildings and the alignment of buildings and setbacks
	Spirit of the space	Considers the meanings linked to a place, including its collective memory and cultural-ecological identity
City	District Characteristics	Analyses the correlations between social and historical characteristics of districts and the level of support for GI implementation
	Land availability	Evaluates the availability of urban morphology for implementing GI.

Results

The results of the study represent the examples of GI implemented in various built heritage sites at different scales. These spatial patterns were determined through a field study according to the attributes outlined in Table 1.

In the building scale, it has been observed that there is a connection between the function of a building and the way GI was used. For example, GI is often used at the entrances of retail buildings to create an inviting atmosphere (see Figure 1a), while educational buildings may use GI in courtyards to benefit students. Another finding is that the buildings that draw inspiration from nature in their unique architectural style also tend to use GI to highlight this inspiration. The Cogels-Osylei district is one example, featuring Art Nouveau and Neoclassical buildings that are accentuated by adding greenery (see Figure 1b).

Another relationship observed on the building scale is between the form and design of buildings, where GI is implemented, and how it impacts the building materials. For example, evergreen climbing plants tend to grow on flat surfaces such as blind facades (see Figure 1c), while flowering plants like trumpet vines are used for shading or highlighting architectural elements like windows and gates (see Figure 1d). Recessed or extended forms such as window sills, balconies, and bay windows are typically used for potted plants like flowers, herbs, and small trees. It has also been observed that flat roofs tend to allow for green roofs in historic buildings (see Figure 1e). Furthermore, It has been observed that the choice of plant species for courtyards may be connected to the building's function and the courtyard's location. Front gardens of residential buildings tend to have large trees or shrubs to provide privacy, while inner or side courtyards are used for gardening and horticultural activities (as shown in Figures 1b and 1f). In spatial limitations, metal wire or wooden trellises are utilised to guide the growth of vertical greenery in a controlled direction which also prevents direct contact between GI and the building façade (see Figure 1g). Subsequently, the interaction between vertical greenery and various building materials, including terracotta, natural stone, exterior rendering, and metal cladding, has been examined. Some surface alterations were observed due to direct contact, but those attached to metal wires did not exhibit such alterations. This is also observed concerning the age and condition of the building. In buildings that have been recently restored or are regularly maintained, fewer surface changes are observed due to the use of GI, based on the analysed samples (see Figure 1h).

Figure 1. Demonstrates the use of GI in building scale: a) Retail Function, b) Building from Cogels-Osylei district, c)Vertical greening on the blind facade, d) Vertical greening around the windows, e) Green roof, f) Inner courtyard of the Rubens House g) GI support structures, g) Implementations of GI in different materials

Figure 2. Demonstrates the use of GI on a Neighbourhood scale: a) Trees along the wide and narrow street canyons, b) Vertical green along row houses, c) View of the central train station from Meir street, d) PAKT

Figure 3. Demonstrates the use of GI on a City scale: a) Schorpioen street in Zurenborg, b) Lange Ridderstraat in the historic centre of Antwerp, c) Utilising the node point as the garden at Marnixplaats, d) Google Earth view of courtyards defined within building block in Marnixplaats

The analysis of GI on a neighbourhood scale considers the street morphology and spirit of the space in the built heritage context. Concerning the street morphology, the influence of building height, road width, and building alignment on GI selection is analysed. In narrow street canyons with limited sky views, trees are not commonly used due to the potential for blocking sunlight and obstructing views of historic buildings. Instead, vertical greening supported by metal wires across the street is often preferred. On the other hand, wide canyons have trees planted in rows to provide shade and cooling without disrupting the aesthetic perception of historic buildings (see Figure 2a). Also, in many cases, the alignment of buildings has impacted the selection of GI types. Trees are often planted in buildings with setbacks from the road or a garden, while climbing plants may cover blind facades or garden walls in detached buildings. Row houses use vertical greening in a continuous order along horizontal divisions (see Figure 2b).

Regarding the spirit of the space, the cases in which collective memory and cultural-ecological identity are influential in the use of GI are observed. For example, there are many cases where trees are planted along historical streets, such as the Meir in Antwerp, to frame significant monuments like the central station (see Figure 2c). Furthermore, it was noted that cultural-ecological identity played a significant role in GI adaptation through urban agriculture in the case of PAKT (PAKT Antwerpen, n.d.) (see Figure 2d) and through the botanical gardens of museums, as in the cases of Rubes Huis and Snijders & Rockoxhuis (see Figure 1f).

On a city scale, districts with different historical and social characteristics are analysed, considering the level of support for green initiatives. Residential areas like Borgerhout and Zurenborg (see Figure 3a) have numerous examples of green streets shaped by the initiative of local participants. Meanwhile, the historical city centre of Antwerp has top-down initiatives such as the green street project in Lange Ridderstraat (stad Antwerpen, 2020), which was systematically handled with the support of the municipality (see Figure 3b). Although there are some examples of participatory initiatives in the historical centre, they are more common in residential areas. Additionally, the availability of land is a significant challenge for implementing GI. However, there are examples at the city scale that have overcome this issue. For instance, greenery surrounds the node points of crossroads, as seen in the case of Marnixplaats, and open spaces within building blocks are used as communal gardens (as shown in Figures 3c and 3d).

Conclusion

This study proposes a framework to study types of GI at or near historic buildings by linking different forms of greenery with different attributes of built heritage sites. The preliminary field study brought forward numerous examples where types of GI integrate with built heritage environments. From this, different spatial patterns were identified.

In the field study, it has been noted that different forms of GI are used at buildings with different functions, designs, ages, and conservation statuses. Façade patterns like vertical and horizontal divisions or blind facades provide a surface for the growth of climbing plants. At the same time, recessed or extended forms such as window sills, balconies, and bay windows are used for pot plants like flowers, herbs, and small trees. The use of GI in neighbourhoods is also influenced by street morphology, alignment of buildings, and the cultural-ecological identity of the area. The main challenges in implementing GI into built heritage at the city scale are the regulations within the urban conservation areas and finding adequate space. However, several examples have been observed that have overcome these challenges, such as green street initiatives and using open spaces inside building blocks as common gardens. Overall, observations have provided creative solutions to overcome regulatory and spatial limitations.

These examples could serve as best practices and guide the integration of GI into built heritage environments in a way that is both functional and respectful of their cultural significance. The findings of this study invite a further in-depth study. In the next phase of our research, we will conduct a comprehensive study in Antwerp's historic centre to further assess the compatibility of GI in heritage environments. This study will include quantitative data analysis using QGIS and QField and gathering feedback from the general public and experts. Through this combination of approaches, we aim to under-

stand what factors contribute to successfully integrating GI in historical contexts.

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From architecture to community: adaptive reuse as social practice

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Abstract

This paper brings forward the idea of adaptive reuse as a social practice able to reconnect urban communities, and actively contribute towards their consolidation.

Further, it demonstrates how skills and competences from the academic realm can facilitate community engagement and (re)engender a sense of belonging.

Adaptive reuse, intended as a series of actions and processes to transform existing buildings into different ones 'fit' for new purposes, is a practice that has become the focus of discourse around architectural heritage, sustainability and the future of our cities. The central idea of the discipline is to reprogramme existing buildings through a set of tools and tactics able to modify structure and matter. However, it is our contention that the remit of the discipline has evolved, emphasising the notion that buildings are symbolic entities - "memory spaces" and "cultural experiences" able to actively contribute towards the building of communities.

Looking to the principles of maintenance and care that adaptive reuse embodies, we propose an interpretation of reuse, that considers how people interact and identify with places, rather than focusing on function or mode of inhabitation. Consequently, the process of re-activating/re-using architecture situated within the public realm, can be framed as a social practice.

As Spatial Designers we work on projects focused on establishing a dialogue with the community as both an idea and a real entity, identifying practices of engagement, gaining trust and exercising empathy. Working in contexts where communities are sometimes fragmented and not readily able to build a dialogue - a situation exacerbated by covid and the current cost of living crisis in the UK, our role is to support and enable a process of envisioning.

Spatial adaptive practices - by embedding principles of maintenance and care - become an effective strategy for actively engaging with the complex and often conflicting needs of diverse communities and neighbourhoods. The contribution to the Handle with care/Inclusivity track is enriched by the account of KilburnLab, a practice-based research project led by the Interiors Team at Middlesex University in London, comprising a series of collaborative activities with local stakeholders exploring the future of the area.

The Kilburn Lab project is part of a wider strategy for reframing adaptive reuse as a social practice that transposes the principles of 'care', that are evident in its processes and tactics, to urban regeneration. Buildings, and more generally existing spaces, are custodians of memory, history and legacy.

Author keywords

Interior architecture; adaptive reuse; social practice; community engagement.

Introduction

> 'Architecture is not simply about space and form, but also about event, action and what happens in space [...] architecture cannot be dissociated from the events that happen in it' (Tschumi 1981).
>
> 'What we really need to study is how the world gets put back together.' (Rottenberg and Segal from the Care Collective).
>
> 'The vision we need is one that advances a model of 'universal care', where care is understood as an enduring social capacity and practice involving the nurturing of all that is necessary for the welfare and flourishing of human and non-human life. Care is our individual and common ability to provide the political, social, material, and emotional conditions that allow for the vast majority of people and living creatures on this planet to thrive —along with the planet itself.' (Shannon, 2018).

This paper brings forward the idea of adaptive reuse as a social practice able to reconnect urban communities, and actively contribute towards their consolidation. Further, it demonstrates how skills and competences from the academic realm can facilitate community engagement and (re) engender a sense of belonging. In rearticulating adaptive reuse as a strategy for recovering communities as social entities, we look to its empathetic core and appropriate its tactics to rebuild dialogue across and between the various actors and stakeholders that comprise them, and reopen a dialogue impacted by the dismantling of public services and the reassignment of municipal architecture as commercial infrastructure. Offering a counterpoint to gentrification – the default mode of neoliberalism, which tends to frame the transformation of urban environments in economic terms -

we are looking to institute a practice of care that supports and enables communities to thrive.

The etymology of the word adaptation has its roots in the Latin words 'ad' (to) and 'aptare' (fit) and means 'to make fit' - make (something) suitable for a new use or purpose and become adjusted to new conditions. Adaptive reuse, intended as a series of actions and processes to transform existing buildings into different ones 'fit' for new purposes, is a practice that has become the focus of discourse around architectural heritage, sustainability and the future of our cities. The central idea of the discipline is to reprogramme existing buildings through a set of tools and tactics able to modify structure and matter. However, it is our contention that the remit of the discipline has evolved, emphasising the notion that buildings are symbolic entities - "memory spaces" and "cultural experiences" able to actively contribute towards the building of communities. Looking to the principles of maintenance and care that adaptive reuse embodies, we propose an interpretation of reuse, that considers how people interact and identify with places, rather than focusing on function or mode of inhabitation. Consequently, the process of re-activating/re-using architecture situated within the public realm, can be framed as a social practice.

Out of Place

Interiors as a spatial practice deals with the idea of place as a porous membrane able to mediate between the built environment (in a very broad sense) and its inhabitants. The definition of place is filtered by social, political and historical constructions; it is defined by local institutions, cultural heritage and social conventions. A place can be described in many different ways - as a physical environment, through its history, features and inhabitants; and also as "experienced", which can encompass a multitude of perspectives. For Kilburn Lab[1] - which we will come back to later - it is evident how the perceptions of residents, politicians, students and tutors are sometimes radically different. The place, in its positive and negative connotations, is held responsible for supporting or fragmenting communities, bringing forward the dual effect of inducing a sense of belonging or being out of place.

The Sense of Place, as defined by Steven Feld and Keith H. Basso, is 'the experiential and expressive ways places are known, imagined, yearned for, held, remembered, voiced, lived, contested and struggled over [...]' (Feld and Basso, 1996) - there isn't one single sense of place nor one place identity that can be univocally representative of any place. Exploring the idea of place and its relationship with communities, it is undeniable that there is a strong connection between people's quality of life of and the physical environment in which they live and thrive. This doesn't simply relate to their private dwelling but, in a substantial way, with the urban space they inhabit (as residents or workers, for example) – the place of the local community, the neighbourhood.

Cultural Geographer Doreen Massey wrote extensively on the idea of place, which she described as 'as an ever-shifting constellation of trajectories [that] poses the question of our thrown togetherness.' (Massey, 2005).

For Massey, place - as a specific and highly contextualised entity - represents the experience of space, which is itself complex and continually in flux. 'Space for Massey is (after Deleuze & Guattari, 1987) "striated," highly variegated, and dynamically evolving. It derives both its use and its exchange value from a combination of the value of its physical characteristics (i.e., bedrock stability, or waterfront adjacency), its relational proximity to other users (i.e., the number and composition of people who exist and act nearby), and humans' experiences of its aesthetic properties' (Pierce & Martin, 2016).

From Massey's extensive writings on the subject we can summise that places, and communities, do not have a single identity but are plural, full of conflict and never static. They evolve and adapt to new circumstances, transforming their material structure and receiving new inhabitants. What gives a place its specificity is not a shared historical background but the network of social relationships and common experiences that are able to illicit 'a sense of place which is extroverted, ... link[ed] with the wider world, which integrates in a positive way the global and the local" (Massey, 1991).

Daniel Kemmis argues that our disengagement and loss of interest for public life goes parallel with our loss of a sense of place (Kemmis, 1990). The construction of a 'sense of place' goes through a renewed desire for inhabitation and care for the public spaces of a neighbourhood, producing collaborative and humane policies that create better places to live. The satisfactory sense of belonging to a place further triggers a process by which citizens become actively engaged in rethinking the city they want to live in. 'The right to the city is, therefore, far more than a right of individual access to the resources that the city embodies: it is a right to change ourselves by changing the city more after our heart's desire. It is, moreover, a collective rather than an individual right since changing the city inevitably depends upon the exercise of a collective power over the processes of urbanization" (Harvey, 2008).

It is evident today how the debate about cities as hubs for social, human and economic development - and the role urban environments play in the well-being of its population, has shifted its terms of reference and is today focused on the research aimed at managing the risks associated with its development, promoting systematic actions and regulatory frameworks in which participation, integration and sustainability are the driving goals. These strategies do not just lie at urban and metropolitan level, but also at a global level, such as in the Sustainable Development Goals established by the United Nations in 2015.

The UN SDG goal #11 Make cities and human settlements inclusive, safe, resilient and sustainable recognises how this is an essential condition, which has an impact on a number of other Sustainable Development Goals. The 2030 Agenda also calls for local authorities to put in place strategies to "localise' the 2030 Agenda – for example providing leadership in the mobilization of a wide range of stakeholders and facilitating "bottom-up" and inclusive processes. Looking at the principles of maintenance and care and notions of empathy and trust, we argue that identifying and reusing collective dismissed spaces (adaptive reuse) could be an effective strategy to investigate how people interact and identify with places, and actively propose new uses for the future.

The built environment, the multiple spaces we inhabit every day, plays a central role in creating a sense of place and

1 Kilburn Lab is a practice-based research project led by the Interiors Team at Middlesex University in London, comprising of a series of collaborative activities with local stakeholders exploring the future of the area.

a sense of belonging that ultimately impact upon communities' wellbeing.

Care and Community

> 'To study maintenance is itself an act of maintenance. To fill in the gaps in this literature, to draw connections among different disciplines, is an act of repair or, simply, of taking care — connecting threads, mending holes, amplifying quiet voices' (Mattern, 2018).
>
> 'Maintenance and care, as practices crucial to the production and reproduction of places, are less spectacular . . . , but nonetheless essential elements of throwntogetherness and, as such, undoubtedly political' (Lisiak, 2022).

Moving forward from Massey's concept of 'throwntogetherness', as a consequence of the 'conflicting and unequal' social relations that characterise space and place (Massey, 2005), we need to look towards how we produce and reproduce places in order to address how these are both understood and experienced. Fundamental to strategies of adaptive re-use are the dual principles of maintenance and care, which operate in tandem to effect positive change within our world. Agata Lisiak, in her essay 'Politics of maintenance and care: Rosa Luxemburg's commonplace urban theorizing' (Lisiak, 2022), references the writings of Berenice Fisher and Joan Tronto around the definition of care as a 'species activity that includes everything we do to maintain, continue, and repair our world so that we may live in it as well as possible'. She continues, 'That world includes our bodies, our selves, and our environment, all of which we seek to interweave in a complex, life-sustaining web' (Lisiak, ibidem). Lisiak further talks to the work of the Care Collective (specifically their Care Manifesto), which was formed in 2017 initially as a reading group focussed on articulating the crises of care that manifest in our times - 'As the authors of The Care Manifesto note, "care has long been devalued due, in large part, to its association with women, the feminine and what have been seen as the 'unproductive' caring professions"' (Lisiak, ibidem). There is a notable alignment here between the gendering of care as a feminine activity and the marginalisation of interior architecture and design - with which adaptive reuse is intrinsically connected - as a largely invisible and misinterpreted practice and discourse that is similarly gendered[2]. It is through strategies of adaptive reuse that we can reidentify both the practice of care and interior architecture and design as (re) productive activities that operate in tandem to reimagine the places we inhabit.

Underpinning the definition of care as a set of actions that work upon and inside the world(s) we live in, are the principles of empathy and trust. Within late 19th century German philosophical aesthetics, empathy or 'einfühlung' was a term used to describe 'the human ability to "feel into" works of art and nature in order to aesthetically perceive them' (Devecchi, Guerrini, 2017). This notion of empathy as an emotional response to something has been harnessed by designers as a mechanism for intuiting the needs of users and interpreting them - 'designers are expected to focus on their empathic abilities in order to make interpretations of what people think, feel and dream, and to envision the experiences triggered by products or services' (Devecchi, Guerrini, ibidem). Trust however is more reciprocal - where empathy implies a feeling towards something, trust is embedded in an understanding of shared experience and unconditional support. Within the context of space and place, empathy and trust are core to the success of neighbourhoods and the communities that comprise them.

The etymology of the word "community" is rooted in the Latin word "communitas", which means the public spirit, partnership, joint possession/use/participation and emphasises an active role in aspects of "participation" and the "public". A neighbourhood[3] is defined as a 'a group of people living in the same place or having a particular characteristic in common' and 'the condition of sharing or having certain attitudes and interests in common'[4], providing citizens with opportunities to meet, share and support each other, but also with the responsibility to contribute to building physical places that facilitate civic engagement, community interaction and participation within the planning processes.

For a community to work, members need to 'feel' part of it. This sense of community is defined by Chavis and McMillan as 'A feeling that members have a sense of belonging, a feeling that members matter to one another and to the group, and a shared faith that members' needs will be met through their commitment to be together' (McMillan, Chavis, 1986).

As Spatial Designers we work on projects focused on establishing a dialogue with the community as both an idea and a real entity, identifying practices of engagement, gaining trust and exercising empathy (Rifkin, 2010)[5]. Working in contexts where communities are sometimes fragmented and not readily able to build a dialogue - a situation exacerbated by covid and the current cost of living crisis in the UK, our role is to support and enable a process of envisioning. Peter Blundell Jones, has argued in Architecture and Participation that the reason why community engagement is indispensable to practices of maintenance and care within neighbourhoods and communities, is that it creates 'a sense of belonging to the world in which they (the user) live' (Blundell Jones, Petrescu, Till, 2005) - an existing space that is reimagined through adaptive practices is better able to reflect and embed that sense of belonging. Spatial adaptive practices - by embedding principles of maintenance and care - become an effective strategy for actively engaging with the complex and often conflicting needs of diverse communities and neighbourhoods.

Trust+Emphaty > Care+Adapt

In his seminal essay, 'Old Buildings as Palimpsest', published in the journal Progressive Architecture in 1976, Rodolfo Machado defines the remodelling of existing buildings as a process of 'rewriting', where 'the past takes on a greater significance because it, itself, is the material to be altered and reshaped. The past provides the already written, the marked

2 For a fuller exploration of this discussion see Harriet Harriss and Naomi House, 'Interiority Complex', in A Gendered Profession, RIBA, London, 2016.

3 https://www.etymonline.com/word/neighborhood

4 Oxford Languages https://languages.oup.com/

5 Design approach should address the issue of how to create the conditions for the empathic experience, for it is "the very means by which we create social life and advance civilization" (Rifkin, 2010, Chapter 1, Section 2).

"canvas" on which each successive remodelling will find its own place. Thus, the past becomes a "package of sense," of built-up meaning to be accepted (maintained), transformed, or suppressed (refused)' (Machado, 1976).

More often than not interiors, if not the architecture that frames them are altered, hidden, closed off – they become invisible, subtracted from our vision and perception. As spatial designers and educators we have developed a number of tactics for reading and interpreting the often difficult to detect signs and clues that present themselves at the surface of the urban landscape - survey and surveillance, the collection of evidence, intuition and narrative reconstruction - in an attempt to access and decode the 'past' that Machado refers to above. These 'pasts', which in turn embody hidden narratives are themselves in a perpetual state of flux resulting in an entanglement of interactions that imprint themselves upon the material environment.

The implication of Machado's reading of the material environment is that it is full rather than empty - similar to Massey's articulation of space, which Joseph Pierce describes as 'seething with plural occupation' (Joseph Pierce, 2019). Says Pierce, 'for Massey what space is includes all the things that it has ever been and all the things it could be in the future' (Joseph Pierce, ibidem). Adaptive reuse acknowledges this fullness, beginning with the building itself as a rich and textured "body" comprised of the conjunction between the material and immaterial. Rather than evoking the tabula rasa, the practice of adaptive re-use assumes complexity rather than negating it. In dialogue with the existing, adaptive re-use invokes strategies of maintenance and care to build empathy and trust.

KilburnLab

Kilburn is an area of northwest London which spans the boundary of three London Boroughs: Camden, City of Westminster and Brent. Located between Oxford Road and Kilburn Station, Kilburn High Road is the second largest town centre within the London Borough of Camden. The area has a rich history – the former heartland of London's Irish community, Kilburn is a multi-cultural/multi-ethnic community - a consequence of diaspora. Due in part to its strategic position with a good public transport network, Kilburn is a 'hypersensitive' and 'fragile' place, that is in constant flux.

There are a wide number of developments planned or undergoing in the wider Kilburn area, from large-scale housing schemes and public realm projects - the result of both traffic and "greening" policies - and smaller-scale community-driven initiatives. Camden and Brent have recently teamed up to pilot a new experimental process aimed at fostering and supporting local stakeholders – residents, businesses and associations – in finding mechanisms to transform the neighbourhood.

Kilburn Lab is a practice-based research project led by the Interiors Team at Middlesex University in London, comprising of a series of collaborative activities with local stakeholders exploring the future of the area. As educators in Higher Education Institutions, we are involved in Teaching and Learning and Research activities and in what is defined as the 3rd mission – the commitment for higher education institutions to "contribute to society". These aims are shared by local authorities who are investing in strategies for facilitating and promoting citizenship and community engagement.

107 Kingsgate is a former community centre at the heart of Kilburn. Owned by Camden Council, it has been closed since 2019. During the pandemic, the space was adapted to function as a Covid testing centre and now hosts live-in Guardians[6]. As one focus of the Kilburn Lab, this site pilots the use of adaptive strategies to facilitate a collective rethinking of urban public space at the scale of the neighbourhood, encouraging the community to consider how they can use and share this space, by talking about its past(s), present(s) and future(s).

The important role these neighbourhood communities can play in effecting urban regeneration and transformation, and the ever-growing challenges to so many aspects of our urban and social life (pandemic, cost of living crisis,..) are among the reasons why local authorities are developing new tools and tactics to engage different stakeholders.

One of the tools of such a strategy is the Community Improvement District – a concept refined by Professor Tony Travers who is an expert on London's local governance and which has been adopted by some local authorities within the UK - 'from a loose set of guiding principles for local people to apply as they see fit, or a more structured and funded system. . . that will help stakeholders develop their place for the benefit of all. With a CID in place, management of the neighbourhood is stewarded by local stakeholders on an equal footing, recognising the interdependencies between them, creating strong local networks and extracting greater social, economic and environmental value for local benefit' (Stephenson, 2020).

Because the CID is a bottom-up strategy, but formally included in the body of laws, it has the capacity to undertake some of the functions suggested for neighbourhoods within the Localism Act[7] and Community Right to Challenge[8], such as community planning enabling voluntary community bodies and parish councils to express an interest in running a local authority service. The benefits of involving communities in the regeneration of their own neighbourhoods can contribute to an increased sense of 'ownership and responsibility' towards the local environment. Although a CID has yet to be implemented in London, it is possible that Kilburn could pilot the scheme.

It is worth noting that many neighborhood communities struggle to have an effective communication platform, get organised and adopt tools able to establish a dialogue and then translate this into action. In the last few years, the role of local government has shifted towards the construction of a support framework to build into the community the necessary awareness and willingness such action. Our project Kilburn Lab, and more broadly the activities promoted by the Interiors Directorate at Middlesex University[9], provide an opportunity for students to share design skills and competencies to facilitate a process of envisioning, putting forward the idea that the academic realm can facilitate community engagement and (re)engender a sense of place.

6 https://liveinguardians.com/property-guardians

7 The Localism Act 2011 is an Act of Parliament that facilitate the devolution of decision-making powers from central government control to individuals and communities https://www.legislation.gov.uk/ukpga/2011/20/contents/enacted

8 https://www.gov.uk/government/publications/community-right-to-challenge-policy-statement--2

9 The Interiors programmes at Middlesex University (BA Interior Architecture, Ba Interior Design, Ma Interiors) collaborate with council, association and organisation to support community engagement in process of adaptive re-use and urban regeneration.

We believe that this process, to be impactful and long-lasting, must be led by a network of 'actors' including resident citizens, local businesses, associations, institutions as well as experts. Camden Council, in collaboration with Brent Council, has facilitated and enabled social interaction between the different stakeholders, identifying organisations, groups and individuals interested in actively taking part in this reclamation of public space.

The first activity organised and promoted by the Participation Office of Camden Council, was a series of walkabouts – each one focused on exploring a specific area (North Kilburn, South Kilburn,..) or topic (history walk, community engagement walk,..). These very simple activities have established new relationships between individuals and associations already operating in the area, facilitating a space for debate, rather than simply operating as a device for collecting local histories and memories. This groundwork has resulted in the publication of the OneKilburn website [10] - a tangible map of all the stakeholders currently participating in the process. The website also functions as a repository or 'project bank' – anyone can add an idea and circulate it to see if there is interest to develop or even to fund it.

The work that students at Middlesex are currently undertaking, is concerned with reading and interpreting the Kingsgate Community Centre and its surrounding context, to provide the local community with insights and ideas able to generate a discussion around the future of the building. This process of research and investigation, utilises forensic methods of detection that seek out existing or passing design precedents, and uncover hidden narratives - gathering fragments and traces of previous occupations, compiling and scrutinising the evidence presented, and constructing narratives that attempt to understand and re-imagine the past(s), present(s) and future(s) of the site. Further, using Secondary Research, our students look to reconstruct the sequence of events that have been witnessed by the building, establishing priorities and registering effects. Through the exposure of different interpretations and assumptions at play, these tactics enable not only discussion, but offer an envisioning of possibilities.

Kilburn Lab's work is in progress and will continue to be the main focus of final projects for both BA and MA cohorts this academic year. It is anticipated that the body of work produced will impact on the future choices for the building at 107 Kingsgate Road and the wider community. At the end of January 2023 an event organised by Camden Council, in partnership with Brent Council, Kiln Theatre and Middlesex University, invites local residents and workers in the area to explore possibilities and ideas, through a series of workshops that, using the design outcomes produces by students so far, will focus on 4 main questions: 'What makes Kilburn special', 'What is the vision of Kilburn', 'What can we do now', 'What can we do in the future'. The outcomes that emerge from this event will inform and potentially shape the next phase of the students' projects culminating in an exhibition that we are planning for Summer, 2023.

CONCLUSIONS: Design Activism

> 'If we apply "care" as a framework of analysis and imagination for the practitioners who design our material world, the policymakers who regulate it, and the citizens who participate in its democratic platforms, we might succeed in building more equitable and responsible systems' (Mattern, 2018).

The Kilburn Lab project at Kingsgate Community Centre is part of a wider strategy for reframing adaptive reuse as a social practice that transposes the principles of 'care', that are evident in its processes and tactics, to urban regeneration. Buildings, and more generally existing spaces, are custodians of memory, history and legacy.

The principles underlying this approach to urban regeneration can be found in design activism as an agent for change. Guy Julier suggests that while design cultures are 'largely produced through circumstances', their 'agency is often less explicitly declared'. Design activism on the other hand 'is a movement that is more self-consciously and more knowingly responsive to circumstances. It is politicized' (Julier, 2013). Julier's thesis envisions design activism as a response to the 'crises' of neo-liberalism, which, in its privileging of the market over communitarianism, has contributed to its destabilisation. He continues, 'I take design activism to include the development of new processes and artifacts, where their starting points are overtly social, environmental, and/or political issues, but where they also intervene functionally in these' (Julier, ibidem).

An example of such an intervention may be seen in Granby Four Streets in Toxteth, Liverpool. The project is led by the local community who, over a period of two decades, have gradually rebuilt this once derelict neighbourhood. In 2011 the Granby residents 'entered into an innovative form of community land ownership' with Assemble Studio and Steinbeck Studios working with Granby Four Streets CLT 'to present a sustainable and incremental vision for the area that builds on the hard work already done by local residents and translates it to the refurbishment of housing, public space and the provision of new work and enterprise opportunities'[11]. The overarching approach is underpinned by what Assemble Studio describe as a 'resourcefulness and DIY spirit' [12], which is evident across all of the different projects that have so far been instigated. In 2015 Assemble were awarded the Turner Prize for their 1:1 model of the Granby Workshop Showroom, which further exhibited a range of products they had created in collaboration with artists, designers and makers working in Granby.

As an ongoing collaboration between various stakeholders within the Granby Community and Assemble Studio, the regeneration of this once fragmented neighbourhood has been achieved through the slow, but steady renovation of its architecture and streetscape through processes of maintenance and care.

In this perspective, Spatial Design - specifically the practice of Interior Architecture - becomes a mediator between places (in our case existing buildings) and the communities that inhabit them, facilitating the transformation of spaces into places within which all stakeholders have agency.

10 https://onekilburn.commonplace.is/

11 https://assemblestudio.co.uk/projects/granby-four-streets-2

12 ibid.

Kilburn Lab facilitates the process through which the (local) community actively engages with the decision-making mechanism that invests aspirations, needs and practical considerations. Exploring its past and present multiple identities and narratives, envisions shared possible futures.

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3 gratefully acknowledge the grant from NSF (#1234-2012-ABC). This is just an example.

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Methodology and evaluation of digital assets reconstruction of cultural heritage with visitor participation in museum

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Abstract

On the basis of hardware conditions, the 3D digitization of cultural heritage entities still requires a lot of human resources. In a short period of time, it is difficult to obtain a large number of 3D models of cultural heritage with conservation and communication value under the current mainstream production process. The ability of smartphones in photography and video has been enhanced by the mutual emphasis of manufacturers and consumers, and it is gradually becoming possible to generate reliable 3D models from the photos taken by them. In addition, the images generated by the large number of visitors taking pictures of objects and other content in museums provide a large amount of potential data for the digitization of cultural heritage. This work aims to examine the reliability of 3D entities of cultural heritage generated using images of cultural objects recorded by visitors in museums through mobile camera devices such as smartphones and to verify the value of the application of the models. The method can provide a way to quickly record large amounts of data for cultural heritage conservation with sufficient accuracy and ease of use, making it a potential alternative to traditional methods that rely on specialized personnel and specialized equipment, such as photogrammetry or laser scanning with specialized equipment.

Author keywords

Digital assets; 3D reconstruction; Cultural heritage; Mobile devices.

Introduction

Background

In the digital era, the primary work of systematically constructing digital resources of cultural heritage is to carry out the digitization project of cultural relics and realize the transformation of cultural relics from material form to digital form. Three-dimensional digitization has become a common practice in cultural heritage conservation, but there are still some problems. On the one hand, the equipment used for digitization of cultural relics, such as laser scanners or camera arrays, is mostly expensive and requires specification of the operation, which requires a certain amount of money and human resources. On the other hand, because the workload of digitizing cultural relics is large and difficult, the staff needs to have basic operational knowledge and experience in data acquisition and processing. Therefore, the work is usually done by cultural and museum institutions or professional teams. Cultural and museum institutions usually use professional recording equipment and follow standardized operating procedures to complete the digitization of cultural relics. Both the data kept within the institution and the models open for public viewing have high-quality information recorded in terms of form and color.

Today, the improvement of digitization technology has made digitization significantly less difficult. Structured light (Rocchini, 2001), encoded light methods, and photogrammetry are all mainstream methods for 3D scanning. Among them, photogrammetry, with the optimization of algorithms and the improvement of the performance of image acquisition equipment, has had the effect of significantly reducing the cost of both acquisition and computing (Pavlidis, 2007). Individual use of camera equipment, with software such as RealityCapture or Metashape and other related processing software, allows you to do the three-dimensional digitization of real entities. Even ordinary people can go digital by using their smartphones (Boboc, 2019). This undoubtedly reduces the resources and learning costs of the process of digitizing the real world in 3D, making everyone a mover of 3D information in the physical world and a producer of assets in the digital world. Among the models in the public 3D content center sketchfab, the model assets under the "Cultural Heritage and History" tab are both produced by professional cultural and historical institutions and also by users themselves. The majority of them are produced using multi-image generation methods.

Even in the three-dimensional technology is so convenient now, there are still a large number of cultural relics in cultural and museum institutions have not been established a digital model file, but also can not get a large number of preservation, dissemination value of cultural heritage digital model in a short period of time. This is both because the calculation and processing of data requires considerable computing power and time, and at the same time requires considerable human resources to complete the image acquisition work used to generate the model. At the same time, as mobile camera tools are

widely used by museum visitors, more and more "wild digital images" of cultural heritage are being produced (Makantasis, 2016). Widely uploaded to online platforms such as social media or stored on users' devices, they are not considered valid data for the preservation of cultural heritage, but constitute potential content for its digitization. With the help of device updates, visitors have generally become capable of digitizing cultural heritage at the two-dimensional level. Although they are still not widely practiced at the three-dimensional level, an opportunity does exist to enable every visitor to the museum to participate in the preservation of cultural heritage. This enriches the museum experience while saving institutions significant human resources costs and enabling the rapid reconstruction of digital assets (Mingyao Ai, 2014).

Purpose

This research aims to check the reliability of 3D entities of cultural heritage generated using images of artifacts recorded by visitors in museums through mobile camera devices such as smartphones and to verify the value of the application of the models. The main focus is to compare models generated through multiple devices (smartphones, cameras) and methods (structured light, encoded light, photogrammetry), demonstrating that phones are quite effective as data acquisition devices for photogrammetry for 3D reconstruction of tangible cultural heritage, providing morphometric data comparable to laser scanning results and easier-to-use color information.

Based on this, a participatory approach can be designed to help subjects or visitors complete the photography of the collected objects more efficiently and with high quality, and a real-time visual participation system is used to complete the guidance of the visitors' photography and provide real-time feedback of the results. Finally, the quality of the obtained model results is checked.

Methodology

The study is divided into two main phases, and each phase contains a variety of practical and testing steps.

Digital practices in the Hunan Museum scenario

The first phase of the study was designed to verify the ability of visitors to obtain relatively accurate and usable digital assets in the current real-life museum scenario. The 15 volunteers who participated in this phase need to enter the Hunan Provincial Museum as ordinary visitors, select artifacts displayed in the museum as their digitized objects, and use their mobile devices (cameras or smartphones) to complete the multi-view photography work and finally generate a polygon with color information.

Most of the participants had no experience with or knowledge of polygon modeling and had never been exposed to 3D inverse knowledge like photogrammetry before, so they needed to learn and practice some relevant knowledge and skills in advance before starting the practice, including the following:

1. An explanation of the fundamental principles of photogrammetry to give volunteers an idea of what to expect during the acquisition process.
2. A photogrammetry lecture designed to help participants quickly master the methods and techniques used to generate a set of high-quality images for 3D modeling. Also, participants will be asked to take photos of an object with at least three horizontal tracks and at least 60 photos to make sure there are enough images for model generation.
3. Practical shooting exercises and model generation tests. Participants test their learning by taking pictures of pre-prepared acquisition objects and generating models.

The entire learning process was kept to less than one hour, and most people obtained excellent-quality 3D models after only one practice session. Afterwards, the volunteers started a two-hour tour and photography practice, at the end of which the images were collected and used to generate 3D models, which were then tested and evaluated.

Figure 1. The state of aging of the collected objects in the Hunan Museum.

Usually, the quality inspection of 3D models obtained by reverse scanning is done by matching and comparing them with the original digital model. Since there is no absolutely accurate native digital model of cultural heritage entities, new ways and methods are needed to evaluate the latter models. A cross-sectional comparison of the results of multiple models obtained by different equipment or processes for the same collection object to draw conclusions is the accuracy test method used in this study. The distance difference of the meshes can be used as a basis for judging the accuracy of the reconstructed model shape. In addition to this index, the evaluation of the digital reconstruction model of cultural heritage should also be done in terms of speed, cost, the ability to acquire complex forms, and the ability to acquire color information.

User actions and model generation validation under two scenarios

In the second phase of the experiment, two simple acquisition environments for the multi-view reconstruction method were designed for inexperienced visitors, and the main goal was to avoid the generation of low-quality acquisition images while reducing instructions.

The first scanning space solution consisted of two soft lights, an automatic turntable, and a pre-positioned camera, with the rotation of the turntable set to 18 degrees at a time and the vertical height of the camera set to three positions so that the line from the center of the turntable to the camera was angled at 20, 40, and 60 degrees from the plane of the table. The object is placed on the turntable, which rotates every

time the camera shutter is pressed, and the camera position is adjusted upon completion of the turnaround, resulting in 60 images for model generation. Anyone can use the space, and the user can easily get the information they need by pressing the camera's shutter button and changing the height of the camera when the turntable is done turning.

The other space consists of only a light box and a manual turntable. The subject is placed on the turntable, and the user manually controls the turntable and uses phone to take multi-angle shots. Unlike the previous method, the user's cell phone is connected in real time to the computer responsible for model generation in order to visualize which images have been aligned and point cloud data generated, and which locations need to be supplemented with new images.

Figure 2. Two acquisition environments

After a brief evaluation of the experience of the two processes, the quality of the newly produced digital model is verified. Prior to this part of the validation, a high-precision laser 3D data was prepared and compared with the experimentally produced digital model to verify the accuracy of the latter.

Results

Model quality

The quality of the final model was excellent even though there were some limitations in the real museum environment, such as the glass covering the collection, uneven lighting, etc., which created some obstacles to the image acquisition of the visitors. The digital models created from the images captured by the volunteers were not only true to form, but also contained color information with a lot of detail that can be used directly in digital scenes such as digital archives, film and television productions, and online exhibitions.

In the first phase of the experiment, two visitors used a camera and a smartphone as the image acquisition devices to reconstruct the " Bronze square ding (cauldron) with human faces" in 3D to obtain results A and B respectively (Figure 3). After aligning the two, the grid distance between A and B was calculated using A as a reference, and the average value of the mesh distance was about 0.0044, with no obvious error in the shape of the two (Figure 4). The accuracy of the digital shape is still guaranteed even when using a smartphone, which is inferior to a camera in terms of pixels and professional parameters, as the acquisition device. Although not as good as professional cameras in terms of color and grid detail, the more popular mobile devices have greater ability and potential to provide a large and useful digital asset of cultural heritage.

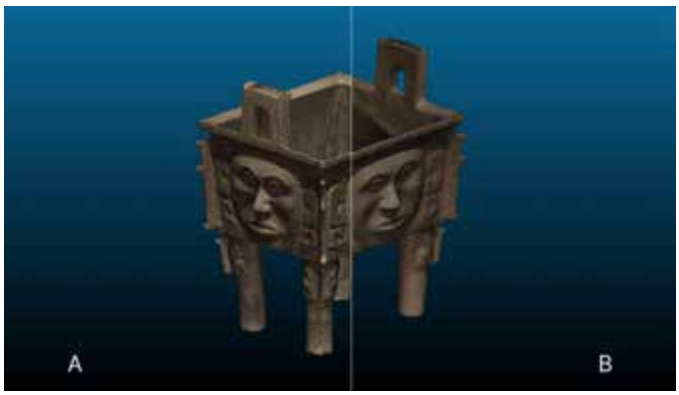

Figure 3. Model results obtained by using a camera and a phone as acquisition devices in the museum.

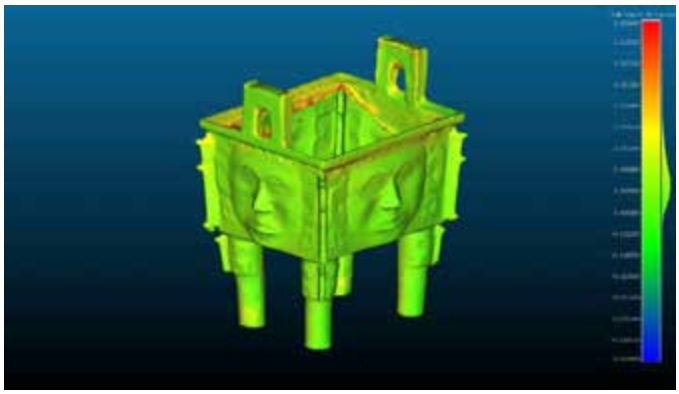

Figure 4. The mesh distance between the model obtained from the phone and the camera in the museum.

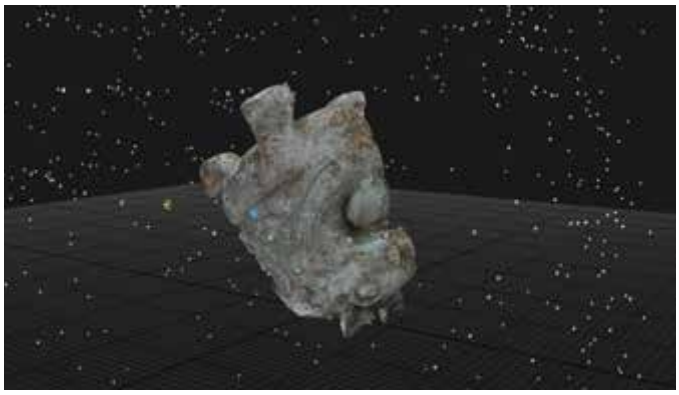

Figure 5. Model results obtained by phone in the laboratory.

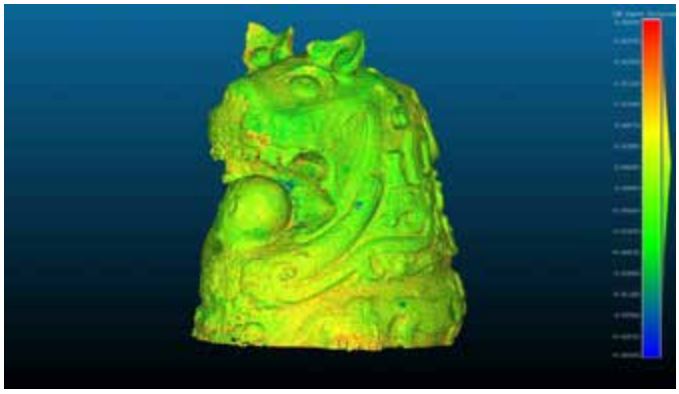

Figure 6. The mesh distance between the model obtained from the phone and the laser scanner in the laboratory.

In a more well-lit and less constrained acquisition environment, with real-time feedback of acquisition information, smartphones can perform 3D reconstruction faster and better, as reflected by a more detailed and color-accurate model mesh (Figure 5). In addition, if redundant image information is provided using different devices, the model quality can be further improved, although the computation time increases.

User experience

Most participants were pleased that they were able to create a digital resource about their cultural heritage and were willing to continue to participate in this work. Most visitors were more comfortable using their mobile devices to reconstruct objects in 3D than to scan them with a simple press of a shutter, although they may be tired of the process or unsure whether their images would produce valid results. In addition, the real-time feedback of scanning results on the screen or the use of AR to guide the user to the best shooting position can calm anxiety and enrich the experience of participating in the digital preservation of cultural heritage.

Conclusions

In summary, visitors can use their own mobile devices to digitize cultural objects, although there are limitations in the current museum environment that affect the quality of the 3D reconstruction results. At the same time, museum institutions can value the ability and willingness of visitors to create cultural heritage image resources, actively provide opportunities for visitors to participate in digitizing cultural heritage, optimize the user experience of creating digital assets through AR and cloud computing, and provide new, fast, and sustainable paths for cultural heritage preservation and digitization.

In the future, the role of visitors in museums will also gradually transform from being educated and entertained to being conservators and builders of cultural heritage. Public participation in cultural heritage conservation is the key to addressing the current crisis in cultural field, and new and proven technologies and products need to be brought to the public in order to awaken more potential forces and tap into hidden resources for this cause.

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Community heritage: an immersive approach to disaster resilience

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Abstract

Geological disasters often cancel or alter the intangible heritage of the affected community. Even if (re-)constructing houses provides fast solutions to solve the emergency, these housings alter the community dynamics and organisation by changing the location and character of neighbourhoods. Such conditions can be observed in the aftermath of the earthquake in Albania in 2019.

The results of this project aim to implement community-based participatory design techniques to strengthen the resilience of tangible and intangible Cultural Heritage by using technologies in the areas affected by environmental risk or disasters.

The research envisages the implementation of promotional interventions in professional training and experiences of excellence, which can guide a transformative process in the immersive Cultural Heritage and Storytelling of communities affected by an environmental disaster. Following the earthquake in November 2019 in Albania, there has been a strategic recognition of cultural heritage as an essential driver of the country's sustainable development; therefore, there is a need to innovate heritage preservation processes, such as digital heritage. The created digital heritage is destined to become strategic and more widespread over time since individuals, organizations, and communities increasingly use digital technologies to document and express what they value and want to pass on to future generations. Therefore, a community approach to heritage is a participatory process in which we discover and negotiate our sense of self, place and community and which values the 'unofficial heritage' that includes everyday practices and narratives, local and personal histories, buildings and local institutions. The action focuses on two levels of exploration of the case study: the preservation of tangible heritage (composed of physical artefacts produced, including artistic creations, built heritage and other physical products of human creativity) and intangible heritage (practices, representations, expressions, knowledge, skills, and associated cultural spaces that communities and groups recognize as part of their intangible cultural heritage, passed on from generation to generation).

The emergence of non-professional historians within the community of citizens, and unofficial historical sources, represents a collateral shift from the usual canon of national history and heritage towards a more participatory narrative of research. Heritage goes beyond physical artefacts, built structures and historical sites. It is also an interaction of time, memories, emotions, and lived experiences. Ensuring that this intangible heritage also becomes digital is a crucial issue, especially for those countries that have suffered environmental disasters or are at risk (such as Albania after the 2019 earthquake). It is also crucial to equip communities in developing countries with the literacy to access, document, and preserve their tangible and intangible heritage. In these processes, design assumes the role of facilitator of community needs and, using advanced technologies, becomes an enabler in this process. For example, virtual and immersive reality are used to simulate an environment that is otherwise impossible in the real world. Thus, digitization practices represent an innovative tool for both tangible and intangible cultural heritage resilience.

Keywords

intangible heritage; community; digitization; immersive; resilience; earthquake

Introduction

The global crisis generated by the Covid-19 pandemic is hampering progress towards achieving the Sustainable Development Goals, particularly in those critical areas where progress was already limited, as the United Nations Report (2020) notes. From a political point of view, the Western Balkans, specifically Albania, represent a priority for Italy and the EU, thanks to their physical, historical and cultural proximity and the start of accession negotiations to the European community. The priority of this project is to support research and enable sustainability and circularity processes with technologies in the themes of Cultural Heritage and environmental risk. Compared to the new strategic perspectives, the two reference objectives of this project are framed in environmental and climate resilience and digital transformation.

The project plans to implement educational interventions in the field of professional training and the structuring of experiences of storytelling, which can guide a transformative process in the sector of immersive Cultural Heritage and Storytelling of the communities involved in an environmental disaster. Following the earthquake in November 2019 in Albania (World Bank et al., 2020), there has been a strategic recognition of cultural heritage as an essential driver of the country's sustainable development; therefore, it emerges the need to innovate the processes of heritage protection, such as through

digital heritage. This digital heritage created is destined to become strategically crucial and more widespread over time; more and more individuals, organisations and communities are using digital technologies to document and express what they appreciate and want to pass on to future generations. A community approach to heritage is thus a participatory process in which we discover and negotiate our sense of self, place and community and which values 'unofficial heritage', which encompasses everyday practices and narratives, local and personal histories, buildings and local institutions. All this combined generates a new sense of identity, which has been lost by the modernisation of lifestyle and, moreover, through dramatic, disruptive events such as earthquakes. The project focuses on two levels of exploration: training in safeguarding **tangible heritage** (composed of physical artefacts produced, maintained and transmitted intergenerationally in a society; includes artistic creations, built heritage and other physical or tangible products of human creativity) and **intangible heritage** (practices, representations, expressions, knowledge, skills, and associated cultural spaces that communities and groups recognise as part of their intangible cultural heritage, transmitted from generation to generation).

The emergence of non-professional historians within the citizen community and the industry-wide recognition of the need to develop diverse, non-official and popular historical sources represent a general shift in focus away from the usual canon of history and national heritage towards a more localised narrative of research. Heritage goes beyond physical artefacts, built structures and historic sites. It is also an interaction of time, memories, emotions, and lived experiences. Making sure that this intangible heritage also becomes digital is a fundamental issue, especially for those countries that have suffered environmental disasters or are at risk (such as Albania after the earthquake or Italy due to hydrogeological instability). It is also essential to equip communities in developing countries with skills and knowledge to access, document, preserve and share their tangible and intangible heritage. In these processes, design assumes the role of facilitating the community's needs. Using advanced technologies becomes an enabler in this process: for example, virtual and immersive reality is used to simulate an environment that is otherwise impossible in the real world, video gaming, drone use, etc. Digitisation practices represent an innovative tool for tangible and intangible cultural heritage resilience.

Immersive technologies as a tool for storytelling

Intangible heritage is often based, if not mainly, on narration when we refer to history and culture. The narrative is also the oldest form of passing knowledge and tradition from mouth to mouth, from generation to generation, long before written testimonies appear. It represents the treasure of a community, on a larger scale, the culture of a society. On this, the narrative paradigm formulated by Walter Fisher claims that all meaningful communication occurs via storytelling or reporting of events. Humans participate as storytellers and observers of narratives. Fisher elaborates on five elements:

> "Starting with a notion of narration as something all humans already use in their communicative interactions, the narrative paradigm advances five presuppositions (p. 64). First, humans are *Homo narrans* —they are innate storytellers. Second, the paradigmatic mode of communication is not an argument but instead is the provision of "good reasons." These reasons implicate important values and vary across communication practices, objects, and situations. Third, the production and assessment of good reasons are affected by human history, experience, and culture. Fourth, human rationality is ruled by our nature as narrative beings. This means that humans have an "inherent awareness of narrative probability, what constitutes a coherent story, and their constant habit of testing narrative fidelity, whether or not the stories they experience ring true with the stories they know to be true in their lives". Fifth, the world is not a set of puzzles to be solved. Instead, the world is known as a story, and there are always a range of potential stories to choose among in explaining the world and our place in it" (Stroud, 2016, page 1)

As it emerges, that narrative is based on good reasons and not on scientific data; there is a risk of alteration of historical facts by the emergence of non-professional historians within the community of citizens, and unofficial historical sources, which represents a collateral shift from the usual canon of national history and heritage towards a more participatory narrative of research. Nonetheless, a community approach to heritage is a participatory process in which we discover and negotiate our sense of self, place and community and which values the 'unofficial heritage' that includes everyday practices and narratives, local and personal histories, buildings and local institutions. The richness of determined geography is based on "mainstream" facts that build a kind of skeleton structure to which personal stories, vertical narratives and testimonials of traditions and facts are attached. An emerging innovative technology in the field of cultural heritage, Augmented reality (AR), Virtual Reality (VR) and Mixed Reality (XR) for sure assume a privileged role in building a digital twin of what the narrative (therefore intangible) together with tangible artefacts can offer:

> "In fact, AR and VR allow you to discuss the beauty of the area, discovering what is hidden behind a work of art or a historic building, allowing you to better appreciate archaeological sites and museums, in short, enriching the visitor experience as a whole. Thanks to the incredible ability of immersive technologies to make the invisible visible, it is possible to create real journeys between historical eras and places, recreating particularly representative settings, buildings or moments in our history."[1] (Cappannari, 2022, page 100)

What has always been a vocal narration in a digital world becomes a visual narration, enriched with all elements an immersive technology can offer: 3D models, audio as music or vocal registration, images, animations etc. However, a full immersion into digitalized realities is currently limited to VR applications and works very well in indoor environments, as far as virtual reality recreates real digital spaces, entirely playing on the concept of suspension of disbelief and leveraging immersion to tell stories or make the user live experiences that can catapult into them. The technology requests the use of vision blocking screen to reach full immersion. In out-

1 Translated from original language by Authors.

door environments, this is not applicable. At the same time, Augmented reality is an expansion or integration of the reality that surrounds us, an enrichment of our senses thanks to digital information also using pass-through technology that shows reality through a monitor, such as that of our smartphone. This way, adding digital content to the real environment overlaying holograms to the framed image is easy.[2] In many cities, there are available applications to amplify the information flow through AR technology.[3]

An interesting example is Buyeo, a town in South Korea rich in history that has recently become the first holographic city in the world: thanks to a social holographic augmented reality platform, the citizens of this historic town will be able to contribute to enriching the digital twin of Buyeo with 3D models, text, video and audio messages.[4] It reminds Google Earth of some years ago, where people could upload 3D models created in Sketchup to enrich the experience.

Methodological approach to disaster resilience through community participation

New technologies open new dimensions in the resilience of tangible and intangible cultural heritage of communities affected by environmental disasters, but not only; through experimental and experiential design, useful tools and enabling technologies can be created for the regeneration of a dynamic and participatory identity of communities whose tangible/intangible heritage is at risk which could lay the foundations for a future community of practice.

Community design, as recently defined and formulated, within the broader scope of territorial design, redefines certain challenges posed by the contemporary world and expands the repertoire of investigative and operational tools able redesign the territory and elaborate regeneration scenarios through the involvement of local communities (co-design, co-planning, co-delivery, co-assessment) (Brandsen et al. 2018). With this vocation, this research places design "at the center of the transformation process" (Sicklinger, Varini et al, 2019) with the aim of generating design actions by supporting communities in the identification, co-design and valorization of local tangible and intangible resources and in the definition of system strategies and regenerative design actions that have environmental, cultural, economic and social spin-offs in the reference territories, capable of increasing their value by reactivating their underlying potential. The project study intends to investigate and demonstrate that a transdisciplinary action between "Community Design" and "Design for heritage and cultures" can act as a regenerator in territories affected by environmental disasters. Reconnecting academic social design research with participatory, applied and experimental forms of knowledge and action research is an important mission for universities and institutions involved in cultural and environmental education and development. In fact, the complexity of urban micro-contexts in a panorama of climate change and territorial policies calls for greater interpenetration between academic research and action and inter-action research between public actors, private actors and civil society. The proposed research project aims to develop a joint reflection on the city's challenges and formulate concrete proposals for a regenerative and integrated local development of resident micro-communities affected by ecological and environmental disasters. Faced with the complex and multifaceted nature of urban, environmental and social problems, interdisciplinarity enables the development of a global understanding, a transversal sensitivity and the adoption of an original perspective to propose new practical solutions.

The main methodological approach adopted involves experimenting with new forms of urban research that are both theoretical and practical through bringing together resident and temporary communities and mobilizing the knowledge of experts and locals to promote temporary community design workshops with a collective and interdisciplinary approach. A wide range of investigation and dissemination tools will be experimented with at the intersection of regenerative design, strategic and systemic design and co-design, adopting an open and participatory, dynamic and regenerative approach based simultaneously on research and practice and developing multiple visual outputs.

The case of immaterial heritage in Albania

Most of the inhabitants of Albania were woken up early on November 26th, 2019. A 6,4-magnitude earthquake hit the most densely inhabited area of the country, leaving behind 51 victims, more than 2000 damaged buildings, and around 5000 people temporarily or permanently displaced (World Bank et al., 2020). After the emergency interventions and when search and rescue operations were concluded, a more laborious and long-term problem arose. The displaced people needed new accommodation.

The European Union and the international community engaged in assisting Albania, reconstructing most of the destructed houses and facilities. To accommodate most people in an efficient way and in order to reduce infrastructure costs, not all destructed houses could be built at the original location. In the alternative, the government proposed new settlements, so families from rural areas are being allocated to apartment blocks on the peripheries of larger cities. These communities might have received back the lost houses, but the loss of intangible cultural heritage is difficult to estimate. The earthquake and the successive reconstruction process separated families from the community and eradicated communities from the territory. Narratives connect individuals to communities, and stories connect the past to the present of a settlement. The disruption of this intangible network that connects people, places, and times is an important loss that, being unquantifiable, is difficult to restore.

Digital tools and design strategies can assist in mending lost connections through the digitalisation of intangible cultural heritage. Digitisation processes have generally needed mediation from a professional figure, acting as a gatekeeper for smaller and rural communities in developing countries. Lately, design has been assisting in the removal of entry barriers. The

2 As a second possibility, the *see-through* technology uses transparent lenses through which - with a complex system of optical refraction - holograms are superimposed on physical reality, as in Google Glasses or Microsoft's Hololens and makes it, therefore, more convenient for the user, at the same time much less applicable due to scarce distribution and high cost of devices.

3 An example for historical application of Vienna/Austria: https://www.youtube.com/watch?v=ZdWeYBBtxZA

4 For more references related to immersive technologies in cultural context, see Cappanari, L. (2022), Futuri possibili, Giunti, pages 89-103

large spread of digital devices, better access to the internet, and the creation of applications and user-friendly interfaces make the use of advanced digital technologies accessible to a large portion of the population, even in developing countries. This is reducing digital illiteracy and the digital divide. Online access to digitalised intangible cultural heritage will make it possible to restore lost connections of communities not sharing the same territory anymore. On the other side, the presence of the digitalised cultural heritage will create new connections and enlarge the network of participants in the shared memories, stories, narratives, and values.

These conditions favor new ways of remembering and celebrating shared narratives of the disrupted territories and communities. Design and innovative digital tools employed by VR and AR technology can so be used to mitigate the effects of the displacement of the communities.

Participatory strategies: ethical implications of the project

The research aims to explore possible approaches to participatory design practices, taking strongly into consideration the ethical implications of participants and their approach to intangible heritage. As long as the facilities have been reconstructed in Albania, and housing needs have been satisfied through the (re-)construction of dwellings, the main task is to rebuild the sense of belonging and identity of inhabitants who necessarily need to be the actors of this process. The choice of what to keep alive as memory, what to archive and keep available for later generations and what can be considered unnecessary will be a challenge for the community involved. Participatory strategies represent a new opportunity to increase human rights to access digital and public participation by and for digital technologies, supporting access to culture, education and information, facilitating economic and societal inclusion and access to quality public services in heritage and culture fields by diverse stakeholders.

The project is complemented by a programme of offline/online workshops with an international body of participants representing heritage institutions, university collections, students, NGOs, artists, and museum audiences. New approaches will be workshopped with these communities to improve access and interpretation of community heritage. Interaction with the target groups will inform the final selection of objects for the VR, thereby reversing the top-down approach of the digitisation workflows commonly used in cultural heritage institutions and moving toward more equitable community-level engagement. These workshops aim to question and debate who owns such collections and who may contribute to them, questioning the nature of co-creation and co-curation. The project envisions the setup of Co-created output in the form of an exhibition using technological solutions resulting from collaborative work undertaken in the workshops. These may be used by teacher or student in the present and the future, highlighting how knowledge acquisition, exchange of ideas, and collaborative thinking is key to developing interpretational skills suited to the complexity of today's world.

Lastly, there are legal and ethical considerations to be taken into account. It is important to ensure that any cultural heritage objects presented in the XR are done in a way that respects the objects and their cultural significance and context and that any use of the objects is done with appropriate permissions and in accordance with relevant laws and regulations.

Conclusions and proposals for future research directions

This research project straddles the line between re-elaborating memory - through participation and narration - and looking towards the future – through immersive technology and 3D digitisation. The future activities of the research aim to foster the resilience of Albanian communities' tangible and intangible cultural heritage in the 2019 earthquake-affected areas through experimental and experiential design that aims to create useful tools and enabling technologies for the regeneration of dynamic and participatory community identity.

Immersive and extended reality technologies in regeneration contexts could:

- **a)** enable support capacity for community-based participatory, integrated, sustainable and inclusive management.
- **b)** strengthen initiatives to protect and safeguard cultural and community heritage.
- **c)** support less developed regions affected by the earthquake to develop sustainable and resilient reconstruction processes.
- **d)** Implement community-based participatory design techniques to strengthen the resilience of tangible and intangible Cultural Heritage.

The use of Mixed Reality (XR) as a technological substrate for this participatory 'journey' offers solutions to academic communities in the target country with common working tools and technological knowledge for heritage conservation through an interdisciplinary approach; it also lays the foundation for the promotion of knowledge of heritage and cultural assets through new technologies such as video gaming, virtual immersive reality, use of drones to represent the destroyed architecture of ancient monuments, and other forms of digitisation. Based on a digital twin concept of existing and destroyed heritage, it will be possible to rebuild the lived environment how it was, augmented with narratives of those who lived in the place.

Future steps will investigate how to interact with and (re-)interpret digital heritage archives to engage meaningfully with the digitised heritage by exploring the objects and their narratives via extended reality artworks but also to create playful yet socially-engaged game-like experiences using extended reality (XR) technologies, disrupting dominant narratives, and representing marginal cultures and communities by embedding hidden stories, perspectives and artefacts that are currently obscured by heritage collections' (often unwittingly) dominant narratives. The new connections, meanings and nuances that will emerge will help demonstrate the novel uses of digital heritage archives to create rich, diverse, and layered narratives, which can invite and entice a wider community, to engage and participate more deeply with the memory "before" and "after" the disaster.

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Caring for human diversity and built heritage through design: a multiple case study enquiry

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Abstract

Inclusive design aims to accommodate as many people as possible by considering the diversity of human abilities and conditions during design. This raises challenges in relation to built heritage: proposals to make it more inclusive may encounter objections from conservation authorities. Our research aims to (1) explore this tension between the conservation of built heritage and the ambition to make the built environment more inclusive and (2) identify strategies that allow addressing it. Based on existing research, we first examined how the domains of inclusive design and built heritage conservation are related, where they conflict and strengthen each other, as well as how researchers with different backgrounds suggest to address them. Second, we studied six building projects, all located in Flanders, where built heritage and inclusive design meet. Due to the Covid-19 pandemic, we relied mainly on desk research. We identified challenges and issues that came forward in the development of these projects as well as strategies adopted to address them. Two cases – the focus of this paper – illustrate how built heritage can be an asset to provide high-quality care. Confronting them with four cases located on a historic university campus makes clear that built heritage can be made more inclusive, and might even contribute to inclusive design, and that this involves a time consuming process with transdisciplinary input.

Author keywords

built heritage; conservation; inclusive design

Introduction

Human abilities considerably differ, both across the population and within the course of a person's life. *Inclusive design* can be described as a design approach that aims to accommodate as many people as possible by being mindful of this human diversity (Heylighen et al., 2017). Understanding disability as a consequence of mismatched interactions between a person and the surrounding environment rather than a personal attribute, makes clear that such design approach raises challenges in relation to the built environment. If the built environment is to reflect and contribute to an inclusive society, major challenges lie in adjusting existing (historic) buildings to make them more inclusive (Heylighen et al., 2017).

Historic buildings may indeed have heritage values that are important to protect and preserve. In practice however, interventions in the historic fabric aiming to make a historic building or site more inclusive often face objections from heritage authorities. This may frustrate, discourage and confuse owners and managers of heritage sites and/or designers who are willing to contribute to a more inclusive built environment. Thus, a tension seems to exist between the conservation of built heritage and the ambition to make the built environment more inclusive. The research we report on focuses on this tension and how it is addressed.

Architects as spatial mediators have gathered experience in negotiating with different stakeholders and experts and mediating their different needs and advice in the design process. When built heritage is concerned, heritage authorities are typically one of the stakeholders architects negotiate with. In doing so, they might develop strategies in order to overcome tensions between built heritage conservation and other stakeholders' interests. Besides architects/designers, other parties may gather experience and develop strategies in dealing with such tensions on their own account. In this connection, we set out to investigate which challenges and issues arise when making a historic environment more inclusive; and what strategies are adopted to address these.

Approach

In a first stage, exploratory research and literature review allowed us to delineate the existing context and frameworks of the areas of inclusive design and built heritage conservation. In a second stage we studied six cases in two different settings, based on an extensive document analysis. This paper focuses on two case studies – *De Korenbloem* and *Karus* – that illustrate the challenges when redesigning built heritage to accommodate a care program. Both projects were designed by leading architecture firms in Flanders and Europe and reviewed by renowned agencies, e.g. the Flemish Gov-

ernment Architect[1] team or the jury of an international architecture award, which testifies to their architectural quality. The available documentation on these cases includes design material and presentation graphics, publications in (international) architecture magazines or books, texts written by the designers during or after the design process, and, in one case, scientific literature. The four other case studies provide insight into KU Leuven's approach towards making its historic university campus more inclusive. More information on these can be found in (Van de Bemdt, 2020).

The final stage of the research entailed a cross-case analysis and a confrontation of the findings with insights from the literature study. Note that this research was conducted during the Covid-19 pandemic. As a result, the insights gained through document analysis could not be verified by users' experiences.

Towards a more inclusive historic environment: a literature review

Historic buildings were often constructed long before inclusive design approaches started gaining interest. As a result, interventions may be needed in order to adapt the buildings to contemporary standards, so that they can be used and their conservation is ensured. Interestingly, research suggests that some elements in historic buildings better suit the needs of diverse users than contemporary interventions (Heylighen, 2012). Identifying where interventions are needed is thus an important step in making a historic built environment more inclusive. The major challenge, however, lies in balancing the needs of diverse users and the needs for the conservation of built heritage when they are in conflict (Heylighen et al., 2017). Interventions aiming to make a historic building more inclusive may raise objections from built heritage authorities when these interventions are thought to compromise heritage values. The accessibility legislation in Flanders, for example, makes an exception for a historic building if it is protected (Gewestelijke stedenbouwkundige verordening Toegankelijkheid, 2009). In this way, the accessibility of such a building becomes dependent on the professional judgement of the heritage expert, who has to weigh interventions for inclusion and heritage values. According to Foster (1997), conservationists sometimes object to alterations because of 'moral and ethical issues', as alterations may affect the building or site's historic interest adversely. One could, however, consider interventions to make a historic building or site more inclusive as a new layer, which would allow future generations to derive that our current society aspired to be more inclusive (Neyt, 2008). Solutions to do so are often proposed either by experts in built heritage conservation or by experts in inclusive design. Research by the latter suggests that political and financial support can be a successful motivator for addressing the need to render built heritage more inclusive (Nilsen Ask, 2015). The framework *Built Heritage for All* (Neyt, 2008) delineates a strategy to develop a heritage-accessibility plan, focusing on the multidisciplinary input of experts in built heritage and accessibility. Research from these sources also highlights the contributions of user/experts[2] (Heylighen, 2012; Heylighen et al., 2017; Neyt, 2008; Nilsen Ask, 2015). Built heritage experts tend to focus on specific solutions for creating a more inclusive built environment. Two types of solutions are proposed: management solutions rearrange use and organization, facilitating navigation and communication (Van den Bossche, 2012); other solutions physically alter the historic fabric (Foster, 1997).

Creating a care environment in a built heritage context

Due to growing medical knowledge in the second half of the 20th century, hospital buildings became focused on providing care efficiently, rather than creating an agreeable environment for patients (Wagenaar, 2006). This led to care architecture with a uniform and institutional character, dominated by norms and standards and of questionable architectural quality, sometimes referred to as 'bedhouses' (Boie & Vandamme, 2015). Some care institutions want to address this lack of environmental quality for their patients (De Bruyn & De Vleeschouwer, 2014a). As research points out, inclusive design can contribute to creating qualitative care environments (Heylighen et al., 2017). The two following cases illustrate that (adaptive) reuse of historic buildings could contribute to creating a higher quality care environment.

De Korenbloem is a residential care facility for older people based in Kortrijk, located near a historic park site with two villas: the 19th-century neoclassical *Villa Landhuis*; and *Villa Portiek*, built during the interbellum. The design task was to extend the villas with residences for people with early-onset dementia and people who have had a stroke, as illustrated in Figure 1.

This project confronted the architects with several major design challenges. On the one hand, it required insight into the situation of people with early-onset dementia. How to introduce a feeling of home while ensuring that care can be provided efficiently? On the other hand, the villas needed to be conserved and restored, while their spatial organization did not allow reusing them as residential care facility. The architects proposed a 'network of little worlds', based on an ethnographic case study about Mary, a woman with early-onset dementia (Van Steenwinkel et al., 2014), and a spatial concept of networks based on the architects' experience and architectural background (Van der Linden et al., 2016). This concept was visually presented by the architects through a sketch of a resident's mental map (see Figure 1, left).

While the ethnographic case study offered insight into the experience of people living with early-onset dementia, the architects were able to translate the research findings to a spatial concept based on their architectural design experience. Retrieving knowledge through scientific research findings can be considered as a strategy to identify the needs of future users of the site. The translation of the research findings into a usable spatial concept is the merit of the architects, and using their professional experience and architectural background can be considered as a complementary strategy. The team of the Flemish Government Architect thus titled the project of *De Korenbloem* very accurately "Built heritage and reconversion

1 The Flemish Government Architect team aims to promote the architectural quality of the built environment. It advises public patrons in designing and realizing buildings, public space, landscape and infrastructure, and it stimulates the development of visions and reflection, with an emphasis on interdisciplinary and cross-sectoral initiatives.

2 "A user/expert can be anyone who has developed natural experience in dealing with the challenges of our built environment. User/experts include parents managing with toddlers, older people with changing vision or stamina, people of short stature, limited grasp or who use wheelchairs. These diverse people have developed strategies for coping with the barriers and hazards they encounter everyday." (Ostroff, 1997)

Figure 1. (*left*) Sketch of a 'mental map of a resident' (Studio Jan Vermeulen et al., 2013); (*right*) View of Villa Landhuis and the extensions housing residents with early-onset dementia, situated in a historic park (Müller, 2019).

Figure 2. Kanunnik Petrus Jozef Triest Square (Dujardin, 2017)

as carriers of care", referring to the role of the villas as built heritage in creating a feeling of 'homelikeness' by appreciating its qualities, and in using it as a means to draw external people to the site in order to acquire social inclusion.

The second case is the *Kanunnik Petrus Jozef Triest Square* in Melle (Figure 2). This project is situated on the historic site of the Psychiatric Center Caritas, currently known as *Karus*. However, many of the site's heritage values have been lost due to former interventions. The ambition to design 'the psychiatric center of the future' directly reflects the need for a higher quality in the care environment, not only because the buildings on site were considered outdated, but also because it acknowledges that it is not clear what the psychiatric center of the future should look like. Identifying and addressing the needs of future users is considered as a crucial aspect in this matter by Boie and Vandamme (2016) and by the management of the center.

As a strategy to identify these needs and ensure that the design solution reflects and meets these needs, BAVO initiated a working group with the current patients, staff, nurses, doctors and management. The approach to adopt a participatory design process resonates with the indication that user/experts could bring valuable information to the design table. This way, the user/experts are really involved in the design process, not merely as a stakeholder or an advisor with valuable information, but as co-designers (Boie & Vandamme, 2016).

While top-down financial incentives and management assumed that the historic buildings should be demolished, the working group soon revealed an appreciation for one of the buildings that had already been partially demolished. The working group argued to preserve this building as a 'monumental outdoor space' and to integrate it in the future of the center. This proposal posed an unprecedented design challenge, spatially and architecturally translated by architecten de vylder vinck taillieu. Their approach towards the building was to intervene cleverly and minimally, to only make spatial and material interventions where it is absolutely necessary.

While the building is not really inclusive because the architecture would not allow it to be used by all people, the use of the historic building as a monumental outdoor space in the context of a psychiatric center does promote social inclusion: the building contributes to removing stigma about psychiatric patients by drawing visitors to the site.

The renewed building raised awareness of the qualities of other buildings on site as well. Boie and Vandamme (2015) mention the perception that the open floor plan of the historic pavilions makes them easy to rearrange. Pavilions from the end of the 20th century, characterized by endless and dead-ending corridors, seem to offer less possibilities for adaptive reuse.

Challenges

In the case of adaptive reuse, built heritage conservation policy demands that a building's function matches its capacities. In this regard, care functions in historic buildings tend to raise objections from built heritage authorities because such functions often require thorough interventions. Care institutions on the other hand, are not always keen on implementing such interventions as they may not recognize the potential opportunities of historic buildings. This came forward in both cases, where it was initially planned to demolish the historic buildings.

Both cases show that it can be very difficult to adapt a historic building with respect for its heritage values and at the same time accommodate a high-quality residential care function.

Furthermore, literature review shows that financial support can be a major factor to invest in making historic buildings inclusive. For *Karus*, building anew turned out to be better supported by care authorities than thoroughly renovating the existing building. Additionally, the financial support for care infrastructure is granted per bed, often resulting in the so-called institutional 'bedhouse'. Because of this, integrating built heritage in a care environment is financially discouraged, regardless of its qualities or opportunities.

Besides functional mismatches and financial issues, analyzing cases on the KU Leuven campus illustrates that authenticity of materials often complicates interventions towards accessibility (Van de Bemdt 2020). In several cases (historic) cobblestones are considered as an important aspect of the heritage site. However, they are hard to navigate, especially for people with an impairment, and have a major influence on overall accessibility and usability of a historic site.

Strategies

Bottom-up and top-down

In Flanders, both built heritage conservation and accessibility are regulated top down through spatial planning regulation. Without this regulation, many historic buildings would not be conserved and many public buildings would never be made accessible. In the case of *De Korenbloem*, the management wanted to replace the historic villas with a new structure but was not allowed to do so because the villas were listed as protected built heritage.

However, to determine which functions heritage buildings can accommodate, or which interventions are most suitable to make them accessible, a bottom-up approach seems inevitable and preferable. Inevitable, as there is no clear and detailed legal framework regarding inclusive design, let alone inclusive design of built heritage; preferable, as the case studies illustrate that users may deliver valuable contributions. In the case of *Karus*, consulting the users even led to the conservation of more buildings than originally planned.

Transdisciplinary input

The challenges faced with when creating a more inclusive historic environment, are very complex. Therefore, it is preferable to unite knowledge, insights and skills of experts in various disciplines. Architects and building clients' insights and ideas are enhanced by consulting several experts in fields related to a certain project. An invaluable contribution across several cases came from user/experts. The case studies as well as literature show that they can be involved in different ways. For one, an on-site audit with user/experts may reveal difficulties as well as qualities of a historic site (Heylighen, 2012). In the case of *Karus*, user/experts were involved into the design process as co-designers. For *De Korenbloem*, architects gained insight into the living world of user/experts through a scientific study (Van der Linden et al., 2016).

Taking time

Selecting and contacting (user/)experts and agencies takes time, gathering and processing their input even more. First, it takes time to identify the heritage values and needs for their conservation as well as the needs of future users of a historic site. Second, conflicting needs should be balanced during the design process. Based on these considerations, different solutions should be proposed, tested and evaluated by the different stakeholders.

Furthermore, as illustrated in the university campus cases (Van de Bemdt, 2020), valuable solutions might be rejected for invalid reasons. For example, the choice for concrete pavers to make a courtyard more accessible raised objections from built heritage experts, who preferred a pavement with a more historic look. Taking time for research turned out to be useful to make a strong argument about why the proposed intervention was nevertheless acceptable.

Opportunities

Historic buildings as incubators for inclusion

The projects for *De Korenbloem* and *Karus* both started from the assumption that historic buildings were not suited to accommodate contemporary care. Gradually, the insight grew that these buildings could be used to organize functions that are complementary to residential care. Using built heritage as a more public part of the care environment invites people who are unfamiliar with the residents or patients to pay a visit. Facilitating social inclusion this way may help reduce and avoid stigmatization of residents and patients and contribute to their quality of life.

Built heritage as a means to improve mental well-being

A careful conservation, restoration or renovation can reveal and enhance the existing quality of a heritage site. In the case of *De Korenbloem*, for example, the architects associate the villas' rich interiors and spatial organization with the feeling of 'homelikeness' they want to introduce, with the aim to contribute to mental well-being (De Bruyn & De Vleeschouwer, 2014b).

Conclusion

The case studies reported on in this paper illustrate that the aim to create a high-quality care environment in a built heritage context may conflict with the conservation of heritage values. Through a multiple case study enquiry, we have attempted to identify the challenges and issues related to this aim, as well as strategies to overcome them.

A first challenge may be a functional mismatch between the historic site and the desired functions. Secondly, authenticity of materials may complicate interventions towards accessibility and inclusion. A third challenge relates to financial support for interventions in historic sites, either encouraging or discouraging inclusive interventions. Both literature and the case studies suggest that consulting various experts, including built heritage experts and user/experts provide a valuable contribution towards identifying the needs for built heritage conservation and inclusive design. Evidently, elaborate research takes time, but has been proven necessary for the cases we studied. The case studies also illustrate some unforeseen opportunities: by caring for built heritage and human diversity, we can preserve built heritage for future generations and contribute to the inclusion of human diversity in the process.

However, due to the Covid-19 pandemic, the scope of this research was limited to document analysis. Future research is necessary to determine to what extent findings from our document-based research correspond with how users experience the resulting environments. In this way, additional challenges, strategies and/or opportunities may come forward.

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Adding value to the future through design and entrepreneurship: PLACE

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Abstract

In a worldwide context of uncertainty, new generations of Design students face sustainable and social evolution issues during their education. These future professionals also bring crucial and timely issues to their curricular projects. However, such projects are usually forgotten once students graduate and ideas with high potential fall flat.

The Programme for LASALLE Creative Entrepreneurs (PLACE) is an initiative of the Faculty of Design of LASALLE College of the Arts. Singapore to support design students to turn their big ideas into sustainable and socially-engaged start-ups.

In its second year, the preliminary results of this programme already hint at high entrepreneurial consciousness among design students with socially and sustainably engaged projects. This poster presents the programme's initial results and possible effects on social and sustainable engagement through education.

Although many university incubators have been created over the years, creative programmes of this kind are scarce and often prioritise new technologies and fast profits instead of providing sustainable solutions and participating in socially and environmentally responsible enterprises.

Our results show a deep connection between this generation of design students and social and sustainable matters. We highlight how programmes like PLACE can improve the quality of the students learning experience and allow them to create value beyond their ideas.

A video game for emotion regulation of medical students

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Abstract

Depression among students has increased due to the COVID-19 epidemic (remote learning, lockdowns, isolation, etc.), especially those who suffer from cognitive dysfunction. Teachers in the health fields regret that emotional regulation methods are not sufficiently taught in France. In this study, we design a pedagogical Ludo application that cares about the mental health of medical students throughout their studies. This application called, TeachMod RE, aims thus to learn how to regulate students' negative emotions.

Method

TeachMod RE was developed with Unity3D and offered a 3D virtual environment where the learner embodies a first-person student avatar to increase immersion and involvement in the game. The main scenario consists in managing the pressure generated by exams in 25 different situations. Several multiple-choice questions are displayed to the learner to study his/her emotional regulation strategies (emotional suppression or cognitive reappraisal). The evolution of the events thus varies according to the user's previous choices. For gamification, the learner must control their concentration to improve the "revision" gauge. Several game-design elements were incorporated into the game such as heartbeat sounds and crouching positions of the avatar to amplify the anxiety, the pressure of the family and the time displayed on the clock for stress, the reception of the teacher's email to induce anguish.

Results

The game was tested with 50 speech therapy students, 22 at the Bachelor level and 28 at the Master level. After the playtest sessions, users' responses were collected to analyze the emotional strategies made by future health professionals. The responses from undergraduate and Master students were very similar. In addition, the results obtained showed that 67% of the students regulated their emotions, however, 49% of them used inappropriate emotional regulation strategies (emotional suppression rather than cognitive reappraisal). For the next step, we attempt to verify if the emotional regulation's methods differ according to the investigated fields, whether they are in the medical field or not, and by considering different cognitive profiles.

Conclusion

In this work, we proposed an educational application that takes care of the mental health of medical students, particularly neuroatypical ones. It aims to teach them the appropriate cognitive strategies for each emotional situation in a dynamic, immersive, and interactive way. The visual and auditory game design elements were beneficial in triggering the required emotions and hence increasing students' involvement and participation.

Video game design for ecological impacts

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Abstract

Video games have a potential impact on people and society. In addition to entertainment, they can be considered as conducive media for raising users' awareness of societal and environmental issues. In this work, we design three video game prototypes where each one highlights a particular problem (climate change, consumption, resources management, etc.). Our motivation for designing multiple mini-games is the possibility to analyze the individual impact of each game on the related issue [1-2]. These prototypes incorporate game design elements such as visual and auditory cues, gameplay, and game feel that attempt to influence players' attitudes and behaviors in a fun, educational and interactive way.

Method

The first game focuses on the planet's climate warming and intends to sensitize the players to the direct impact of their own habits and actions on the environment. The gameplay consists in choosing between fast but polluting cars or slow/electric but ecological cars. Then, the universe dynamically degrades according to the users' choices. In the second game, the player embodies a damaged, old, torn sweater that must learn to repair and sew itself to become attractive and find a new buyer. The goal of this game is to promote the circular economy, textiles recycling, and to avoid wastage by adapting the consumption of users. The main message is to show users that the consequences will not necessarily be bad by changing their practices. The last prototype is an interactive narrative game that proposes to players to manage a city and take strategic decisions. The players embody political decision-makers who negotiate with "Aliens" who have destroyed their planet and wish to live on ours. Decisions made during the dialogue are expected to foster skills in strategy, diplomacy, and management of the city's resources (managing overpopulation, civil infrastructures, construction of a new nuclear center, food consumption, public transportation, etc.).

Results

These games were developed using the Unity Engine, where the 2D virtual models and graphical aspects were designed for a casual purpose. The primary results based on a few direct observations of playtests showed a positive acceptance by the players towards the games. The user's exhibited ecological consciousness and sensitization to climate change and its negative environmental effects. The game design-based elements (visual, gameplay, and mechanism) played an important role in increasing immersiveness and triggering the necessary emotions that encourage users to take individual responsibility by adapting their mindsets and practices. For the next step, we plan to carry out a comparative study before and after the gaming sessions to analyze the change produced by these prototypes on the players' behaviors and attitudes.

Conclusion

In this work, three ecological impact games have been designed that encourage positive changes in our lifestyles (behaviors, decisions, energy and food consumption, clothing, recycling, etc.). We believe that game design can foster a better understanding of climate change issues and provide solutions and actions needed to create resilient and zero-emission societies.

Dwell and move, change ensues

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Abstract

Creativity is "adapting from" that lies at the heart of resilience as opposed to "adapting to" that captures an ineluctable co-existence. In Schöpfungslieder (1844), Heinrich Heine writes "Disease was the most basic ground of my creative urge and stress; creating, I could convalesce, creating, I again grew sound." Creativity is a way of resilience in the face of the banality and imperfection of the world, as expressed by Tarkovsky (1984). The absent desideratum, otherwise understood as lack and deficiency, is perceived negatively, and yet the negative, the absence, affords an ontological space for exploring the given and conceiving of the alternative. On a larger scale, this underlies development and change, in either the paradigm of post-development or the tradition of international aid and NGOs. From lack and deficiency therefore arise a call for creativity, the transition from "being" to "non-being" set in motion and a consciousness of the alternative becomes possible.

The poster presentation discusses the case of the University of Central Asia (UCA) located in the town of Naryn, Kyrgyzstan. UCA is a development university dedicated to improving the quality of life in the mountain communities of Central Asia. Established by the Aga Khan Development Network (AKDN), the university presents an instance of social innovation to facilitate and accelerate resilience, capacity building, civil society and economic development in the region through VET, higher education and research programmes. In 2022, UCA's School of Arts and Sciences held the Nomadic Image 2022, the 7th Transdisciplinary Conference of Imaging at the Intersections of Art, Culture, and Science. The conference was intended as a creative and generative platform to bring together local and global perspectives on identity and representation at the cross-roads between East and West, and hypermodernity and tradition in Naryn—a small town located on the periphery of a peripheral country, Kyrgyzstan, in a peripheral region. The conference was inspired by the Playful Eye project in 2020 held in Osh, Kyrgyzstan, an experiential method for encountering the "Other" through contemplative, somatic, and embodied practices informed by the concept of play. Play is breaking loose from the rigidity of the given and therefore underlies creativity.

In the same vein, UCA has envisioned and committed to the Naryn Urban Resilience Project (NURP). With the potential for growth, Naryn however faces significant limiting factors to supporting further investment. Impacted by natural hazards exacerbated by climate change as well as by social and demographic shifts, further investment in Naryn is likely to deliver sub-optimal returns if not aligned with frameworks and tools to enhance the resilience of Naryn over the coming years. The poster presents UCA not as a conventional education provider, but rather as a network of cultural and intellectual stakeholders with a mission to promote economic development, social transformation, and resilience. In a context where resources are limited and conflicts rife, this is only possible through generating and adopting new conversations, perspectives, and connections rooted in the local cultural, natural and epistemic milieux and enriched by the global experiences and discourses.

Transposing timelines

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Abstract

The research will speculatively project the influence of the Metaverse on our city centres and their contemporary urban challenges whilst proposing an optimistic scenario in which the digital and physical city complement one another to conserve the built environment for future generations.

We are currently living in an era where the lines between physical and digital are becoming blurred, and whilst recent research has measured the value and financial impact of the metaverse over the coming years (McKinsey & Co, 2022), it is imperative to consider the impact it will have on our environment, education, society & experiences.

We live our lives and interact within the physical built environment, however the need for a more innovative way of working, socialising and learning has only been further highlighted since the Covid19 pandemic; ultimately teaching us that these interactions will exist beyond the physical but in digital and hybrid reality. Since this, all cities now have the unique opportunity to rethink their landscape and infrastructure (Rees, 2021) addressing the needs of residents and communities, new and old. This paper suggests we must reimagine the city and utilise digital technology to our advantage when tackling contemporary urban issues.

Using Manchester in the UK as a case study, this paper will explore the narratives and perceptions surrounding the metaverse to analyse whether it can be more than just an e-commerce and marketing tool. An exploratory questionnaire of the citizens (n=50) and expert interviews (n=5) including a landscape architect, a procedural artist from a global game engine company, academics in advanced digital design, designers, and a metaverse concept architect) along with rigorous trend analysis and scenario building surrounding advanced digital technology were conducted to investigate the meaning and opportunities of metaverse for the city. It argues that whilst the metaverse is in its infancy as a digital entity, there is huge value for the city in tackling the current issues identified by the citizens.

Drawing on its findings, this paper reinforces that when designing in the virtual world, it is crucial we do not forget the physical. The metaverse provides an opportunity for local authorities, designers and urban planners to rethink cities of the future, and while for some it may be too soon to appreciate its impact, it Is not too soon to ask. Is the metaverse ready for us?

Artificial intelligence-aided type design for Chinese script

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Abstract

In digital typography, a set of "Hanzi" or Chinese logogram characters includes around 6'763 commonly used glyphs (Billeter 2010, Yuho 1993), the minimum number required to compose basic texts in Chinese. In Latin typography, a comparable set would include the alphabet in full caps and several punctuation signs. This disparity in the number of characters is crucial when it comes to type design: unlike alphabet-based languages, a Chinese typeface could take more than one year to complete, involving teams of people. The practical constraints of Chinese script design prevent individuals from entering the field. Moreover, creating a Chinese typeface represents a considerable investment that also prevents more graphically experimental shapes, thus becoming an obstacle to innovation (Skala 2013, Takagi 2014).

How can Artificial Intelligence (AI) be employed to reduce the amount of work done on the design of an entire Chinese set, starting from 267 basic characters only?

This research question is at the centre of an applied research project, which has developed an AI algorithm that can automatically generate Chinese typefaces, hence enabling a richer type design environment for the Chinese script. The present paper reports on the development of the research project and on its final outputs.

While other databases of Chinese script already existed, they are privately owned by Chinese type foundries: the newly established database is public and open source. It was fed with 90'000 entries, decomposing Chinese characters into radicals and components according to a reduced number of layout patterns. The database is built to train a Generative Adversarial Network (GAN) and was made available to all type designers for both training data for AI and hand-crafted design activities.

GANs are formed of two neural networks contesting with each other in the context of a zero-sum game, where the result is an advantage for one side and an equivalent loss for the other. Given a training set, this technique enables the generation of new data with the same statistics as the training set: new elements that look authentic to the human eye since they bear realistic characteristics. GANs allow for the model to learn in an unsupervised way, thus reducing human efforts (Goodfellow et al. 2014).

The research provided with surprising results: AI is doing better work at generating calligraphic 'humanistic' shapes rather than rationalist geometry, which questions the process of type design and the bias brought in the field by vector drawing. As any AI-related project, the research project questions the relation of designers with authorship and copyright. In the current type design scene, automatization of labour is already a reality: a large part of the designers' work is to discriminate between machine-generated forms. The outputs underline the fact that Artificial Intelligence can only operate from existing design, and cannot create outside of a given structure. The fear of an AI-Leviathan taking the jobs of designers is only serious for those who are themselves creating in the nutshell of existing styles. Finally, the project proves that AI can stimulate creativity by making fruitful mistakes.

Design and reconstruction of the new interest youth community in china in the post-epidemic era

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Abstract

After COVID-19's epidemic, indeed, higher rates of psychological distress, psychiatric disorder, and specific diagnoses have been reported. Relevant studies have demonstrated that youths' involvement in community activities can be effective in social skills. New Interest Action, with its characteristics of outdoor social interaction and cooperation, will serve as a unique emotional connection for the youth community and promote the development of youths' physical and mental health. Few studies, however, have focused on social relations' restoration in youth communities' offline space, and New Interest acts are used as part of youth community action rarely. It is necessary to explore how youth groups construct community identity in contemporary urban communities lacking emotional connection. This study is concerned with reconstructing the new youth community relationship model with further interest action as the core, as well as finding the strategy and value of socially innovative design intervention in the community. The research's two theoretical foundations are the integration of community development design theories and social identity. In the context of the epidemic's new normal, this paper takes New Interest youth groups' participation in community action as the entry point and further analyzes the resistance problems that are caused by activity environment cognition and emotional attitude in existing communities. Combined with the sporadic nature of the epidemic and participatory observation and in-depth interviews were used to summarize the community composition, youths' behavioral characteristics, and functional changes of the community under the background of the normalization of the epidemic, which reveals the dynamic generation mechanism of the community. Finally, practice implementation and case analysis were applied, to discuss the communication of community culture the characteristics of offline and online interactive behaviors in social places based on geographical relations with interesting fate as the core, and the currently existing problems. In this paper, it is suggested that New Interest Youth can be the stabilizer and adhesive of the new community relations of the Post-Epidemic Era. The new type of community design composed of interesting groups has shifted from activating the "identity" of the minority to mobilizing the "cultural identity" of the enthusiasm for the majority. Under this circumstance, the designer's work center is to build group connections and reorganize existing assets. New unbounded consciousness, new vitality of activities, and smart new living can be considered as design support, which promotes the emergence of creativity for the community and supports the organization of new types of community members. The contribution of this article is to put forward the design reference ideas for constructing new lifestyles and expanding cultural space for youth during the post-epidemic period.

Sound E-scape: an interactive, digital application for music therapy and soundscape generation

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Abstract

This poster details the design and construction of 'Sound-Escape', an interactive software application that provides the ability to generate natural soundscapes and filtered noise sources for the purposes relaxation and sleep, as well as the ability to engage in musical therapy by presenting interactive musical therapy instruments digitally. The application is operable by mouse, however, a design for an associated MIDI (musical instrument digital interface) controller that provides a simple six-button configuration that allows a user to navigate through the application and activate its various features is also provided.

Sound-Escape is designed to align with four Universal Design Principles (Universal Design Institute, 1989): Equitable Use. Simple and Intuitive Use, Perceptible Information, Low Physical Effort. Its purpose is to provide a digital means of generating soundscapes and engaging with musical therapy.

Development of existing biophilic interior design definition

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Abstract

In previous centuries, there was a great emphasis on holistic approaches in the built environment, such as in medicine, which has been lost within the recent buildings in Europe and with the rise of modern building technologies, especially in the US. "Most modern buildings demonstrate no understanding of ecology or ecological processes, implying to their users that knowing where they are is unimportant", which leads to increased isolation from nature and the growing "placelessness", as described in David (1999, p. 212–213).

Recently built environments, whether healthcare facilities, offices, homes, etc., are more focused on functionalism rather than human well-being, missing a balance between psychologically relaxing, aesthetically pleasing spaces and functionality. More recent studies have questioned the importance of considering human well-being in the interior built environment as a holistic approach that returns to past eras. Another factor is that human behaviour is affected by the built environment, but how can we influence human behaviour through the built environment? Recent research suggests incorporating nature into space, also called the biophilic approach.

This approach was developed by Stephen, Judith, and Martin (2008) and named after the book Biophilia 1948 by the biologist Edward Osborne Willson. The theory of the Biophilic approach originated from the biophilia concept, which is "the deliberate attempt to translate an understanding of the inherent human affinity to affiliate with natural systems and processes"(Stephen, 2008). Biophilic interior design is "an innovative approach that emphasises the necessity of maintaining, enhancing, and restoring the beneficial experience of nature in the built environment"(Stephen, 2008), with two main basic dimensions—organic or naturalistic dimensions (directly, indirectly, symbolically), and the place-based dimension (Stephen, Judith, and Martin, 2008). Stephen (2008) created a matrix of six elements that appear in more than 70 biophilic design attributes.

Biophilic Design from building to cities starts with initial questions: how does the constructed environment influence the natural environment, and how does nature influence human experience and aspiration? How can we establish reciprocal and long-lasting advantages between the two? The concept of Biophilic design stems from the growing realisation that the human mind and body developed in a sensorially rich environment, which remains crucial to people's health, productivity, emotional, intellectual, and even spiritual well-being.

Through a systematic literature review and quantitative methodology, this paper will explain four phases, including literature search, literature screening and selection, literature appraisal, and thematic analysis, to identify the various existing biophilic definitions, aspects, and matrix. It aims to transfer the current understanding of biophilic design to a newly developed definition and present a matrix that will inform the basis of testing experiments in the following phases.

Design-driven approaches to human augmentation. An exploratory study

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Abstract

Human Augmentation, also referred to as Human 2.0, is the set of practices and disciplines that focus on creating cognitive and physical enhancements as an integral part of the human body, augmenting its natural capabilities through the implementation of technological devices. Various questions arise from the implications of such interventions on the human body, with opinions on its legitimacy being conflictual and while sparking ethical concerns in the definition of a post-human condition in which creativity is one of the human capabilities that could be augmented. The Design discipline is set to be both affecting and being affected by this transition, paving the way to augmented forms of hybrid interaction, perception and cognition mediated by on-body interfaces. This exploratory poster aims at investigating the field of Human Augmentation under the lens of Human-Centered Design and understanding the role of the designer in this novel research field. This investigation is carried out through a review of academic papers and case studies - including projects, experimentations and workshops - in the field of Human Augmentation that include the implementation of a design-based approach in their development, with regard to the processes and methods adopted.

This poster has the overall objective of offering a contribution to the debate on Human Augmentation from a Design point of view, with the idea of highlighting the positive approaches to the field that are dedicated to the synergic confluence of human users and their cyber-physical extensions to guide the future development of Human-Augmenting Design.

Designing with people: creating a multi-level interdisciplinary design education environment for more inclusion

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Abstract

Attention for inclusion and diversity in the learning and living environment of students in higher education is important. Universities can play a key role in educating, facilitating and setting a good example themselves in their communication, infrastructure, teaching methodologies, etc. The educational programs of 'Interior Architecture and Architecture' and 'Occupational Therapy' (OT) of [university left blank] both teach about inclusion and human-centered design approaches, but want to join forces for the purpose of elevating knowledge and expertise on inclusion to a higher level (cf. Young et al., 2019).

In a two-year project (Oct '22-Sep '24) we explore how to create the best possible setting to teach inclusive design and create an inclusive learning environment. This poster outlines the steps to develop a new, multidisciplinary inclusive design course 'Designing with people', where knowledge on diversity and inclusion will be gathered and disseminated throughout the design process through the paradigm of Universal Design.

The following three steps are taken:

STEP 1: Optimizing interdisciplinary design teams (within education): Expertise and competences of both disciplines are analyzed according to complementing and strengthening/reinforcing properties. They are combined to establish a more powerful design team.

STEP 2: Realizing an inclusive learning environment: This learning environment is realized on two fronts. First, students and staff will focus on Universal Design for Learning (UDL). Staff members will test teaching methodologies and alternative strategies to create an enabling environment for everyone. Students will need to communicate and present (within the design team with students of different backgrounds and user-experts, with clients, etc.) in an inclusive way.

Second, for stakeholders involved within real-life cases (clients, end-users & staff) a network is installed in which different clients (with end-users) who initiate a real-life design issue not only learn from the design teams' (i.e. 'experience user-experts' with different backgrounds and students OT and design) spatial analyses of the as-is situation and design proposals, but also from each others problems and possible solutions. Within this network the Universal Design paradigm will be used to open up the design process to the widest diversity of people possible.

STEP 3: Developing a systematic and efficient methodology for inclusive co-creation:

Experiences, improvements and suggestions from the process of optimizing powerful design teams (i.e. step A), from the inclusive learning process (i.e. step 2A) as well as from the Universal Design process within the broad network (i.e. step 2B) will be structurally gathered from all stakeholders and analysed. Insights and lessons learned will be established in a theoretical framework on designing with people to further disseminate to other courses and other environments in order to facilitate diversity and inclusion in real life.

The outcome of this project is threefold: (1) a new interfaculty course linked to structural and sustainable learning networks; (2) more knowledge and awareness towards inclusion and a variety of people, with different (dis)abilities, needs, experiences and backgrounds, not only among students, but also among staff as well as the broader network of real-life cases; (3) the development and dissemination of a theoretical framework on inclusive co-creation.

Material connotations: meta-structure research of practice based projects with invasive species plant waste

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Abstract

In nature, change is inevitable as Greek philosopher Heraclito already said 'everything flows, nothing stays the same'. Nowadays we live in a fluent reality where the past, present and future change every moment and relate to new possibilities and disasters (Haraway, 2016). We have been embedded in a human centered design that has cost too much to our environment. Into what is called Anthropocentrism, crisis is a disease with several symptoms: deforestation, loss of biodiversity, global warming... are just some of them.

In this project we focused on nature biodiversity loss due the proliferation of invasive species and nature management systems through getting closer to the natural matter-material element from a co-creation perspective. The aim is to develop a recipe of how to understand and deal with invasive species raw matter through a context specific practice based research full of connotations, multidimensionality and ambiguity. To elaborate, through our own experimentation, a guide of 'how to' take into account all embedded aspects of its meanings.

With the diagram presented in this poster contribution, based on The Krebs cycle of creativity III (Oxman, 2016) we seek to make visual connections in between all agents, situations, conceptual concepts and decisions in order to make affordable the unseen backend of two related projects: the finished research 'What doesn't belong here' and the on-going thesis project 'Biomaterials and matter from the Galician natural environment applied to the design, printing and manufacturing of everyday life objects'.

Both projects focused on two different locations, 1. Genk, Belgium and 2. Umia river, Galicia, Spain; are being used to elaborate and re-elaborate the presented strategy. The diagram, a graphical representation of the Method, is presented as a combination of simple figures, circles and interconnected lines, whose interaction allows us to read it from inside to outside, left to right, top to bottom and vice-versa. Hence that everyone could start their own dialogue with the diagram in order to achieve its own conclusions and working method. It has been tried to stay in the middle, growing in all directions at the same time, as plants do (Marder, 2013), to be specific but open at once. It is considered that by applying a global to concrete perspective and creating rare kins and relations (Haraway, 2016) in between disciplines, the creators can be witnesses of the project's needs and possibilities.

'What doesn't belong here' is a matter-material research contextualized in Genk, Belgium, in between the months of March and June of 2022, developed in collaboration with the LUCA School of Arts Inter-actions research unit and focused on the invasive exotic species Japanese knotweed. 'Biomaterials and matter from the Galician natural environment' is an on-going thesis project in the program of Creativity, social innovation and sustainability at the University of Vigo in Galicia, Spain, that is being elaborated in collaboration with the forestry engineering school and the fine arts college at the campus of Pontevedra, working along with four invasive exotic species Arundo donax, Phytolacca americana, Tradescantia fluminensis and Eucalyptus globulus.

From collecting natural objects to presenting the future anthropocene: exhibition design for the anthropocene theme in museums

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Abstract

At present, frequent natural disasters have led to serious concerns about the environment and the future of human beings in both the academic and public spheres. In this context, The Anthropocene no longer only refers to the geological era shaped by the environment but gradually evolves into a word with multiple symbolic meanings linked to environmental protection and ecological crisis, on the other hand, which also reflects that human beings are responsible for the current ecological changes.

Traditionally, in many natural or science-themed museums, this type of museum has tended to establish the scene from a collection of fossils, animal bones and fake indoor nature artefacts. However, several museums seek to exhibit the future "Anthropocene", which does not exist and for which no historical evidence exists. Meanwhile, scholars associate museums with the "Anthropocene", and the keyword "Anthropocene" often appears in exhibitions with such keywords as environmental protection and climate change, which also show the relationship between the Anthropocene, climate change, and ecological and natural environments to some extent. By illustrating the before and after of the Anthropocene and the potential future crisis, it inspires the audience to reflect on the present ecology, thus fostering the propagation of sustainable development concepts.

Unlike other knowledge export channels, the museum provides an accessible and hands-on knowledge platform by combining expertise in the fields of art and science, allowing audiences to experience the concept of the Anthropocene from multiple perspectives and senses and also evoking a certain degree of reflection on environmental protection and a sustainable future. In modern society, museums have evolved in their functions, and future-themed museums have become one of the current trends in museum development.

In the design area, the Anthropocene is increasingly integrated with diverse design subjects, such as some design trends include speculative design, object-oriented design, biological design, non-anthropocentrism, human hegemonism, and so on. Many disciplines have attempted to approach the Anthropocene from different perspectives, stepping away from post-humanism studies focusing on human centralisation and thinking more about globalisation, the natural environment, and sustainable development . This literature indicates that humans need to take on the material consequences of improving their well-being and no longer be passive, marginal agents shaped by the changes in the Earth's environment. Trends such as the Anthropocene and Speculative Design cultivate a sense of crisis among the public, encouraging architects and designers to react in advance by moving forward in geological time and responding intentionally to future expectations.

Through a range of research methods, this study wants to focus on the emerging theme of posthuman-world narratives in museum contexts, especially in relation to the future, and examine the power that design methods can contribute to the production of knowledge in contemporary museums. This study aims to expand the horizon to explore the reasons, purposes, and needs for the rise of posthuman world narratives in museums from an epistemological perspective, and to focus on the impact of posthuman narratives in museums at the level of society as a whole.

Catacombs: refuge on the border of the virtual and the real

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Abstract

The poster aims to present the project Inverse City and its development process, from the initial concept to its final execution. The site-specific installation fuses analogue and digital forms of immersion to provide the viewer with an embodied, spatial experience of finding refuge.

In our times of political and ecological unrest, the idea of a catacomb gains new connotations and appeal. The project aims to offer the viewer a symbolic, secular catacomb that they can fill with their personal hopes and beliefs to shield them from what is oppressing or endangering them. "Underground" virtual worlds are often perceived as dangerous places, but this work aims to portray the joy of creating a community and resisting.

Catacombs are underground spaces most commonly built by oppressed communities, which is why its construction is often done in secret and develops organically. A typical example of catacombs is those created by early Christians under the rule of the Ancient Roman empire. They could only bury their dead outside the city walls, for which they would dig labyrinths of corridors and chambers underground with the walls of the catacombs consisting simply of earth.

My artworks present architectural spaces made of human bodies to reflect and unearth the socio-political structures of architecture in general or regarding specific institutions and communities. In this case, I aim to reflect on the enormous communal effort that went into the construction of ancient catacombs. Another interpretation of the human figures is that they represent all those who found a place of eternal peace here, such as those half a million people who were buried in the catacombs of Saint Callixtus.

The experiment which led to this project was the attempt to find a method that combines a digitally constructed environment with a physically immersive installation. Firstly, the two scenes were modelled in Blender, from which images were rendered with equiangular cameras so that one image could incorporate multiple traditional views. The first image was made with an extended view on the horizontal axis, while the other was made with a broadened vertical axis. These high-resolution images were then printed onto large PVC sheets so that the spaces they depicted were life-size. These were exhibited in an arched cellar art space, for which the prints' sizes were measured to fit the forms of the location perfectly. The second, vertically extended print was installed along the arch of the place, thus folding vertically along the ceiling to create an illusion of an extended virtual space.

The overall atmosphere of the exhibition with its underground cellar location, soft lights and beckoning prints aims to create a modern-day catacomb to provide a symbolic shelter for all in need of a refuge.

Hybrid specimens: Phygital artefacts at the intersection of analogue + digital crafts

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Abstract

Exploring the intersection of analogue and digital crafting, this visual paper presents two physical sculptures and their digital re-assemblies. The physical sculptures were originally created in the frame of a computational design case-study, as meditative material sketches, but quickly acquired a separate creative life of their own.

Two formal gestures that originate in the field of computation, 'array' and 'blend', were manually enacted on the body of two stone fragments. Scavenged from the case-study's site, these fragments related to their initial spatial context through different material qualities. Upon this base, the author sought to physically perform the digital gestures, this time however departing from the pure, mathematical quality that these actions have in the digital realm.

The process was driven instead by reflections, and the detailed observation of the fragments' perspective views, different surfaces and micro-textures. Through intuitive co-relation, each fragments' material specificity (form, transparency, texture) inspired their sculptural development. Intuitive formal associations led to the introduction of new materials, and the sculptures evolved as an interplay of colour, assemblage, shadow and light. At this first stage, the creative process was purely analogue and involved time-intensive, delicate craft.

At the next stage, these sculptures become fragments themselves, as a digital formal exploration begins.

Based on a combination of close-up photography and 3D scanning, fragmented views of the sculptures are selected and digitally re-assembled. Through a process of digital collage, different resolutions and materials are tested, expanding the aesthetic qualities of their analogue precursors. The resulting artefacts evoke organic impressions, which however remain consciously undefined and open to interpretation. Chimerically, their formal impressions range from mineral to animal to textile, defying a taxonomic interpretation. In an interplay of scale and perception, the objects could both be the specimens and the landscapes themselves.

The gradual formation of these artefacts seeks to highlight the artistic perception and associative layers, that both inhabit and drive the production of sculptural form, yet often remain hidden in the established, performance-oriented architectural discourse. The resulting sculptures and phygital collages are fusions, not only of matter, but also of two completely different strands of design mentality and process (digital vs analogue). The last step of this project seeks to fuse the two realms together, to activate different aspects of their embedded tacit knowledge in parallel, and to explore their alchemic interaction.

Content management system in mapping movable objects

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Abstract

Movable everyday items as sites of culture and design studies surface the challenge of collating, coding, and archiving multifarious sources. The development of a content management system [CMS] is a digital archiving solution to store expansive and diversified samples that maybe here today and gone tomorrow. CMS in design studies facilitates the extraction of categories and indices of a phenomenon expressed in the form and technique of society's material culture. At the core is the coding protocol to gather, organize, generate, and curate the visual accompaniment of the inquiry.

CMS is a tool to chart the figurative mobility and provenance of the object through the archival photographs, drawings, and illustrations. With the inclusion of location maps and the anecdotes behind the objects, they lend the texture and materiality of the quotidian articulation. The narrative surfaces the positive values of the ordinary arts commonly produced by the masses (Fajardo. 1990. p. 95) and embraces the plurality of design studies. CMS cultivates a norm to explore marginal topics as the seminal essay of Prys Morgan (2012) in the "The Hunt for the Welsh Past in the Romantic Period," or in the contemporary topics of Del Coates (2003) in Watches Tell More Than Time and Sophie Woodward (2007) in Why Women Wear What They Wear. The integration of digital technology in this new provocation, tackles the challenge of burgeoning content collection.

The rationalized system promotes inclusivity in the replicability of the methodology to manage research. It anticipates the future by subsuming the virtual space and optimizing the capacity of digital technology to craft new knowledge. CMS is an indispensable tool to excavate contexts, meanings, and symbols, preserving movable everyday objects in document-based narratives.

FlavourGame: Interaction design in hybrid games

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Abstract

Throughout the past years we have seen games with augmented reality (Arnold, 2017), board games using smartphones as assisting tools (J. Rogerson et al., 2021), and tablets being used as boards (Mora et al., 2016), or even games using real food – edible games (Sandercock, 2019; Wei & Cheok, 2012). This combination of physical and digital components presents new and unimagined possibilities to game designers.

A serious hybrid game model is being developed in the scope of the project, which combines the digital component (based on a Tangible User Interface) with a board game. This hybrid game is called FlavourQuest and its objective is to support the autonomy and motivation of children from 10 to 12 years old regarding healthy food choices. In fact, real foods with their flavors, aromas and textures are introduced as props to the players during the game, creating a whole new sensorial experience.

Obesity is seen by the World Health Organization (WHO) as an epidemic that will cause several health problems. WHO recommendation number 1, for tackling the obesogenic environment of children and norms, is to "implement comprehensive programmes that promote the intake of healthy foods and reduce the intake of unhealthy foods and sugar-sweetened beverages by children and adolescents" (WHO, 2016). WHO also recognizes the important role that Information and Communication Technologies play in improving public health. Thus, WHO identifies eHealth as a strategic area (WHO, 2023). With this in mind, FlavourGame is a project that has a social impact by improving the quality of life and health of children by intersecting Arts, Technology, Communication and Health.

Regarding the methodological framework, the FlavourGame project follows a participatory design approach with children who were involved in the design process from the early stages in order to share their ideas and feedback.

In this poster, the various stages of design and development of the FlavourQuest hybrid game are presented, namely: a) the analogue prototype; b) the design of the narrative and its framework; c) the design of the characters and the game tiles; d) the graphical interface of a web app for mobile devices that guides the game tasks, and e) the physical computing layer.

Bibliometrics in circular design visual representation

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Abstract

The main goal of this poster it represents graphically the evolution made in Circular Design Research (CDR) in Portugal and Worldwide. This research demonstrates that Portugal's representation (at the global level) in this area is residual, and the Netherlands assumes a position as the leader in CDR, having as its base the Database collected in Web of Science. The last 5 years represent 65% of all scientific knowledge produced in CDR, revealing the opportunity and relevance of the studies of Circular Economy in Design. Besides that, the data collected in RCAAP (Portuguese Open Access Scientific Repositories), Design has a strong position in CDR, but if you see the metrics in Web of Science the participation of Design in CDR is residual, contrary to fields like Engineering, Technology, and Environmental Sciences.

The methodology is based on data collected and analysed. We resort to Web of Science and use the term "Circular Design" in three different types of searches: Keywords, Topic and Abstract. We collect the Data and organize them in a spreadsheet and treat the data and organize them by Author, Year, Journal, Title, Affiliation, Country, and Area of Study. In the case of RCAAP because of the browse limitations (which don't allow us to find by Topic, Keywords and Abstract) and sample dimension, we expand the search for more 2 terms (Sustainable Design and Circular Economy – in Portuguese and English) doing the search by Topic. In the data organisation, we used the same parameters used in Web of Science search.

It's possible to conclude, based on Web of Science results that the Topic has more information entries (211), followed by Abstract (161) and Keywords (51). Findings make through Keywords it can be readied as the more important method of data collection in this type of analysis because create a direct relation in the real subject of the article. But, in the 3 types of searches, it's possible to establish coherence in the qualitative data analysed:

Netherlands is the most representative country in both searches and TUDelft the most representative University. Environmental Studies and Science Technology are represented in all searches as one of the most scientific productions in CDR. Design representation in Web of Science assumes a residual position Portugal is represented by 6 communications indexed by Web of Science.

In RCAAP database it concluded that only exist 14 PhD Thesis and 53 MsC Dissertations: Design has a representative position in Portugal in CDR, on par with Management and Engineering. The expression "Circular Economy" (in Portuguese and English) is the most expressive Keyword because of your thematic coverage. The PhD in Design in Portugal 2 they are made using the Methodology of Research for Design (based in Frayling). The temporal comparison between Web of Science and RCAAP shows us that is a similarity in growth and decrease in the same time spaces.

Inclusivity as a hype phenomenon in advertising

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Abstract

Inclusivity is a major sociological trend. This article aims to understand how this trend has been pre-empted by advertising into an inescapable paradigm. The concept of inclusivity is duplicated in advertising without any reflection on its strategic relevance for the brands using it. Today, brands repeat the word inclusivity ad nauseam, regardless of the product. This woven patchwork of ideology, new aesthetics, and commerce, creates a context in which it is difficult to discern true commitment from opportunism. We will question the core nature of inclusivity in brand communication by identifying three different typologies of inclusivity. We will conclude by proposing a life-cycle diagram for sociological trends applied to inclusivity. The paper is a contribution to the CONNECTIVITY AND CREATIVITY IN TIMES OF CONFLICT conference themes.

Inclusion in recruiting

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Abstract

This paper investigates the promotion of inclusion in large Swiss companies through an anonymised recruitment process in the Metaverse. For this purpose, the following research question is posed: "To what extent can the recruitment process in the Metaverse promote inclusion by allowing parties to get to know each other as avatars?" To answer the research question, three areas were analysed:

In a first step, the recruitment process was analysed in theory and practice through literature, internet sources and interviews with experts. In a second step, the avatar and the metaverse were analysed using specialist literature and internet sources. The findings from the first two areas, additional internet sources and expert interviews provided the knowledge base for the scenario analysis of an anonymised application process in the metaverse. The scenario was examined for feasibility, acceptance and plausibility. The evaluation of the qualitative interviews and internet sources shows that the research question cannot be answered definitively. A direct connection between the increase in inclusion and diversity and anonymity cannot be proven. Unconscious bias, on the other hand, would be eliminated with the help of an anonymous process. The technical feasibility is given.

There is still no agreement on the definition and future vision of the metaverse. Whether the metaverse will establish itself as a platform is still unclear. There is acceptance of an anonymised process, but only to a certain extent. An interpersonal exchange in the real world is still desired.

Values, design and educational project: contemporary projections

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Abstract

This poster wants to show a journey through a unique design higher education project: ESDAPC. A public project that takes advantage of the synergies of the methodologies of the artistic discipline of design to transmit, cultivate, investigate and develop contemporary values that are articulated in a complex network of participatory practices: putting the user in the central point, sensitive to the ecosystem and conscious of diversity.

From this point of view, the ability to transform reality is encouraged, a common reality in which the designer plays a strategic role in which his participatory proposals bring us closer to shared futures. With this basic ideology, we want to show how, through the academic space, some lines of work are promoted in which values shape the local and global challenges to which we are subjected as a complex world. In this way, the pedagogical project accommodates a teaching guide that nourishes its content, value system, giving meaning through applied knowledge that leads the student to seek a real impact of their work.

We organize this pedagogical project account into different conceptual blocks that are interconnected with a selection of proposals from the students themselves: ecological strategies, cultural activism and participatory practices.

Project Hope: the creative revolution mural, a human singularity approach

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Abstract

Art & Design schools, coming into the 21 century realized the growing need to keep up with advancing technologies, the global consumer markets, and especially how people are learning. The global pandemic served an inevitable disruption across all industries. It was necessary to adapt and figure out 'Hybrid' learning methods. Artists are driven by the environment they are immersed in, but during this time we were stuck inside our own bubbles. How can design, which is fundamentally community and collaboration based, be taught remotely?

Learning happens beyond the class sessions and assignments. The interpersonal relationships among peers, the open dialogues between professors, and cross-department conversations facilitate great work. It is clear that physical space matters at an Art & Design school. The environment must nurture various perspectives and bring cultures together. This would lend itself to experiments and encourage learning through experience.

The College For Creative Studies (CCS) in Detroit has gone through a century-long transformation. But, the past few decades, CCS has taken the fine art 'White Cube Gallery' approach. As the college goes into the next era, two international students decided to make their final project to understand the role physical space will play in the future.

This thesis was a cross-department, collaborative passion project that eventually took the final form as a mural displayed permanently in the Walter B. Ford building at CCS. The project was based on 4 foundational pillars: Creative, Community, Culture & Collaboration. Through this project, the participating members began to understand the approach we must take when it comes to diversity, inclusivity, and culture in a learning environment.

More-than-human ways of thinking through felting wool

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Abstract

Felting is a traditional and contemporary process of making surfaces from fibers such as wool, by compressing fibers with water and alkaline. I am making textiles with this method because it is an ancient craft method used by nomadic people. I am specifically interested in feltmaking made by Turkish nomads, namely Yoruks. What I am trying to do is to research this process through a more-than-human lens. Felting means a lot to me as a researcher and designer, but it also has a personal meaning to me, which I try to reflect on my research.

As Tsing writes, "human nature is an interspecies relationship" (2012, p.144). For designers, it is important to explore how humans and nonhumans are in relation, and to recognize the bifurcation of nature (human-nature divide). In many ways of knowing such as indigenous/traditional knowledge, humans and nature have a nonbinary relationship. I think of ways to listen to nonbinary definitions of human-nature, and acknowledge it in this research through understanding wool as an entity.

Wool as a material and a renewable resource has many layers of cultural meanings and significance. It is an animal fiber, which may come from sheep, camels, alpaca, rabbit, and other animals. In Norway, it is a material that protects from the cold weather and there is a rich tradition of using wool yarns and textiles for clothing. Wool and its usage in artifacts such as textiles can be traced back to ancient civilizations. Through history, wool had an important role in the daily life, economy and culture of many societies. Wool also has unique properties such as its insulating properties, durability, flame resistance and its ability to absorb and release moisture.

While there are many resources on wool and its history, qualities for designers, this research aims to take another approach, taking wool as a nonhuman agent relevant to all other-than-humans. It explores wool's relationship and role in feltmaking process from posthuman and more-than-human perspectives. As a part of this research, the poster demonstrates my relationship with wool material through felting experiments. Felting in itself is manipulating the wool and giving it shape, and I wanted to approach it as not a manipulation but more to observe how it shapes itself, with many wool types and colors. The images all refer to different entanglements of wool through different stages of felting, many were left unfinished/half-felted to demonstrate the process of wool becoming felt. In other words, felting practice in different stages of making is presented in the photos, focusing on the wool material. As feltmaking requires minimal additional tools, the interaction with wool can be underlined easily.

Care strategies to strengthen heritage structures as a community asset during the pandemic: the case of Bahay Nakpil-Bautista

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Abstract

With the ongoing pandemic serving as a challenge on local built heritage, structures like the Bahay Nakpil-Bautista (BNB) in Manila, Philippines have been greatly affected in two ways. One is the temporary closure of its museum and exhibition spaces to visitors. Revenue being made from the entrance fees was intended for its maintenance as a 108-year old structure. Second is the construction of a nearby building—when no one was around to challenge it—which will affect the architectural foundation of Bahay Nakpil-Bautista. The BNB is an important architectural and historical structure built in 1914. It was home to a family of Filipino artists, jewelry makers, musicians, philanthropists, and leaders during the revolution against Spain. The house had been adaptively reused as a heritage museum, providing community-based programs on art, culture, literacy, health, and wellness to marginalized residents. As a community asset, its closure was greatly affected by the pandemic as it relied on human traffic.

In this academic paper, the author aims to present the Care Strategies done in order for a heritage structure to survive the effects of the pandemic and remain in the public eye to create awareness of its cultural significance. The main objective of the care in design solutions was to strengthen the socio-cultural sustainability programs of BNB. The continued usage and support of its adaptively reused spaces should focus on both care and sustainability as a way to future proof the structure. First, it became the subject of a case study for the development of a socio-cultural sustainability index, including the assessment of its interior spaces for further adaptive reuse. Second, online fundraising activities for its maintenance were conducted. Third, public lectures helped raise awareness on the value of the adaptive reuse of historic spaces. As a result, the house is able to protect its status as a community asset by caring for its structural and intangible foundations in spite of limitations of the pandemic.

A novel offloading insole system designed for healthcare

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Abstract

Foot pressure is the focus to manage the lesions and/or pain for a broad range of people, such as the elderly (Menz et al., 2007), people with diabetes (Chatwin et al., 2020), or cyclists (Bousie et al., 2018). Common foot lesions like corns and calluses can cause pain and impact quality of life (Farndon et al., 2015). The authors have investigated an offloading technology in a prototype insole, which is potentially used by people with low-risk pressure-induced foot lesions, such as corns and calluses, to reduce plantar pressure.

It is designed with a modular cell structure allowing cells to be removed to create a customised cavity to relive pressure on the target zone. To evaluate the effects of the insole prototype on the user, foot pressure distribution was measured during normal walking cycles. Fifteen healthy participants walked under four conditions: wearing their normal footwear without the prototype; with the prototype but without cavities; with the prototype and cavity on one insole; with the prototype and cavity on both insoles. Ultra-thin, in-shoe pressure mapping technology was used to measure the pressure under both feet, synchronised with a motion capture system. User experience (UX) was collected in terms of insole fitting, comfort rating and balance feeling.

The results confirmed the modular design has an offloading effect without affecting gait. On average, wearing the prototype insoles with cavity reduced around 28% of mean pressure in the target zone than wearing normal shoes. In addition, the prototype has cushioning effects, evidenced by reduced plantar forces. UX data also showed their satisfaction in comfort and provided insights for future design development.

The research demonstrates that for a novel insole system to benefit people it is essential for the design development process to measure both subjective and objective responses to the product. Using triangulation between methods, the researchers have been able to validate the design with human factors considered and tested, as well as gain insights from a sample of end users that can be fed into an iterative cycle of designing, prototyping and evaluation to ensure inclusivity.

Towards an embodied expression of pandemic nodes & networks in the age of social distancing

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Abstract

Before the covid-19 virus was well understood by scientists, social distancing was the pandemic's only effective remediation tactic. Despite this, social distancing became politicized and denial was persistent. An inability of the human body to perceive the spectrum of scales through which disease spreads may be one contributing factor. Here, we present a case study collaboration between a professional dance company and a chemistry professor using the body to comprehend the calculus of disease spread. The collaboration resulted in a five-minute dance film, made while in quarantine between March and May 2020—a design artifact made through, with, and by the zoom typology of social connection.

Neely posits the "the-body-in-motion" as the fundamental center of all human experience. (Neely, 2019) He then states: "We have no affinity for cell division, or nuclear fission, or the digital change from 1 to a 0. This is to say, we have no way to feel these things, so if the goal is to make them known, [...] the designer has to first recognize this threshold and then offer a bodied interaction to foster the knowing" (p. 133). As dancers intuitively understand this, the company decided that embodying the calculus of disease spread would help to calibrate their bodies to the virus's invisible forces, from the micro to the macro.

These ideas are not new, with multiple instances of scientists engaging dance as a communication tool (BPSOfficial, n.d.; Bohannon, 2008; Stolberg, 2006), using dance to teach technical disciplines (Barnes et al., 2020; Chen et al., 2018; V. Geršak & G. Geršak, 2016; Jane Franklin Dance Company, 2009; Lerman Z.M., 2003, 2005), choreographers finding inspiration in science (Derry, 2022; Lerman L., 2006, 2010), and technical fields creating new knowledge vis-a-vis dance (Flink & Odde, 2012; Green, 2019; Jürgens & al., 2021; Loke & Schiphorts, 2018; Designing Dance, 2022). Less so, are there instances of the two conversing with one another as equals, Physics and Dance (Coates & Demers, 2019) is one such example—a workbook of movement activities exploring principles of classical mechanics and dance technique concurrently; explicitly posing the disciplines as two ways of "knowing the same thing" (p. 1).

It is from this mindset that this project was born, with an approach that engages both expert dancers and an expert scientist throughout the entirety of the project—rehearsal/lesson planning, movement generation, storyboarding. The SIR Model of Infectious Disease, first postulated by Kermack & McKendrick (1927), divides a total population into susceptible, infected, and recovered individuals in calculating a disease's reproduction number (Straub, n.d.). The dancers created movement phrases for each of these, drawing upon experiences of dancers who had since contracted covid-19.

The film was made in quarantine through and with zoom—as a meta-medium for social communication—representing populations with zoom-like grids. The cells of the grid were each individually filmed with one dancer performing each movement phrase a specific set of times. The virus visually passed from zoom-box to zoom-box through use of video filters. Three scenes depicted different reproduction numbers: ½, 1, and 2.

Evolution of 'Mashrabiya' in the Middle East and North Africa: traditional wood carving technique revival

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Abstract

Traditional handicrafts are witnessing a sharp decline in consumer purchases and the number of artisans making handicrafts is decreasing. Some of the reasons behind this shift are globalised markets, mass production, and technological advancement. This phenomenon has left many artisans struggling to adapt to the modern world's needs. Current innovations offer value to products, yet at times, their production process excludes the artisans from the production process. 'Mashrabiya,' a wooden architectural element commonly found in the Middle East and North Africa, is an example of a traditional lost craft due to its high cost and poor adaptation to dry climate. It has been given attention in recent years, considering its social, aesthetic, and functional value. The research finds aspects of the craft, the materials, tools, production methods, and techniques by following the 'participatory design' process and workshops, adapting Christopher Frayling's approach 'Research for design' (Frankel & Racine, 2010) by collaborating with 'Turquoise Mountain,' 'The Ministry of Culture (MOC)/Heritage Commission,' and 'The Royal Institute of Traditional Arts' (TRITA) in Saudi Arabia - 'Chambre d'Artisanat de la Région Chambre de L'artisanat de La Région Rabat-Salé-Kénitra.' The purpose is to understand and develop a method for crafts revival as an intangible heritage.

Author keywords

Craftsmanship, Artisan, Digital Artisan, Designer, Intangible Heritage.

Table 1. Terminology

Mashrabiya	An architectural element made of engraved wood, placed by windows.
Moucharaby	Term for 'Mashrabiya' in Morocco.
Roshan	Term for 'Mashrabiya' in the Arabian Peninsula.
Manjoor/Mangoor	A technique common for 'Roshan' or wood lattice screens achieved by piercing wood.

Introduction

The synergy between design methods and craftsmanship is present in the work of many first-generation designers. Ugo La Pietra is a notable pioneer who explored this strategic relationship by exhibiting at the 'Abitare il Tempo' exhibition (Follesa & Armato, 2019, 61). 'Mashrabiya' is an architectural element and traditional craft gaining importance after being abandoned. It is a conventional wooden lattice-based window frame in the Middle East, North Africa, and other parts of the world including Europe (Alothman, 2023).

Figure 1. Traditional 'Mashrabiya' in Old Jeddah, Saudi Arabia. Taken by Ayyad Almilli in 2022.

The 'Mashrabiya' is made from interconnected wood piercings and carries functional, social, and aesthetic values (Alothman, 2023). According to the French Egyptologist Gaston Maspero, 'Mashrabiya' began to develop during the Tulunid era and then spread in various Arab regions (Maspero, 1974). This rise slowly fell in the 19th century due to their cost and poor weather adaptation. However, the current interest in sustainable architecture has allowed a revival in their restoration (Zahabi, 2022). The 'Mashrabiya' is an icon of heritage infused with a purpose that should be considered a tool for artisans, homeowners, architects, and home builders. The revival of this craft form could spread globally as an art form. A successful design that relied on the functional and aesthetic philosophy of the 'Mashrabiya' was the 'Institut du Monde Arabe' in Paris, designed by Jean Nouvelin is a successful architectural project that used the 'Mashrabiya' as a central element in its structure. He relied on the idea of movement by using the shutter lens concept, installed between two layers of glass to control the amount of light entering the building. He achieved that through a central device influenced by the functionality and aesthetics philosophy of 'Mashrabiya' (Bayomy, 2016).

Methodology

The 'participatory design' process defines techniques where experiments are co-interpreted by the designer and artisans (Spinuzzi, 2005). The method includes collecting information about the craft, building workshops, and receiving feedback. As described by Tone Bratteteig: 'The process is a six-phase

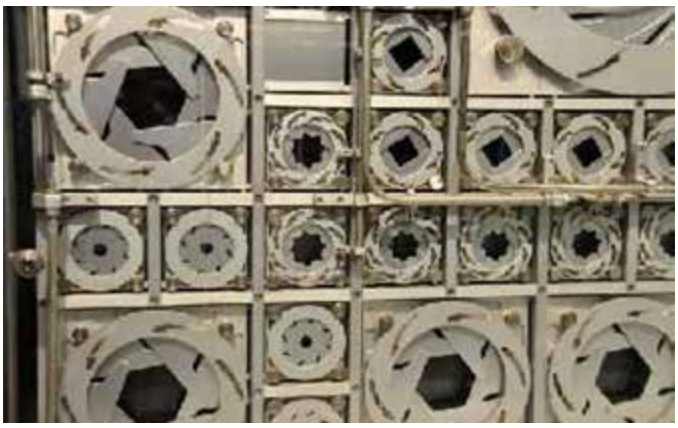

Figure 2. The construction of one part of the façade of the Arab World Institute in Paris, France.

design cycle: Real-life situation, understanding, describing, identifying needs, materializing, testing' (van der Velden & Mörtberg, 2014). Data collection varies between tools such as questionnaires, observations, interviews, workshops, 'research for design,' and literature review. Table 2 elaborates on the approach:

Table 2. Research methodology

Literature review	Implementing theoretical research by collecting historical background and running interviews with organisations and running workshops of the craft.
Case study	Analysing a case study/documenting learnings on a 'Mashrabiya' restoration project at (TRITA) in Jeddah, Saudi Arabia.
Data collection	Running interviews, creating questionnaires, learning the craft with a trainer.
Data analysis	Studying data about 'Mashrabiya': Crafting styles–technique-tool -material-temperature-production-styles–patterns.
Conclusion	Understanding the craft and artisans' conflicts in the modern.

Target Audience, Problem Statement, and Goal

This project aims to preserve heritage crafts through collaboration and workshops. The beneficiaries include artisans who seek developing methodologies and revive heritage crafts, the public who could discover contemporary artists through workshops and digital education, design practitioners and educators to connect to more extensive networks, and organisations who could establish public workshop spaces to allow artisanal communities to commercialise local crafts. The proposal addresses the importance of adapting traditional manufacturing processes to new production methods and highlights the role of designers as middle persons to introduce and maintain traditional crafts in a changing world. The project suggests art-sharing applications for promoting the revival of the craft. Yet, it mainly addresses social issues concerning artisanal retirement and the breakdown of their communities by preserving intangible heritage in a declining era of craftsmanship. Socio-economic benefits can be obtained that returns with an advantage for parties involved in the craft. The project also explores the term 'Artidesign' as a conflict solver (Cristallo et al., 2019) by allowing exploration and finding a balance between new production methods and traditional manufacturing processes, which can establish a connection between design and craft in contemporary practice using 'digital fabrication' (Malakuczi & Di Lucchio, 2016, 352).

General Objectives

- **GO.1** Developing existing methodologies common in Morocco and Saudi Arabia in 'Mashrabiya' designs.
- **GO.2** Developing universal terms in carving processes for artisans for unified practices.
- **GO.3** Implementing traditional and digital knowledge with artisans.

Specific Objectives

- **SO.1** Understanding historical aspects and current technologies in the craft.
- **SO.2** Developing craft guidelines through participatory design and workshops.
- **SO.3** Training artisans with digital and marketing tools.

Results

The author collaborated with the 'Chambre d'Artisanat de La Région Rabat-Salé-Kénitra' in Rabat, Morocco: interviewing Abdullah Morchidi, a member at the chamber in charge of wood, who supported in a series of wood workshops to understand the types, tools, and production methods for 'Mashrabiya.' Since 2020, the author has been collaborating with 'Turquoise Mountain (TM),' a non-profit organisation in Riyadh, Saudi Arabia, with a vision of supporting artisans, in partnership with 'MOC'/Heritage Commission' and 'TRITA,' an institute and member of 'Cumulus' association, providing workshops in the field of Saudi traditional arts.

Table 3. Field research activities of the author.

March '23	Attending a workshop in natural dyes. **(TRITA)** Riyadh, Saudi Arabia.
February '23-ongoing	Collaborating with Arch. Franco Audrito **'Studio 65'** for an exhibition celebrating handmade crafts hosted by (**MOC**). (**TM**)-Riyadh, Saudi Arabia.
December '23-ongoing	1. Running research about regional windows-doors in Saudi Arabia. 2. Interviewing artisans for potential collaboration (for workshops and production). 3. Developing questionnaires, quality check, and authentication reports for participating artisans, students, and products made during **'TRITA'** workshops. (**TM**)-Riyadh, Saudi Arabia.
November '23-ongoing	1. Working with artisans for product design in the field of crafts. 2. Running research for 'User and Designer Guidelines' for (**TRITA**) (**MOC**)/**Heritage Commission. Crafts**: Ceramics-pottery-plaster-wood Carving. 3. Building workshop curriculums at (**TRITA**): Traditional Najdi Doors-plaster carving-Manjoor'-natural dyes. 4. Building regional patterns and motifs libraries using design software. (**TM**)-Riyadh, Saudi Arabia.
July–August '22	Running interviews with wood artisans-visiting sites and markets. **'Chambre de L'artisanat de La Région Rabat-Salé-Kénitra'**-Rabat, Morocco.

Furthermore, the author will use a case study on a restoration project at 'TRITA' and will work with artisan Abdullah AlKhuzam for knowledge on the 'Mashrabiya' crafting technique.

Conclusion

The paper aims to revive the art form, create an artisanal community, and explore modern technologies leading to efficiency and function through the research design process. This research fits in the heritage preservation direction through interviews, workshops, observation, 'research for design,' and public interaction. As a larger-scale project proposal, this craft can potentially increase the general focus on art. It will foster relationships between designers, artisans, and organisations through collaboration. Develop document guidelines on establishing 'Mashrabiya' art practices and offer an avenue to explore new styles, techniques, and materials. Furthermore, to consider modern methods to produce their qualities.

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Exploring the potential of material innovation to revitalize traditional crafts in Egypt

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Abstract

This PhD paper focuses on the revitalization of traditional crafts in Egypt through material innovation and design. The traditional crafts in Egypt are facing repetition and lack of development, posing a threat to their survival. The study aims to support local crafts-practitioners in Egypt by exploiting the advancements in the field of material innovation and design in Italy, a country renowned for its expertise in this field.

The research methodology involves three phases: theoretical, practical, and developmental. The theoretical research analyzes traditional crafts in Egypt, including materials, processing, potential for development, and products. The practical research compares Egyptian and Italian materials and production processes, observing innovation and development. The study identifies advancements in Italian design and material innovation that can apply to Egyptian traditional craftsmanship, focusing on tools, materials, design, manufacturing, and collaboration. The final phase involves developing local materials in collaboration between Egypt and Italy to benefit from each other's expertise and heritage, forming new ideas for design and material innovation.

The study aims to have an impact on multiple levels, including political, economic, environmental, social, cultural, and international. The results of the study can provide the basis for submitting proposals to the local government, improving the education system, supporting small industries and crafts, creating a creative climate for the development of traditional crafts, and promoting the traditional crafts as part of cultural heritage and economic growth.

This paper proposes a structured approach to revive traditional crafts in Egypt. Collaboration between craftsmen, designers, and researchers is necessary for innovation and preservation. The methodology includes analyzing the current state of Egyptian crafts and studying typical materials. Four materials used in Italy and Egypt are compared, with examples of material innovation and creative design from Italian labs, companies, and studios. The final phase suggests methods for Egypt and Italy to collaborate in developing local materials in labs and workshops. Also discusses the background of Egyptian society and the importance of collaboration between craftsmen and designers to renew and transform the notion of tradition and local identity. The artisan region is characterized by cooperative societies, creative and supportive economies, relationships, shared experiences, and collective projects, making it a cultural and geographical hub.

Author keywords

Traditional crafts, Material Innovation, Cultural Industries, Local Materials, Egypt.

Introduction

The problems of traditional crafts in Egypt have been appearing for many years. Although there are about 28 different types of craft in nearly 20 cities in Egypt, yet the crafts suffer from repetition and lack of development. Egyptian society is full of these products and this traditional art is now trying to survive, and the solution to survival is to search for new tools to develop these crafts, on more than one level, including the local materials and the design.

Also, one of the important points raised by the research is the method of cooperation with designers, which comes after years of strong closure and separation between technicians and designers, but today we see the opening of borders. Once again in design and production among craftsmen and designers, which today seems essential given the potential memory, tradition and culture.

The traditional crafts problem in Egypt, despite the rich history and culture of traditional crafts in Egypt, these crafts suffer from repetition and lack of development. The crafts have not kept up with modern times and there is a need for new tools and designs to be incorporated to revive and develop these crafts. This lack of development has led to a decrease in demand for traditional crafts, causing them to struggle to survive.

The Importance of Local Materials and Design comes one way to develop traditional crafts to utilize local materials and designs. Local materials are a unique feature of traditional crafts in Egypt, and their incorporation in craft production is an important way to promote cultural identity. Additionally, the use of local designs can also create a distinctive identity for the products, helping to distinguish them from mass-produced items.

Collaboration between designers and craftsmen is crucial for reviving traditional crafts. The Artisan Region serves as a cultural and geographical hub, including cooperative societies, supportive economies, and collective projects. It has a significant history in production processes and can promote cultural identity and economic development. Designers and craftsmen working together can modernize and revitalize traditional crafts by creating new ideas and techniques.

Background

Since the earliest dynasties in ancient Egypt, Egyptians diligently recorded scenes from their daily lives and deeds on the walls of temples, touching on agriculture, industry, religious rituals, and the arts. Handicrafts were an important part of these murals, which depict pottery, glass, papyrus, jewelry, and weaving as well as artisans working with stone, metal, wood, and leather.

The study suggests that traditional craftsmen's products have a human touch due to their use of local raw materials and handmade tools, allowing them to create new forms and explore artistic possibilities. However, modern changes have led to the disappearance of traditional crafts, resulting in hybrid products lacking authenticity and soul, as synthetic fibers and plastics are used due to the scarcity of local raw materials.

This study delves into traditional crafts, examining the intricacies of each craft and the passion of its artisans. It showcases the beauty and detail of each individual craft item produced. The research explores the evolution of Egyptian civilization through its handicrafts, tracing the development of tools, techniques, and raw materials used to create works of art. The study also emphasizes the connection between each craft and the lives of the people who create and use it, as well as the fusion of craftsmen and craft that imbues each piece with brilliance and meaning.

In each craft, the author presents a brief history of the craft to anchor it in time and space and show how it relates to the needs of its users and the architectural and artistic styles prevalent in particular periods. We also look at transition periods and external influences to better understand the evolution of the craft and the evolution of the product. Where the research presents the history of each craft until the modern era, and it is also necessary to highlight the context in which these crafts appeared and developed, and to adapt to changing times in new forms, even with contemporary innovations in the twenty-first century that depend on traditional forms.

Methods and Research Phases for the Study

Methodology

The research begins with conducting a comprehensive analysis of the state of the art and craft in Egypt, including the current situation, problems, and identifying the producers into three categories: makers, artists, and designers. The products will then be classified based on the level of materials and tools used and the types of crafts. The collected data will be analyzed to determine the current state of the craft and its potential for growth through case studies that aim to bring new values to the traditional craft rules.

Figure 1. Examples for traditional crafts in Egypt with different local Materials.

Research Phases

1. Theoretical Research

This phase focused on conducting research and investigating the types of traditional Egyptian crafts, including the materials used, processing methods, potential for development, and examples of products such as hand-made kilim, furniture, accessories, and ceramics. An analysis of the current artists and their practices in this field will also be conducted.

2. Practical Research

In this phase, five typical materials from Egypt selected. The data and results from the crafts in Egypt will be analyzed to understand what still exists in terms of materials, product types, production processes, and the relationship between the craftsperson and designer.

3.Material Innovation and Development

The final phase of the study involves collaboration between technicians from Italy and designers from Egypt to develop local materials in labs and workshops. The study aims to improve the local craft industry at the material level by creating creative links between Egypt and Italy. It will focus on four materials used in Italy and Egypt and compare how each country used and developed them. The final phase will suggest methods for collaboration between Egypt and Italy in the field of material innovation and design in traditional crafts.

Analysis

The data collected will be analyzed form Egypt to get approach to identify the advancements in the field of design and material innovation in Italy, which can be applied to traditional craftsmanship in Egypt. The study will focus on the tools and materials used, the design and manufacturing processes, and the collaboration between craftsmen, designers, and researchers. Impact of Research on traditional crafts and their impact on various aspects of society has become a topic of great interest in recent years.

The impact of research

It is not is not limited on traditional crafts as specific level, but extends to multiple levels, including political, economic, environmental, social, cultural and international levels.

On the political level, research on traditional crafts can provide the basis for submitting proposals to the local government on scientific grounds. The government can use the research findings to provide better infrastructure and create a more creative climate for the development of traditional crafts. The government can also use the research to improve the education system, making it more relevant to the needs of local communities.

On the economic level, small industries and crafts can play a major role in local development. Research on traditional

crafts can provide the basis for supporting these small industries and crafts, which can help restore the economic position of local communities. This can be especially important in villages and small towns, where traditional crafts can provide livelihoods for many citizens.

On the environmental level, research on traditional crafts can help promote the reuse and development of local materials during festivals such as Eid. This is considered one of the benefits of preserving the environment and not wasting natural resources. This can help reduce the carbon footprint of communities and contribute to the sustainability of local ecosystems.

On the social level, Research on traditional crafts can empower women financially and break down traditional gender roles. It can also promote the preservation of cultural heritage sites and raise awareness about their importance for future generations.

On the international level, Research on traditional crafts can facilitate the exchange of experiences between countries and promote cultural understanding. This can foster international cooperation and benefit all parties. Traditional craft research has far-reaching impacts on society, from improving infrastructure and local development to supporting women's empowerment and contributing to sustainable community development.

Conclusion

By the end of the studies, it is expected that incorporating design and material innovation related to traditional crafts will be an essential aspect of utilizing the results to promote local industry development. Traditional crafts have the potential to significantly contribute to local economies. Developing new designs and materials for traditional crafts can help local artisans expand their customer base, create new products that appeal to contemporary tastes, and retain the cultural and historical significance of the craft, generating more income for the community and supporting economic growth. Moreover, promoting traditional crafts can foster international cooperation, as they often showcase local culture and heritage, leading to increased tourism, more revenue, and more opportunities for local artisans. Better infrastructure, such as creating more accessible markets and workshops, improving transportation and communication, and providing better access to raw materials, can support the growth of these crafts and provide more opportunities for local artisans.

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An overview of design suggestions for contemporary theatrical VR productions[1]

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Author keywords
theatre; virtual reality; design guidelines; acting; audience.

Introduction
Since the 1990s, various theatre labs and creators have been experimenting with the relationship of the medium of VR and theatre, although in the earlier times these VR experiences were only suitable for one experiencer. One of the most prominent early pioneers in this field is Brenda Laurel, the author of the book *Computers as Theatre*. In her 1994 site–specific VR installation *Placeholder*, Laurel puts her ideas about VR in practice by reinventing "the sacred spaces where we collaborate with reality" in order "to transform it and ourselves". (Laurel 2013, 197) In her VR performance, the experiencer arrives at a place and put on the HMD and sensors with the help of an assistant and enters a space where she embodies various characters (Crow, Snake, Spider and Fish) and inside the production she is guided by the Goddess – a live–performed character usually played by Laurel herself. This offers a highly personalized experience with a clear specification about the role of the experiencer. Another VR immersive production that provides a strong sense of embodiment (that is, where the environment is in strong interactive relationship with the experiencer's body) is *Osmose* by Char Davies. This 1994 production is a single user experience, where the breathing of the "immersants" (as Davies calls the participants) is monitored and the environment changes in response to their breathing.

If we compare these productions to those that were made in the last three years (e.g. *Welcome to Respite!* by the Ferryman Collective, *Finding Pandora X* by Double Eye Studio), mainly during the pandemic, it is clear that the latter can offer a different sense of immersion by bringing audience members together in a virtual space and offering them a sense of intimacy with the help of the improvisational skills of the actors. While the installation–based VR performances heighten the sense of embodiment, the VR productions that take place in an online space shift our attention away from the embodied experiences and they direct it towards the illusion of agency. When comparing these two types of productions, one important point to note is that performances on various social VR platforms can allow us to experience the performances from a distance, while the earlier ones required the viewer to visit a physical setting. The performances experienced via the Internet can create a new sense of community and togetherness by providing a sense of telepresence, where the audience has a central role.

Social aspects of virtual copresence
The social aspects are dealt with to a lesser degree when defining telepresence or virtual presence. Lombard and Ditton's widely quoted study (1997) is an exceptional case where the social element of presence is discussed along with others. Two of the six elements that they define as key elements for presence in a virtual environment are related to social aspects: one is about how the user can be a social actor within the medium, and this is defined by the user's ability to control or interact with his or her environment; the second is about the medium itself being a social actor, defined as the digital environment's providing to its user the sense that it interacts with the user. However, defining these aspects still do not bring us closer to the question of how the sense of togetherness or community in a multiplayer–like VR chat platform can strengthen immersion. In a 2016 study, Samur compares stage presence to presence in VR; and he states that "Open world environments, found in *Second Life* [...] create the promise of an experience that is unique to them, reinforcing the feeling of presence as the narratives the users create are tailored to their choices. Interactivity can heighten an audience's sense of fictional presence as they realize what they are currently experiencing is the result of past choices made." This approach can shed some light on the above–mentioned question, and it is especially important as immersive theatre productions aim to offer unique and original experiences to their audience member and this is what the audience members are also hunting (Alston 2016, 134). In the same study, Samur (2016) also addresses the question of how theatrical formats could enhance the sense of presence and he briefly mentions the open world productions, even though the performances in VR that can accommodate multiple audience members surfaced mainly in the last 2 years – after Samur's study. Nevertheless, he brings up the point regarding how interaction can heighten the sense of presence (and immersion). The taxonomy of interaction in digital theatrical formats offered by Dixon (2007): (1) navigation; (2) participation; (3) conversation; and (4) collabo-

1 This is re-worked subchapter of the following forthcoming article: Ágnes Karolina Bakk, "'Let's Cross This Portal Together' Immersion Mechanisms in VR Performances and their Current Limitations," in *States of Immersion: Bodies, Media, Technology*, eds. Philippe Bédard, Alanna Thain, and Carl Therrien (Amsterdam: Amsterdam University Press, forthcoming).

ration; where he defines interactive collaboration as a type of collaboration that comes about when "the interactor becomes a major author or coauthor of the artwork, experience, performance or narrative." (ibid., 595.) This type of collaboration that Dixon defines is an important innovation and characteristic of the theatrical VR productions that I will analyse here (even when the collaboration–based agency is only illusory.) Combined with new types of interaction taxonomies (that are defined specifically for VR theatrical performances), reflecting on this new type of co–presence can help us find new ways of discussing these performances.

An overview of design suggestions for contemporary theatrical VR productions

Jason Ferguson suggests that "virtual reality has a storytelling problem and theatre will save it", and he takes it that this problem is due to the first–person delivery mode, making it harder for the audience to perceive the story as a story when they are themselves involved in it. (Ferguson 2016) Although this cannot be denied, here I will suggest that VR theatre performances organized in multiplayer settings can enhance the storytelling effect with the illusion of agency and interaction. I have already discussed how early VR works could be considered as theatrical, due to their installation–like characteristic and also because of the strong sense of embodiment that their users experience. But theatrical VR performances, especially since the new technological advancements, make it possible to bring audiences into the same space, often allowing them to interact with the environment, with each other, and also with the performers. Sita Popat states about VR environments that "[t]hese environments allow us to ask questions about embodiment and humanity through the experiences of our individual bodies in a way that has never been possible before." (Popat 2016, 359) Creators of performances that rely on the Internet also have a very long history with experimenting in novel ways on how the audience members can have new self–reflective experiences via telepresence. These are "telematic" performances, to use an older term for performances that rely on telecommunication networks as their medium. The sense of telepresence allows the creators to produce a new type of telematic performance which exploits the specificities of VR that other telecommunication networks often lack. According to Sermon et al. "[t]elematic artworks emphasize facial and body language, and in certain ways can offer more than physical encounters permit. The presence and observation of their own body in the third space as well as 'the other(s)' provides the participant with an opportunity to make coinciding subjective and objective observations. Since on screen their self is also the other, they are able to reflect on the interactions and performances occurring in front of them while seeing themselves as being directly responsible for it." (Sermon et al. 2021)

While presence in the 'real world' is effortless, virtual reality can offer a special sense, a more complicated one, that shows how complicated is our process of perceiving presence can be.

Recent research also discusses theatrical VR performances and offer design suggestions for this genre. Gupta et al. state that "we operate under the premise that the central pleasures that interactive drama should serve are those of playing along according to the expectations set by the system and communicated to the player directly. This contrasts with the dominant rhetoric of interactive narrative and story–based games, which emphasize the freedom to choose as a central poetic of the form." (Gupta et al. 2020, 10) They emphasize that many productions that are tagged as theatrical VR do not specify the role of the audience. The authors offer several design suggestions for creators such as managing the audience's expectation by offering to them explicit roles. Interestingly, the authors do not describe how this is possible on the narrative level, but they focus on embodiment. They suggest that in the onboarding process the audience members should be faced – in the VR application – with a mirror, so they can have more awareness about their avatar's body. They also suggest that the audience members should have the chance to get familiarized with the system so they should have "situated rehearsals" (Tanenbaum and Tanenbaum 2010) where they can try out the interactive situation in a low–risk environment – this could also be a helpful way to build up the onboarding. Another important suggestion is that the creators have to "invest time in 'high–yield' interactional and visual details that support the illusion of a social reality for the player within the scope of the specific desired interactions called for by the script". (Italics in original.) (Gupta et al. 2020, 9)

Based on their own experiments, Gochfeld at al. (2019) voice some doubts about the importance of the participants' identification with their avatar. They suggest that "for performance, embodiment is not as important as the ability of the actors to convey the characters' behaviours and emotional states: the actors don't need to feel that the avatar is their own body in order to be able to perform as if it is." (Gochfeld et al. ibid.) If true, this means that creators can freely make design decision about the avatar. The authors suggest that actors' performing in VR is similar to operating a puppet, where the performer must master the control system to be able to project their expression through the avatar. (Gochfeld et al. 20219, 4) It is also important to note that actors with more realistic avatars tend to feel more in a rigid context then the less realistic avatars, while on the audience's side the more realistic avatar creates higher expectations towards the performers (Gochfeld et al. ibid.)

Similarly, Yan et al. (2021), offer a specific taxonomy for interactions in VR theatrical settings: (1) individual–based interaction (IBI) includes mainly linguistic interaction and physical contact; (2) scenario–based interaction (SBI) "enables audience to play directly with virtual stage props under the guidance of the performer." (Yan et al. 2021, 3) and (3) narrative–based interaction (NBI), which occurs if there are possibilities to make meaningful choices that influence the story, which is possible when multiple storylines are allowed in the production. The authors also stress the importance of identification and roleplay for the players. Taking the affordances of the medium of VR into consideration, the authors suggest that the freedom for the audience members to move and explore the VR space is very important. They suggest that the creators should offer "rich sensual experience as far as possible to let the audience feel that they are focused by the performer all the time". (Yan et al. 2021, 5) These three strategical advices about onboarding, the audience's role and the specificities of their interactions can serve as an important starting point for analysing VR theatrical performances.

Conclusion

The virtual immersive theatre produced in VR is a specific type of immersive performance very similar to those performances taking place in an analogue setting. For now, the immersive performances in VR cannot be very long (partly due to the uncomfortable setting of the HMDs) and because of this there is less time to build up the storyworld; therefore, these performances need to be prescripted. In order to offer a sense of liveness in VR, what is necessary is a more complex acting style where the actor is ready for improvisational situations and for guiding the audience where it is required. While immersive theatre offers to the audience an original story, physical possibilities to manifest agency, and unique experiences (Alston 2016, 2), in VR immersive performances these unique experiences are harder to achieve due to technological obstacles such as limited possibility for multiplayer participation and limitations regarding navigation in space and interaction with objects. These obstacles can be concealed for a while by creating spatial open–world structures and by attention guiding cues (borrowed from the science of magic), but curious audience members can find out the limitations after a while. On long term, the creators of such experiences could experiment with the possibilities of creating more unique experiences with the help of the actors, a more layered storyworld and interaction possibilities.

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Polymath interpolation for open-ended design, exploring artificial nesting design for the Southern Ground Hornbill

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Abstract
Many of the challenges especially those associated with sustainability and conservation are indeterminate and wicked requiring the transcendence of typical disciplinary domains. This is both in terms of the teams and individuals associated with the solution development. The solutions themselves also need to be adaptable and open-ended. However, achieving open-ended solutions once again requires "openness" in who or how someone might develop a solution. This links to concepts like *DesignX* or what is referred to as *Polymath Interpolator Designers*. Following a *Research through Design (RtD)* approach addressing the sociotechnical challenge of conservation of the Southern Ground Hornbill bird, in particular the development of an artificial nest, the aim is to investigate the concepts of 'polymath interpolator' design.

As a result of habitat loss, among other factors, the Southern Ground Hornbill has seen a rapid decline and is at risk of becoming critically endangered. Artificial nests have been shown to be an important tool in the conservation of the species, especially in areas where no natural nests in sufficiently large trees are available. The adaptability of the nest solution needs to consider new and emerging contexts as well as future scenarios necessitating an open-ended design. This acknowledges the inherent complexity of the design challenge and avoids potentially linear processes, because of specialisation, where a singular limited purpose design is produced. Alongside the primary focus of an artificial nest, many related challenges could be addressed simultaneously, enriching the primary solution. This 'branching and re-joining' are in fitting with the polymath design approach, arguably allowing openness not only in the solutions, but also in the problem identification and scope of engagement. Thereby offering many opportunities for understanding and articulating the concepts of 'polymath interpolation' in a transdisciplinary context while developing open-ended design solutions.

Author keywords
Transdisciplinary; open-ended design; polymath interpolation; conservation; Industrial Design.

Introduction
"Designers no longer fit neatly into categories such as product, furniture and graphics; rather they are a mixture of artists, engineers, designers, entrepreneurs and anthropologists" (Dykes et al., 2009, p. 101). Seymor referred to by Dykes et al says that in design, there appeared to be a trend to two types of designers, "specialist executor" and "polymath interpolator" (Dykes et al., 2009, p. 101). When you dissect the term of "polymath interpolator" the concept of polymath, suggests transcending disciplinary domains, while the concept of interpolator implies 'filling the gap'. "Filling a gap" should also be interpreted as a transient adaptable solution, in other words an open-ended design.

In the *Global South* increasing levels of development results in habitat loss for different species (Skowno, 2019, p. 68). For certain species this can cause dramatic losses in numbers. One such situation is the *Southern Ground Hornbill, Bucorvus leadbeateri*, which in South Africa is listed as endangered. This decline has been rapid, with 50% decline in the last few years (Whitley Awards, 2021). One of the identified strategies for reducing the decline and ensuring sufficient genetic diversity, by linking protected reserves, is to provide nesting opportunities for new groups. A key solution is that of an artificial nest where large enough trees are not available. Typically, the Southern Ground Hornbill nests in a hollow of a tree formed when a branch breaks off, allowing rotting. However, these hollows need to be big enough for the nesting birds, approximately 100cm tall, and therefore requires trees of a certain size and age. Where these trees are not available artificial nests need to be provided.

However, the challenge of the design of these nests is complex in that there are many factors that influence the design. This includes, how they are made which aims to utilise volunteers in the construction, the materials and strength, the ventilation and cooling, and integration with broader conservation activities etc. There are also many emergent factors that are yet to be discovered during the continued efforts in the conservation of the species. This became evident as various nest prototypes were developed and distributed around Southern Africa. Looking retrospectively at past, as wells as using planned activities the aim is to further develop adaptable, contextually appropriate (open-ended) artificial nest solutions for the Southern Ground Hornbill while investigating and better articulating the concepts of *polymath interpolator design* in a transdisciplinary project.

* The study aims to be a cotutelle degree with the Tshwane University of Technology and Ghent University but at the time of writing this is still being established.

Framework

This study relies on a pragmatist epistemology, in particular a "Deweyan pragmatism" which "...regards ideas and theories as tools for action..." (Dalsgaard, 2014, p. 149). Taking the form of a *Research through Design* (RtD) study, undertaking the main as well as many sub- "... designerly component[s]" (Stappers & Giaccardi, n.d., p. ch 43.1.14) of developing an improved, context dependent and adaptable artificial nest solution for the Southern Ground Hornbill. Undertaking these "designerly activities" as part of the broader conservation effort, as a transdisciplinary project, aims to produce various practical outputs contributing directly (nest specific) and indirectly (related and linked) to the artificial nest of the Southern Ground Hornbill and the broader conservation strategy. In addition, the aim is that at the same time by reflecting on actions and vice versa, the concept of polymath interpolator design and its links to open-ended design solutions is better understood.

A Snapshot

As noted, there are often emergent challenges and consideration that we are currently unaware of. To a certain degree one might say the study aims to look at the continued "muddling through" and "satisficing" (Norman & Stappers, 2015, p. 93) in that there will be many occasions of acting opportunistically which is appropriate for the indeterminacy of the arguably wicked challenge (Buchanan, 1992, p. 16). The specific delimitation of the study is a snapshot of a three year, three breeding season period, which will occur across the general iterative process linked to the artefacts and prototypes which will reach a climax at just before breeding season each year, when the nest prototypes that are developed are possibly utilised.

Figure 1. The Initial Prototype - Photographs by Author

Past

This project began as what was incorrectly assumed to be a quick exercise in developing a new artificial nest using an alternative composite material strategy, building on previous work. The initial dimensions and need for nests were the result of a study of natural nests in the protected areas of the Kruger National Park (Kemp & Begg, 1996, p. 13). The Mabula Ground Hornbill Project (MGHP), a non-profit organisation with the aim to halt and then reverse the decline of the Southern Ground Hornbill, began developing artificial nests out of wood. However, the longevity of wooden solutions presented a problem for the 70-year lifespan of the birds. Initially the author ran a project with students developing an initial prototype made from a foam core coated in hessian fabric and an acrylic resin blend (Figure 1). Since then, more than 40 prototypes have been developed with many used by groups of birds (Figure 2) leading to many new discoveries from technical challenges with the materials and form, as well as how to include the participation of volunteers and community custodians.

Figure 2. Prototype Nest used by breeding group of Southern Ground Hornbills - photographs by Author

Planned

One of the challenges that has emerged is the cooling of the artificial nests. Natural nests that occur in trees are kept cool in high temperature environments by the structure and nature of trees themselves. Replicating this is the first step, however there is also likely to be a need for 'better than natural' cooling with increasing average temperatures influencing different bird species (Bourne et al., 2021, p. 1221). This challenge is multi-faceted in that previous prototypes have been seen to effectively insulate the interior of the nests from external temperatures however this same insulation also traps the heat of the nesting bird, once again increasing the temperature inside.

Another important consideration of these nests is that their materials be context dependant and appropriately (timescale) biodegradable. Some of these nests would be placed in outlying locations where once they are no longer utilised should biodegrade and not pollute the location. In other contexts, there would be a much higher occupation and interaction rate (e.g. captive birds) which would necessitate possibly stronger materials. The specific strength of these materials is also something that needs to be more precisely determined. The birds tend to peck at the nest in what appears to be testing its integrity before using it. This pecking has damaged many of the prototypes previously developed, so having more precise data on the forces associated with pecking is important.

The broader conservation strategy of the Mabula Ground-Hornbill Project relies on education programs and volunteers (*Mabula Ground-Hornbill Project - Conserving the Southern Ground Hornbill*, n.d.). The intention is to rely on human effort for the production of the nests but require minimal skill and training. This does present challenges like quality control and accuracy. Accounting for these factors will influence a range of the different attributes from the material choices and strategy, to the form and construction/assembly technique. Planning for this will also aim to create a sustainable, decentralised production strategy for the nests which will also allow for appropriate adaptions for different contexts (Open-ended Design).

For this study, the initial focus would be to look retrospectively at past activities and attempt to map the cybernetic process associated with artificial nests solutions. This would be both in terms of the human interventions (activities of the conservation organisations, community custodians of nests etc.) as well as natural systems (weather, breeding patterns, behaviors etc.). Then using a range of disciplinary diverse design activities to develop tools, the aim would be to ascertaining guiding technical details like the noted, strength of materials or cooling techniques. Thereafter, additional design activities will continue iterating different nest solutions, considering the cybernetics and determined details, before determining the appropriate production strategy for these. As these activities occur the concept of 'polymath interpolator' designer will continue to be reflected on with the aim of developing a specific framework for 'polymath interpolator' design in a transdisciplinary project aiming to develop open-ended solutions.

Conclusion

The sociotechnical challenge of developing artificial nests for the endangered Southern Ground Hornbill presents an opportunity to not only contribute practical outputs in the form of prototypes and artefacts but also better understand polymath interpolator design(ers) and how open-ended solutions can be developed. Understanding open-ended solutions and the approach to achieving them is important for the many sociotechnical challenges we face, especially those associated with conservation and sustainability. This study aims to show the importance of non-specialist approach where the solutions may not be optimal but offer a way to 'satisfice' while we 'muddle through' the complexity of the challenges we face.

Acknowledgments

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Implementation of design culture as a strategic innovation through design-oriented industrial conversion and product diversification

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Abstract

Italian manufacturing companies, SMEs in particular, are lately experiencing a context of great economic uncertainty. Therefore, achieving high levels of flexibility concerning changes in consumption and demand is necessary to increase competitive advantage. The discipline of Design can play an essential role in addressing the challenge of perceiving unexpected change and managing new market visions through new products. The doctoral research concerns a qualitative/quantitative analysis of design-driven industrial conversion and product diversification; both business strategies aim to share company risk in crisis, production inefficiency, or change in technological paradigms through updating and expanding the product portfolio.

The PhD research has adopted the Research through Design as the methodological approach, and in addition, a specific methodology is defined for guiding the experimentation phase. Indeed, the research includes a testing phase with two model companies of Turin and its province (as the Turin Chamber of Commerce founds the doctoral research) concerning a path to accompany a design-oriented production diversification or industrial conversion. The design culture and typical design methods, enriched with those of Innovation Management, create interdisciplinary support for reading the local and corporate production context.

The research is currently in the experimentation phase through the "Design in Progress" project, where two companies with different degrees of design orientation are encouraged to diversify their product portfolio through Design and technology-driven processes.

The final objective of the PhD research is to define good practices for efficient production diversification or, in more extreme cases, industrial conversion, adaptable and scalable according to company needs.

So far, the main results achieved in two years are 1. Five semi-structured interviews with companies; 2. A database with more than 60 case studies of Design-driven industrial conversion; 3. A classifying framework of case studies to display trends in common; 4. A collection of insights from interviews, preliminary desk research and the framework; 5. An analysis of the evolution of the manufacturing landscape in Piedmont, the region in the northwest of Italy, to explore possible new design-oriented sectors. 6. An interdisciplinary methodology to measure the propensity for design-led industrial conversion 7. The launch of the "Design in Progress" project, an experiment to bring two companies in Turin and its province closer to design 8. A literature review focused on: Research through Design, Design and territory, Territorial economy, Design and Innovation Management, Industrial conversion and product diversification.

In parallel to the "Design in Progress" project, a collaboration is underway with a Dutch university to test the path to design for manufacturing companies with young researchers and design students. In particular, a focus group with young researchers to test, expand, and modify the experimentation tools and a workshop with design students to simulate the experimentation path.

These results warrant further investigation with a larger perspective. The doctoral research is currently exploring the strategies of industrial conversion and production diversification towards new products; further research with more focus on the dematerialization of production through services, also in a circular economy perspective, is therefore suggested.

Author keywords

Industrial conversion; product diversification; strategic innovation; industrial design; competitive advantage

Introduction

The Design discipline was born with a solid strategic and pragmatic attitude to support change processes and realize visions and values through products. As it is considered the connector between creativity and innovation (Design Council, 2011), a design-driven industrial conversion or product diversification can be evaluated and used as a strategic lever to foster internationalization and as a tool for visibility and recognition in the territory (Parente & Sedini, 2018) in this period of significant external changes in the corporate environment. Over the last 20 years, numerous researchers working on new directions of design research have focused their studies on the strategic role of designers in firms through design management and design leadership processes (Borja de Mozota, 2003; Brown, 2009; Calabretta, Montaña & Iglesias, 2008). "For more than 175 years, the field of design has followed developments in business, technology, and culture" (Muratovski, 2015, p.119), but the study of the valorization of the figure of the designer in business strategy is still part of the debate in the scientific community in the Design field.

Thus, there is a strong need to enhance the skills of designers and bring them into play to go beyond the mere 'styling', the final form-giving stage (Danish Design Centre, 2001) or an operative tool to solve styling problems (Celaschi, Celi & García, 2011).

The research responds to this request by identifying industrial conversion and production diversification strategies as a means of implementing design culture as a strategic innovation that places designers at the center of business strategy. Specifically, the research proposes an accompanying design path for manufacturing companies, divided into several steps. This accompaniment path to design aims to encourage and simplify the transition from the intuition of research to its implementation and realization (Design Council, 2014), not only to create economic value for the company but to understand the changes taking place and identify future challenges.

Research methodology and working plan

The PhD research adopts the Research through Design as a methodological approach, namely project-grounded research (Findeli, Brouillet, Martin, Moineau & Tarrago, 2008). The methodology is divided into four chronological steps that follow the three-year doctoral path and includes several qualitative and quantitative methods (Figure 1).

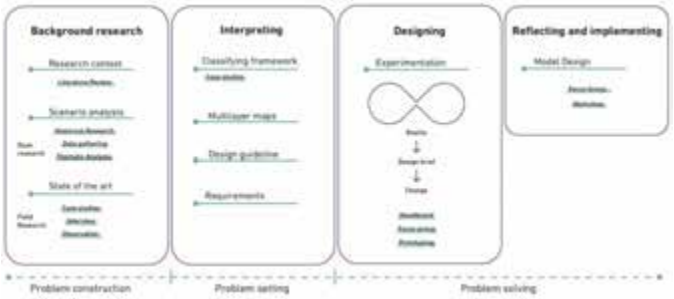

Figure 1. Research method

The first step includes the "Background Research", which aims to formulate the research statement and questions and analyze the topic and scenario. Within this step, the results achieved are manifold; firstly, the analysis of the research contest made it possible to create a PhD-specific literature review consisting of five different macro-themes: Research through Design, Design and territory, Territorial economy, Design and Innovation Management, Industrial conversion and product diversification.

More punctual research on the locution "industrial conversion" followed; in particular, the research investigated different contexts and historical aspects in which it is used, deepening its contextualization of the design debate and formulating a new meaning. The search for case studies helped in this regard, and the opportunity to interview five CEOs or managers of local companies that have implemented the strategies of industrial conversion or product diversification in the past made it possible to collect valuable suggestions and insights for the subsequent stages of research. The semi-structured interviews were conducted within the following ethics parameters: voluntary participation, informed consent, and confidentiality. The results will be communicated to the interviewees during the thesis writing to check the transcription's accuracy.

The keyword "industrial conversion" was rarely used as a password to access this information, making it more challenging to search for case studies. During the first and second years, the research involved a database of approximately 100 case studies of industrial conversion and product diversification to understand the strategic paths taken by companies. The case studies reveal several strategies, such as the exploitation of production assets, thus using different materials by exploiting or implementing the same technology; the achievement of a complete manufacturing process, therefore reaching the level of the assembled product, overreaching that of the semi-finished product or component; the acquisition of high levels of specialization using design strategies such as large format, off-scale, unique surface finishes.

Scenario analysis, which included field and desk research, made possible the construction and definition of the problem. To focus on the cited theme, the research defined the following research questions:

RQ1: How to explore and manage the process of industrial conversion and product diversification from a design perspective?

RQ2: How can designers participate in the processes of strategic business decisions?

RQ3: How to analyze the company's capabilities to identify new products/productive processes/futures strategies?

The second phase included interpreting previously collected data through desk and field research. An essential phase of doctoral research was defining a method for classifying case studies of enterprises implementing industrial conversion or production diversification strategies in mature industries to identify new strategic directions.

The tool built to address this purpose was a case study cataloguing framework (Figure 2).

The framework consists of two levels; the first, the base, consists of three macro areas that demarcate the framework and identify three different conditions: the condition prior to the strategy and a snapshot of the company's condition following a production diversification and/or industrial conversion strategy. Each area contains an additional indication, the life cycle of the technology.

The vertical axis indicates whether the change affected only the product, or whether it led to a production process.

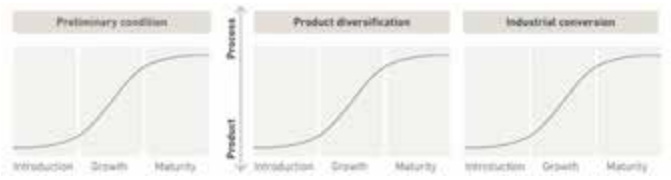

Figure 2. Framework: first level

Each company is then represented through a graph (Figure 3) containing additional information. It is also essential to indicate the company's design orientation in the framework. It can be null, overt, where design activity is active and present, or potential, where the design may be absent, but there is room to intervene (Germak & De Ferrari, 2001; Cantó, Frasquet & Irene, 2019).

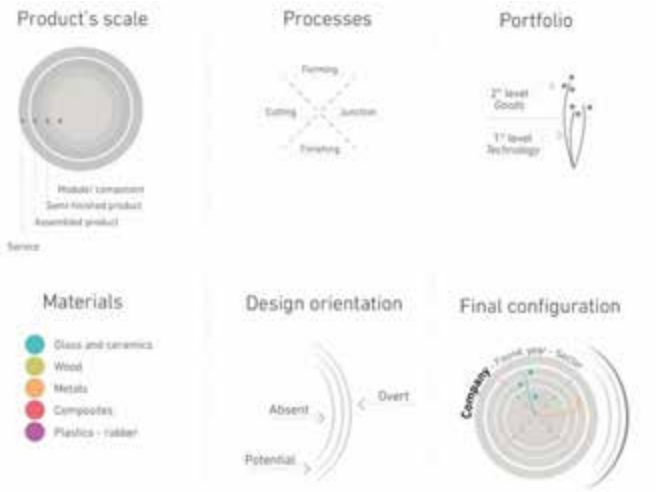

Figure 3. Framework: second level

Including case studies in the framework highlights trends and insights, namely project or managerial strategies, valid for the experimentation phase and defines requirements and characteristics companies must possess to be included in the testing.

The research included a territorial production context analysis through qualitative and quantitative methods to identify shrinking sectors and screen companies for the accompanying design-driven industrial conversion experimentation.

This phase allows for setting the problem and the focus of the experimentation, the implementation of design culture as a strategic innovation through design-oriented industrial conversion and product diversification.

The problem-solving phase begins with the action-experimentation step of the research that adopts and merges the version of the Double Diamond (Design Council, 2019) for Design for Social Innovation (Anderson, 2019) and the Exploring Design methodology (Germak & De Giorgi, 2008), defining a project methodology (Figure 4). It combines the convergence and divergence path typical of the double diamond methodology and the exploration of feasible scenarios with future products and innovative services of the exploring design methodology (Lerma, Dal Palù, Actis Grande & De Giorgi, 2018).

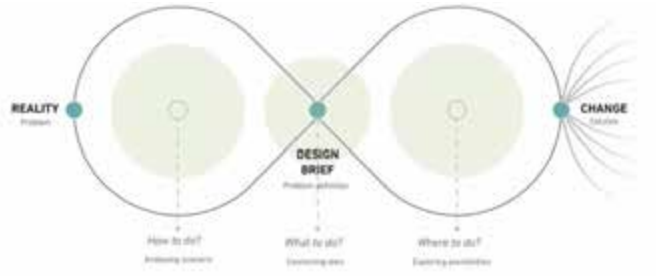

Figure 4. Project methodology

The project methodology defines the boundaries of experimentation, which starts from the business reality, widens the view with the scenario analysis, converges towards the definition of the problem and design brief, and diverges again to explore different possibilities and finally converges in the definition of the solution leading to change.

In detail, the experimental phase consists of the "Design in progress" project, which aims to accompany Turin's manufacturing SMEs on a path of a conscious approach to the design discipline, increasingly understood as a means of strategic innovation and opening up to new markets to increase competitive advantage (Björklund, Maula, Soule & Maula, 2020; Bianco & Rampino, 2017), by reconverting or diversifying production, starting from the company's history, know-how, skills and assets. This is the current stage of research.
The final step includes the verification and implementation of the process through collaboration with a foreign university in the coming months, in which a focus group with young researchers in the design discipline and a workshop with design students are planned to simulate and implement the process of the "Design in Progress" project.

Discussion and conclusion

The research is currently in the experimentation phase with the "Design in progress" project, intending to demonstrate the ability of the design discipline to intertwine and strengthens entrepreneurship (Telalbasic, 2021), as a means of performance improvement of innovation (Borja de Mozota 2002) through the incorporation of new products or services that can exploit company skills and know-how. The project can be the starting point for other activities with companies that want to prevent a period of crisis and experiment with the inclusion of design activities.

Manufacturing SMEs, producing components or semi-finished products with a low degree of design orientation and at a time of business instability or economic distress, are the main target of the project into which to insert the design, according to Borja de Mozota (2010) as "good business" through industrial reconversion or product diversification.

The research fits into and enriches the scientific and industrial landscape dealing with design leadership as it enhances the figure of designers within complex business strategies.

Designers, capable of handling higher levels of complexity (Dorst, 2019), can be critical players in strategic decisions in companies alongside typical management figures. Considering that business strategies inevitably impact the surrounding area, shaping and changing it over the years, the design-oriented industrial conversion can be included in broader projects to enhance local production culture as a policy capable of conferring a new territorial production specialization; this is an important issue for future research.

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Sustainable transformation of age-friendly community centres based on transition design

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Abstract

The world's population is ageing and countries are urgently seeking new solutions to ageing issues. According to Irwin (2015), Transition Design (TD) is a new design proposition for a rapidly changing society based on thinking about the concept of the "long-term" and the idea of global localism, placing the natural world in a more macro context, and advocating a more systematic approach to the transition to a more sustainable future for a design-led society. In the context of active ageing, this PhD research aims to explore how TD guides Design Research and Practice, taking the example of the sustainable transformation of age-friendly community centres (AFCC), from the vision of stakeholders, and the perspective of designers and policymakers, incorporating stakeholders, especially older people, into the design decision-making process, recognizing their entire lifestyle, and involving the infrastructure reimagination, including the products, services, environment, and social systems involved. Through wicked problem in AFCC, stakeholder relations, historical evolution of wicked problem, future visions, and designing system interventions, discussing the transitional design strategy and future trends for AFCC. The transition framework and design strategies for sustainable inclusive AFCC under TD core tenets will be addressed. This will enrich the theoretical and practical basis of TD and have significant implications for the sustainable development of ageing communities.

Keywords

Transition Design; Age-friendly; Community centres; Sustainable transformation; Design strategy

Introduction

In 1972, planner Horst Rittel identified a complex class of "wicked" problems for which the traditional design process was inadequate for solving (Rittel & Webber, 1973). "Wicked problems," such as climate change, biodiversity loss, forced migration, natural resource depletion, and the widening gap between rich and poor etc. require new approaches. Wicked problems affect multiple stakeholders at multiple system levels (Palmieri et al., 2022). Today, population ageing has become a new "wicked problem". The ageing trend is spreading rapidly worldwide. In the United Nations (UN) *World Population Prospects 2019* (UN, 2019), it states that by 2050, one in six people in the world will be over age 65 (16%), up from one in eleven in 2019 (9%), see Figure 1. Ageing has become one of the major social issues that countries need to address, and will have a direct impact on economic development, policy planning, infrastructure, social security and many other levels. Meanwhile, cities and communities are also facing a huge test. The contradiction between the proliferation of the number of elderly people and the construction of local infrastructure and service is also becoming increasingly evident. Existing community living spaces are no longer able to meet the growing needs of older people, and the environment and social services constructed without an all-ages inclusive perspective have caused many inconveniences to older people's lives (Fan et al., 2017; Guo & Pan, 2013; Hu, 2020; Wang & He, 2021). Therefore, the need for age-friendly transitions in communities and spaces becomes urgent, and the systematic and sustainable nature of the transition approach becomes a key factor in measuring the success of the transition.

Scholars have generally suggested that design is an important part of integrating spaces into communities (as cited in Shin & Planning, 2006; Tubbs, 2012). However, there is limited research on the involvement of design in the sustainable transformation of communities and community spaces for older people. Transition Design (TD) is a practice and knowledge that originates from other disciplines and incorporates their principles, and envisages the mediating role of design itself to facilitate multi-level and multi-stage socio-technical transitions (Palmieri et al., 2022). In transition studies, TD is of great relevance and necessity, as it aims to move from understanding to action. Unfortunately, to date, the academic and non-academic fields know very little about the effects and implementation of this new discipline in practice and always end up with an unfulfilled promise. The role, value and potential of transitions has been well defined and explained as the design discipline has increasingly focused on TD. The subject has also been mentioned in several academic literature and conferences. Nevertheless, more importantly, only a very limited number of academic case studies can be found that implement and validate methods and tools, thus validating the potential of TD (van Selm & Mulder, 2019). TD approaches require a highly interdisciplinarity, collaboration and are rooted in an understanding of how change manifests itself in complex systems, coupled with a vision of a sustainable future that expands the problematic framework and therefore requires further discussion and debate. Designers working in the field of social innovation have developed important new approaches from fields such as sociology, organisational science and business that can and should be expanded and deepened in the emerging field of TD (Irwin, 2015). The tran-

Figure 1. Percentage of population aged 65 years or over in 1990, 2019 and 2050, according to the medium-variant projection (UN, 2019).

sition of future communities is inseparable from the involvement of TD.

Aim and Objectives

Identify the wicked problems of Age-Friendly Community Centres (AFCC)–the status quo, problems, and historical evolution–and make theoretical contributions to the relations and approaches between stakeholders' transition products, services, environments, and social systems to propose transition framework and design strategies for AFCC. To explore how TD can engage in design research and practice to influence the planning and design of AFCC, and how stakeholders can actively participate in the design process and play a key role in providing a sustainable vision for finding new paradigms for system-level transitions in design-oriented social transformation and thinking change to make our future community environment more inclusive and sustainable.

Background

With the emergence of economic development, population growth, internationalisation, networking and other factors leading to an increasingly complex society, which is also a source of many problems, as it is a breeding ground for new approaches to these problems. Particularly for specific types of problems at the societal level, which cannot be solved by simple short-term solutions (Loorbach, 2010). According to Ekardt (2020), sustainable transformation will only be achieved if many disciplines contributing to the behavioural sciences are put together to form an overarching theory of individual and collective change. On the path of such transformative research, some fundamental methodological issues must be considered. Sustainability transformation requires a variety of activities by different participants, from a completely different policy approach to (non-verbal or occasional) establishment of new everyday behaviours of people.

In essence, older people are currently on hold as an important human resource and potential force that is not being properly utilised. It is at this point that some scholars propose that how to make community centre (CC), which are "near-home" places of public life, better guide the elderly to live a scientific and healthy life, face aging with a positive attitude and participate in social activities more actively, so as to stimulate the potential positive energy in the elderly and improve the quality of life of the elderly, is an urgent problem that needs to be solved in society nowadays (Gong, 2015; Hu et al., 2021; Lu, 2016). A quality CC is a valuable asset to any community and a well-functioning CC is a thriving hub of activity for youth, families, seniors, civic organisations, parks and recreation departments and more. Unfortunately, in many cities, CC are unable to meet the needs of those around them. In some areas, there are currently no CC (Jumpsix2, 2016).

This shows that CC are in urgent need of development in the city. Therefore, the establishment of an inclusive shared CC in an age-friendly community (AFC) is particularly important. Age-friendly urban planning has gone beyond healthcare considerations to include neighbourhood design and increasingly complex concepts of place (Lui et al., 2009). Recognising that age composition is a dimension of diversity, urban planners now emphasise the value of inclusive design in maintaining community heterogeneity (Gilroy, 2008). Thus, unlike traditional senior centres and day care centres, CC in AFC, although designed primarily for older people, are open and accessible to all ages, promoting active living and becoming an important part of the "lifetime" community.

The discipline of design has developed into a profession that addresses business and social issues through the use of design principles. The design discipline is now studying and experimenting with TD to develop itself as a discipline capable of solving complex ongoing problems and transforming society. TD aspires to be an integrated discipline with multiple knowledge and skills, acting as a medium to facilitate, accelerate and guide transitions (van Selm & Mulder, 2019). We need to reconceptualise and re-imagine everyday life, based on local and regional ways of living, and to communicate new consciousness and approaches on a global scale. Setting a long-term vision and backcasting to the present, drawing on the experience and knowledge of cross-disciplines, dynamically adjusting the methodology and mindset in the step-by-step realisation of the short- and medium-term vision, with a view to eventually arriving at a more sustainable future (Irwin, 2015).

Methodology

Based on the core tenets of TD, this research will be divided into five sections: Wicked Problem in AFCC (data collection and data analysis), Stakeholder Relations, Historical Evolution of Wicked Problem, Future Visions and Designing System Interventions (transition framework and design strategies). The data collection consisted of two simultaneous parts: theoretical and practical. Data analysis will be based on different types of data.

Theoretical Part: (1) Literature research (a systematic literature review). (2) Interviews (qualitative analysis). (3) Survey research (quantitative analysis). *Practical Part:* Workshops (based on TD approach, and the results such as problem map, stakeholder relations map, stakeholder concerns, future visions, transition pathway, and potential projects etc. will be mapped and analysed as the practical data sources for the study).

Stakeholder Relations, Historical Evolution of Wicked Problem, Future Visions and Designing System Interventions (transition framework and design strategies) will be constructed based on the analysis of wicked problem. The AFCC transition framework and strategies will be driven by the future vision, and proposed by combining the *Age-Friendly Communities (AFC) domains and suggested spatial indicators* (Davern et al., 2020) with the *Design for Sustainability Evolutionary Framework* (Ceschin & Gaziulusoy, 2016), based on the World Health Organization (WHO)'s framework *Global Age-Friendly Cities: A Guide* (WHO, 2007).

Case Study

As this research relies on design and practical experience as the basis for academic research, and is based on local and regional lifestyles, the findings of the unstructured interviews with stakeholders led to the proposal for a 3-day workshop on "TRANSITION DESIGN WORKSHOP Age-Friendly Community Centres in 2050," see Figure 2. Nineteen stake-

holders (55-70-year aged people, community and nursing home volunteers, social workers, and architecture and design students) from the Czech Republic, Poland, and China who were working and living in Prague participated. The workshop identified the wicked problems and complex relations faced by AFCC in Prague through the Problem Map, Stakeholder Relations Map, and Stakeholder Concerns Map, as well as through a four-stage design intervention - How Might We, Snapshots in 2050, Projects Informed by Future Visions, and New Projects to create a vision of AFCC's future and backcasting to present to analyse the transition pathways, resulting in four innovative and integrated solutions.

Figure 2. Transition Design Workshop in Prague (Source: author).

Some groups developed projects in the form of services, while others designed products or proposals to intervene in environmental or social systems. These interventions ranged from technical solutions to physical improvements to mentoring projects, demonstrating that the TD approach is an effective way to generate innovative solutions for the sustainable transformation of AFCC, providing a multi-level method for addressing the complex challenges of AFC and positively impacting people's lifestyles, showing the potential of transitional approaches to facilitate design actions.

AFCC Transition Framework

The framework first envisages a sustainable future vision for design-oriented AFCC, and subsequently elaborates a transition strategy for AFCC from the individual to the holistic, and from technology to human-centred concepts from a design perspective. Using TD theory as a guideline to conduct research, and the 8 domains of AFC as indicators, the transition process is divided into four stages: product, service system, environment and social system, with product design, service design, social innovation design and system/transition design as the main design methods, and the stages and methods are developed progressively while backcasting to test the rationality and effectiveness of the process. This is complemented by sustainability, participatory design, collaborative design, interaction and user experience, and inclusive design approaches, incorporating the involvement of the disciplines of sociology, gerontology, psychology and economics, with a view to transitioning to a desired future, see Figure 3.

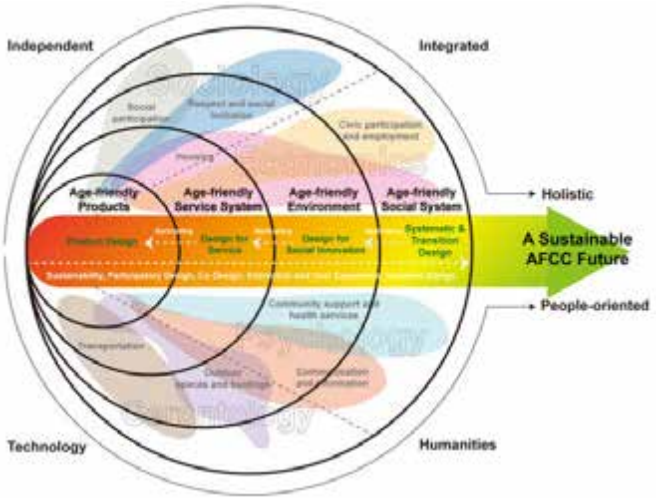

Figure 3. AFCC Transition Framework (Source: author).

Conclusion

In summary, applying the TD approach to address the ageing population, and using the transformation of AFCC as a fulcrum to design a bottom-up solution strategy for older people based on a long-term vision to radically improve their lives, change their lifestyles to be healthier, more inclusive and sustainable, and explore new solution paradigms will be the focus of this study, and will also contribute to TD theory and the ultimate goal of transition to a sustainable future.

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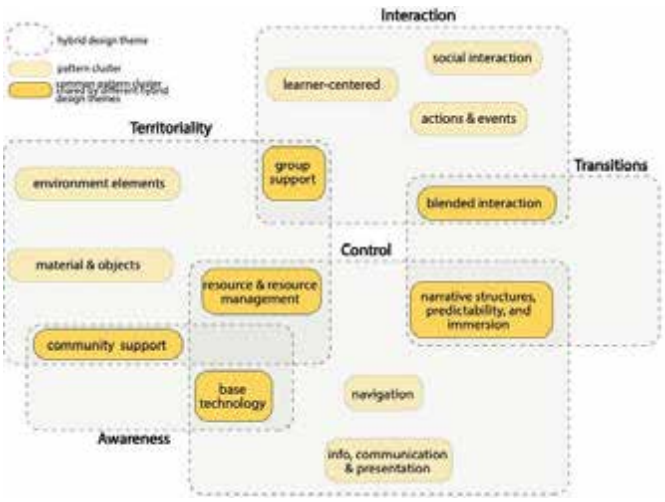

Figure 5. Five hybrid design themes and how they are addressed by 13 generic pattern clusters proposed in this study (Drawn by author).

Parametric Joinery. Development of a system of configurable joints

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Abstract

Making joints through traditional methods generally requires time and experience to be made properly and for this reason they are often an expression of quality and prestige. The development of joints is closely linked to design and fabrication technologies available and accessible in a given period. In fact, over the years, the joints have undergone adaptations based not only on specific needs, but also on the development of new tools and machines. Due to the difficulties of making a well-made joint through traditional methods, following the spread of economic fastening means, such as screws, all wooden joints have been partially replaced by joints that require accessories. The connection accessories offer various advantages, such as the realization of joints in less time and they do not require great manual skill compared to the realization of traditional joints. Despite these advantages, this type of joints could be responsible for several critical issues, in particular regarding the environmental impact, the aesthetics, the performance, and the ease of assembly and disassembly of the final product. Nowadays, the diffusion of numerical control production technologies and the development of computerized design techniques offer the possibility of further evolving this field. In fact, thanks to the development of these technologies it is possible to rethink the concept of all wooden joints that could solve the critical issues of the fastening means. However, designing and testing new joints could require time and particular resources. In addition, a new joint is developed based on the characteristics necessary for a given requirement and therefore its adaptation to components with different characteristics could not be immediate. As a result, these solutions could not be easily achievable by many small enterprises. The present research aims to experiment with parametric systems easily adaptable to the characteristics of the various projects and achievable by designers and small enterprises, which could improve their competitiveness.

Author keywords

parametric; joinery; digital fabrication; furniture.

Introduction

The joints between wooden components represent a crucial part for a piece of furniture. They are closely linked to fabrication and design technologies available and accessible in a given period. Over the years, the joints between wooden components have undergone adaptations based not only on specific needs, but also on the development of new processing tools (Bullar, 2013).

However, traditional joints generally take a lot of time and experience to be made in a proper way. For this reason, the development of technologies for the economic production of connection accessories, such as screws, has caused a change in this field. The connection accessories, allowing the creation of joints in less time and not requiring great manual skills compared to the creation of traditional joints, have had a considerable diffusion, going to partially replace all wooden joints.

Despite these advantages, joints that require accessories could be responsible for several critical issues. Firstly, the presence of accessories made of plastic or metal, could adversely affect the environmental impact of products, especially those made of sustainable and renewable materials, such as solid wood. At the same time, thanks to the absence of plastic and metal components, problems related to the disposal and recovery of end-of-life material are also alleviated. Secondly, many accessories, such as screws, could affect the aesthetics of the products and their performance, especially if they undergo more than one assembly/disassembly cycle. Finally, many accessories could make the products less inviting and engaging to assemble.

The development of numerical control production technologies offers the possibility of further evolving this field. In fact, thanks to this development it is possible to rethink the concept of completely wooden joints.

However, according to author's previous experience with the design of a wooden table-chairs set with new all wooden joints achievable through numerical control milling machines, the development of these solutions could require time and many experiments. In the same way its adaptation to the components with different characteristics could not be immediate. In fact, a new joint is developed based on the dimensions necessary for a given requirement and often it is not sufficient to simply scale the joint in various sizes, but it could be necessary to develop it to fit specifically each time. This is also due to features of the available tools, such as routers bits for CNC machines. This experience leads to investigate the parametric design to simplify the adaptability of new joints to components with different characteristics.

In parallel with the development of production technologies, we are also witnessing the evolution of computerized drawing techniques. Thanks to new design process, such as parametric design, the morphological complexity can be

managed through parameters for the variation of product characteristics, making it easier and faster to apply changes.

State of the art

Over time, several studies have investigated the creation of joints through digital fabrication. However, most of these projects focus on specific solutions for a given project, a process that could be onerous.

Other projects have investigated digital fabrication with the aim to facilitate the design phases. In particular, with regard to the possibility for designers and companies to design products with the help of joints abacuses, which, however, could only be useful on certain occasions. In this context, the following projects are highlighted: "50 Digital Joints", developed by Lab of the Hochschule für Gestaltung Offenbach, German; and "Numerical control joints", developed by the Italian magazine LegnoLab (2018).

Other projects have explored the potential of parametric and generative design to design connection solutions. Among these projects, there are both those that focus on additional pieces made using 3D printing to connect the various components and those that focus on joints to be made directly on the components.

Magrisso et al. (2018) present a project concerning the connection of wooden elements through plastic components made through 3D printing that act as bridges between the components.

However, the present research focuses on all wooden joints systems due to the issues highlighted regarding the accessories.

Zheng et al. (2017) present a project on parametric systems to be made through laser cutting technologies. In this case the field of application is not exclusive to furniture, and the materials can be various.

Biber, developed by Klaus Teltenkötter and Sascha Urban in collaboration with Hochschule Mainz, is a plug-in developed for Rhino-Grasshopper capable of making interlocking panels.

However, projects that take into consideration the connection between panels could limits the aesthetics of the products since they will be made from flat components. The present research focuses on systems that can be used on components of various shapes in order to ensure more freedom of aesthetics.

Discussion

The aesthetic qualities and mechanical performance of the products obtained through digital fabrication are constantly growing to the point that these technologies can be used directly for the realization of the final products, and not only for the prototyping phases.

In addition to this, there is a relevant aspect regarding the complexity and accuracy of the shapes that these technologies can achieve. In fact, thanks to numerical controlled machines it is now possible to make shapes that are difficult or impossible to obtain with traditional production methods, offering new opportunities in this context. Parallel to the development of production technologies, there is the spread of new design processes, which can represent a valid tool for designers to achieve new solutions.

An example in the context of wooden joints can be the kinds of stereotomy. In fact, traditional tools, like saws, planes and chisels, stimulated joints that are characterized by flat surfaces that meet forming sharp edges. However, this typology causes the crushing of the fibers and the concentration of stresses at the edges, and as a result, there is the need to oversize the structures. Today, thanks to computerized drawing techniques and numerical controlled machines it is possible to think of rounded joints without sharp edges that guarantee new and more efficient solutions (Ragazzo, Villani, 2018).

The scope of these technologies does not only concern the characteristics of the products but also involves the companies. In fact, the advantages that can arise in terms of environmental impact are also reflected in advantages on the competitiveness of the company itself. Indeed, it has been found that a supply chain that reflects the principles of sustainability is also more resilient in the event of shocks and emergencies. In particular, the consideration of the companies regarding more responsible environmental policies has changed over the years, passing from being perceived as a burden to being used as a factor of competitive advantage (Fondazione Symbola, 2020).

In addition, the absence of accessories and a low number of total components could improve the ease of assembly and disassembly and make the final products more engaging to assemble.

The use of parametric design and digital fabrication technologies could make it possible to obtain advantages concerning performance, aesthetics, environmental impact, ease of assembly and disassembly, and the possibility of adapting systems to projects with various characteristics.

However, these results could not be easily achievable by many small and medium-sized enterprises because of the difficulties related to the development process of these solutions.

For this reason, this research aims to investigate new design and manufacturing technologies in order to develop a tool that makes this kind of solutions more accessible by designers and enterprises with less resources.

Conclusion

The technological evolutions make it possible to solve the problems highlighted regarding both traditional joints and those concerning the use of accessories. However, if on the one hand, the development of new technologies offers the possibility of obtaining various advantages, on the other hand it requires a reconsideration of the geometries of the systems.

In addition, not all wood species have the same properties, and therefore the characteristics of each wooden joint should meet those of the material used. In this case, the parameterization of the systems can make a significant contribution in making the right choices for each specific case.

Considering the advantages that could be obtained from these technologies, it could be important for small and medium-sized enterprises to have the possibility to achieve these solutions in an easy way.

For this reason, the aim of the present research is to investigate the parametric joinery to develop a tool that can help designers and companies to obtain these advantages.

Furthermore, considering that the production technologies considered for this project are already widespread in the industry (Sanela, Atif, 2017), companies are partly ready from this point of view to welcome this development. Finally, a hope is to stimulate greater interest in this concept.

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Designing a ward inventory for a sustainable healthcare. Framework for healthcare providers of configurations among disposable medical devices, clinical procedures, and medical equipment in the Neonatology department

Abstract

During the pandemic emergency, the need for a critical review of the healthcare sector has been accentuated, particularly regarding the environmental impact caused by the use of single-use, non-recyclable, and non-biodegradable products. The aim of this doctoral research is to investigate and reconsider the flow of single-use products, mainly plastic, generated by local hospital units, with a focus on the Neonatology department. Currently, there are still few sustainable research and actions implemented in one of the departments that most produces single-use waste in the healthcare sector, where the use of single-use products has a significant impact on costs and the environment. The research path aims to conduct a thorough contextual analysis in the field, to review, understand, and analyze the dynamics within the "Salute Lazio" Regional Health System, specifically within the Neonatology departments of Umberto I Polyclinic in Rome. The industrial doctoral research goal is to generate, implement, and communicate new sustainable approaches for the management, reformulation, collection, and disposal of medical single-use items, with the aim of creating a zero-impact circular economy model. New sustainable approaches will be applied both in a corporate context, regarding the production, communication, and configuration of packaging and consumables, and in a healthcare context, such as Neonatology departments. This can be achieved through data collection, field surveys, and multidisciplinary tables on the use and end-of-life management of products, to share ideas and achievable challenges with department personnel. The methodology employed in the research encompasses systemic and circular design approaches, which aim to consider the interconnection between the various elements of a system and their relationships, to create sustainable and resilient solutions. The intermediate results of the research demonstrate how the development of user guidelines leads to better identification of single-use medical devices related to the use of electromedical equipment and clinical procedures and improved management and utilization of resources in the department. The research outputs serve as the starting point for subsequent department visits aimed at defining the criticalities within the entire care delivery system. This process will contribute to the development of design methodologies and greater attention to a practical sustainability model within the Neonatology department system.

Author keywords

Circular economy; sustainable healthcare; Systemic design; Neonatal care; single-use medical devices.

Introduction

The key term of the doctoral path is sustainable healthcare, an expression that refers to a care system aiming to ensure quality care access for all while optimizing the use of available resources, reducing waste, and valuing human resources. Although a universally accepted definition of sustainable healthcare has yet to be established, studies on the topic are united in pursuing solutions to make our healthcare systems more economically, socially, and environmentally sustainable (Jamieson et al., 2015). The present research, as part of the doctoral thesis entitled "Design for Sustainable Healthcare," aims to investigate which design methodologies to apply and which activities to perform for a life cycle analysis of disposable medical devices in the Neonatology department at the Umberto I Polyclinic in Rome. The study operates in new research scenarios for sustainable healthcare. The specific needs of the project are represented by the requirement to review and remodel the environmental impact generated by the healthcare system throughout the life cycle of consumable medical products. In particular, the research questions driving the study are the following:

1. What disposable medical devices are used in the Neonatology department of the Umberto I Polyclinic in Rome and what procedures require the use of specific disposable devices?
2. What procedures, equipment and medical single-use devices are daily used within the various levels of healthcare in the mentioned structure?

Background

The expression "Sustainable Healthcare" is defined by the World Health Organization as a vision in which health systems can improve, maintain, or restore health, while minimizing negative impacts on the environment and leveraging opportunities to restore and enhance the environment for the benefit of current and future generations' health and well-being (WHO, 2017, p.9). In recent years, there has been an increasing interest in circular actions that can be implemented in health contexts, following the shift from a linear to a circular approach to resource consumption. Freire and Sangiorgi (2010), in their

text "Service Design & healthcare innovation: from consumption to co-production and co-creation", state that the role of designers within the English healthcare system has changed, moving from the mere design of products to a role of facilitator of connections between stakeholders and provider of tools, methodologies, and strategies to evaluate and resolve the complex system's problems (Freire and Sangiorgi, 2010). Settimo & Viviano (2013) share a similar vision and state that sustainability concepts allow designers to undertake actions ranging from designing the product from the waste perspective already in the choice of materials, through information and personnel training, optimization of the management system, adoption of computer technologies, and actions that can lead to a reduction of medical waste flows and disposal costs (Settimo & Viviano, 2013). Several studies argue that a "green healthcare team" (comprising doctors, nurses, clinical staff, and environmental specialists) would be useful in promoting environmental sustainability in healthcare (Chenven & Copeland, 2013; Weiss et al., 2016). Therefore, the designer can represent a new key figure for project collaborations with the system's stakeholders to make healthcare sustainable, and multidisciplinary actions considering the entire system can generate environmental, social, and economic results in the short, medium, and long term.

To date, the literature reviewed shows a growing attention to the urgent need for sustainable healthcare, which is becoming a focal point in many departments with diverse procedures, products, and knowledge. However, there are still few sustainable research studies and actions that can be implemented in one of the departments that produces the most single-use waste: neonatology departments. The use of single-use products in neonatal care has a significant impact on costs and the environment (Newman, 2011; Nichols, 2013, 2014). Proper waste separation is crucial for neonatal care as failure to do so can compromise Neonatology departments, reducing staff's ability to effectively separate waste at the point of generation (Nichols, 2014). Proper waste separation prevents non-infectious waste from being disposed of through the more costly clinical waste stream, which can increase costs up to three times higher than necessary (Nichols et al., 2016). The field requires further investigation and interventions that can reduce waste costs and emissions and even lead to revenue generation through increased use of recycling (McGain, 2009; AOMRC, 2014). The lack of published material could indicate that this is a relatively unexplored area, and further research such as the doctoral pathway is needed to address this issue.

Methodology and Research phases

The research presented utilizes the Systemic Design methodology as its investigatory approach, adopting design tools to highlight needs that have emerged through a holistic diagnosis, problem definition, levers for change, system design, theoretical studies of implementation outcomes, and finally, result and feedback analysis (Barbero S., 2016). The phases outlined for the research have allowed for the detailed examination of parameters and values related to consumables within a healthcare facility, generating results that are repeatable not only in other neonatal departments but also in other clinical areas that regularly use single-use medical devices. Greater attention was given to highlighting critical issues and concerns related to polymeric products and hazardous infectious waste during the various analysis phases.

The first phase of the doctoral research involved desk-based studies to allow for a preliminary analysis of the systems to be considered. This phase aimed to acquire knowledge and information regarding the existing regulations within the healthcare system, the registries that track the flow of waste produced, the policies adopted in separation, treatment, and final disposal of waste, as well as the roles of the various stakeholders who get in touch with such devices during their lifecycle within the healthcare facility. Subsequently, after the creation of a Guide for Analysis in the first phase of the research, the following phases focus mainly on the field research conducted for on-site observation, utilizing the analysis tools elaborated in the previous phase.

FIELD RESEARCH. The field research involves on-site analysis to acquire data regarding the lifecycle of single-use medical devices within the healthcare system of the neonatal departments of Polyclinic Umberto I. The research is broken down into sub-phases to allow for the achievement of intermediate research results.

- Phase 1. Department visits
  By accessing the various department areas, the contexts of use for single-use medical devices were defined, related to the respective electromedical equipment and care assistance procedures present in the various levels of the neonatal department.

- Phase 2. Medical Single-Use Device Inventory
  By considering parameters useful for classifying consumable items within the department, it was possible to compile an inventory of all single-use items based on the type of medical assistance provided and the electromedical equipment used for each type of item available in the department.

- Phase 3. Summary Document Generation
  The table summarizing the items, activities, and tools necessary for medical care available, it was possible to generate a research output that had a dual utility, the first being a general overview that would be useful for those involved in planning subsequent phases of the research, and the second being the needs of healthcare providers working in the department by preparing medical procedures and medical equipment, finding precise instructions and guidelines in the document to follow in order to provide care with consumables suitable for the medical procedure or equipment [Fig.1].

Intermediate Results and Future Developments

The proposed research has defined conceivable scenarios within the system by using modeling techniques and analysis methods for each case of investigation. The research outputs aim to answer the research questions, allowing for a more complete understanding of the structure of the life cycle of single use supplies throughout the entire system under consideration.

After completing the field experimental research, an explanatory document was generated to provide end-users, in close contact with medical procedures and medical devices and equipment, with guidelines for a better understanding of

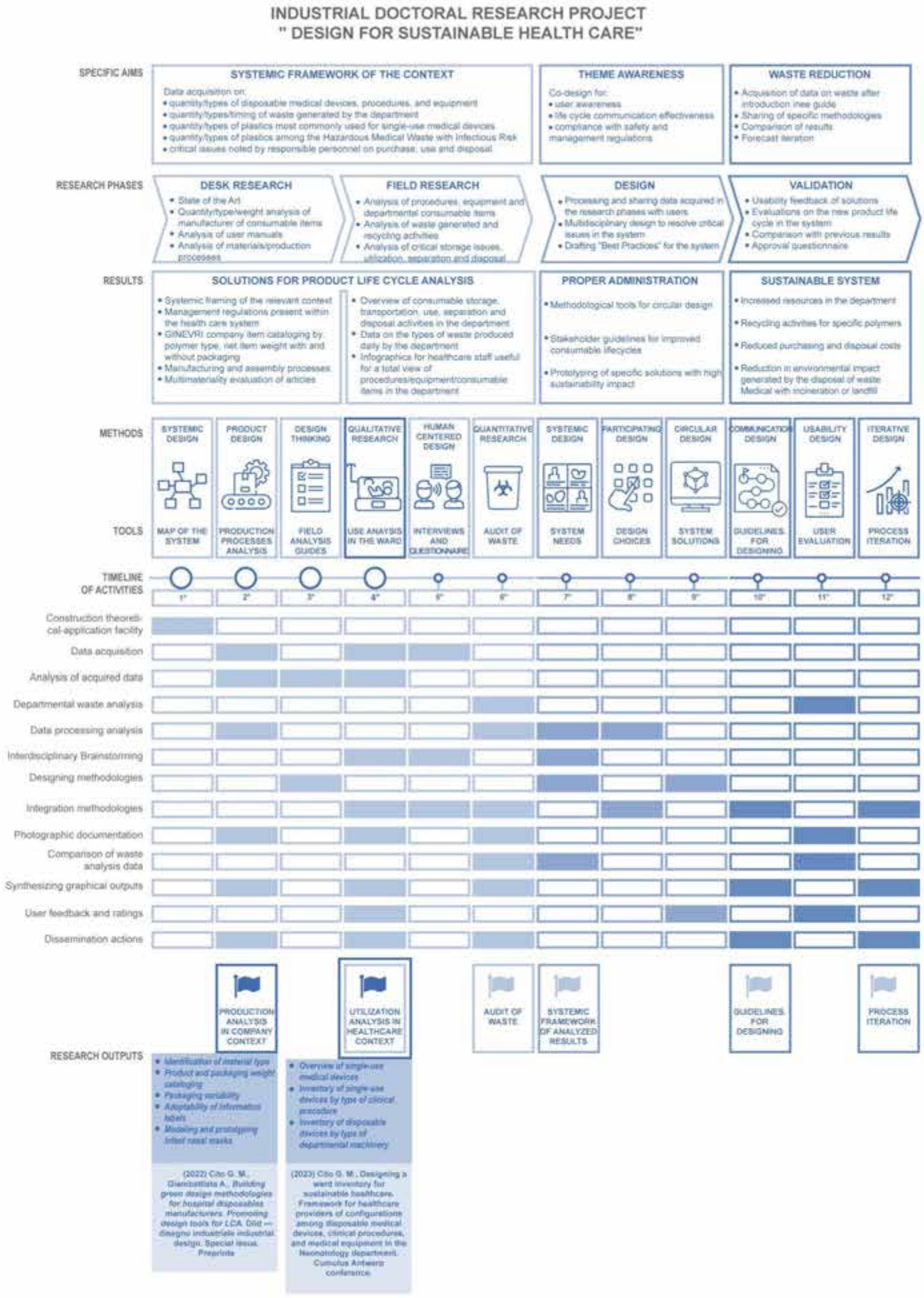

Figure 1. A summary of doctoral research pathway

which items are used for certain procedures, which items are used on specific electromedical equipment and medical devices, and what the needs of the users are in preparing and using this type of product.

Following the highlighted phases, further steps will be taken to evaluate the system generated within the Neonatology department in its entirety. These activities will mainly involve:

- Department Analysis. Insight visits to different healthcare areas within the facility where single-use medical devices are stored, transported, separated after use, and stored before disposal. [Fig.2].
- Interviews and questionnaires. Multi-disciplinary interviews with healthcare personnel, with whom open discussions in round tables are conducted to identify waste management issues and debates and reflections on the results obtained in the previous phase.
- Audit. Review of the waste generated in the department over a 24-hour period, performing a quantitative acquisition on the weight of the bags, items, the type of material, and the quantity of identified items, along with a video documentation for each type of waste, unused open products, those not open but available on the workbench, as well as recycled and reused items.
- Data collection. Data processing and synthesis of research outputs, which will allow to highlight trends and issues in the life cycle of specific consumable items, future estimates of cost and supply reduction.

The next developments of research activities will include:

- SYSTEMIC DESIGN: This involves preparing a program that offers innovative and sustainable solutions for the facility. These solutions should be implementable in the short term and address the issues faced in the various areas where products are produced, used, and disposed of.
- EVALUATION TESTS: Once the identified solutions have been shared with stakeholders, it is important to obtain feedback from them and the involved users. This feedback will help in improving the proposed tools and evaluating possible process iterations. The sharing of methodologies and guidelines, including autonomous forms, should be done by the involved personnel.

Figure 2. Observational study in Neonatology department of Umberto I Polyclinic in Rome where identify instant need of single-use devices and their relationship among electronical medical devices and procedures.

Conclusion

The doctoral thesis journey, in line with the literature, systematically addresses various needs in the healthcare sector. Interdisciplinary collaboration among different professionals was necessary to generate a sustainable footprint in the healthcare context. This collaboration led to the identification of issues encountered in the life cycle of single-use medical devices for Neonatology, which were addressed through systemic design project methodologies to develop new strategies and practices. The journey will allow the Umberto I Polyclinic Hospital to re-evaluate advantageous possibilities of purchasing, storing, using, separating, and disposing of consumable items. These strategies will have a reduced impact on healthcare spending and the pollution generated by the processes involving the life cycle of consumable devices in the various contexts mentioned.

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A safe space of creativity: designing with vulnerable communities

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Abstract

This paper presents recent findings of a practice-based research conducted with underprivileged girl groups in Hungary. The research aims at finding evidence for positive change of attitude in participants, applying an intersectional approach in social design.

It is more important than ever to promote self-sustenance in disadvantaged communities as a pathway to conscious goal-setting and practicing agency over resources (Braidotti et al., 1994), and underprivileged girls have not been studied sufficiently from a social design perspective. Findings in recent research in maker practices (Clapp & Jimenez, 2016; Eckhardt et al., 2021) and the case study below suggest that certain design-based practices can help underprivileged girls gain self-confidence, problem-solving skills, and a sense of agency.

In order to understand how design can contribute to empowering underprivileged girls, the author contextualizes the barriers of the targeted community in the framework of sociology (Siposné, 2020) and intersectional theory (Crenshaw, 1989) along with a criticism of non-inclusive maker practices (Millard et al., 2018), and identifies a suitable methodological approach. When building up an empowering and inclusive methodology specifically designed for the target group, it is important that the relevant barriers and resources are considered. The methodology is based on a participatory creative process that utilizes co-creation tools through a peer-to-peer mentoring system. The results are measured through a hybrid of quantitative and qualitative methods. A case study based on a series of workshops conducted in Hungary in 2022 is presented and discussed, focusing on key factors for an age- and gender-appropriate design approach.

Author keywords

social design; gender equality; maker movement; underprivileged; intersectional theory

Introduction

It is more important than ever to address the increasingly pressing issue of intersecting inequalities underprivileged female communities face. The gender gap has still not been closed despite earlier incentives (UN Millennium Development Goals, Sustainable Development Goals).

There are several ways to define the meaning of disadvantage and understand the circumstances such communities face. Going beyond income in defining poverty, Green (2008) argues for a multidimensional understanding that takes into account the sense of "powerlessness, frustration, exhaustion, and exclusion from decision-making" experienced by people living in poverty (Green, 2008, p. 7). From an intersectional standpoint, gender, class, ethnicity, sexuality and age are identified as intertwined aspects of individuals' identity that are linked to different forms of discrimination, and which can prevent individuals from accessing resources and services, including education – and making decisions about their lives, in the context of personal, economic or ecological threshold. Gaining tools for advocacy "which builds on claimed synergies between feminist goals and social development priorities has made greater inroads into the mainstream development agenda than advocacy which argues for these goals on intrinsic grounds." (Kabeer, 1999, p. 435).

Intersectional feminism is derived from intersectional theory, and focuses on those experiencing simultaneous, concurrent forms of oppression in order to understand the depths of the inequalities and the relationships among them in any given context (Crenshaw, 1989). Intersectionality identifies multiple factors of advantage and disadvantage. Examples of these factors include gender, race, ethnicity, class, sexuality, religion, disability and physical appearance. Since the 2000s, different ethnicities have adapted this originally black-centered argument on their feminism (Durst, 2001; Fernández Kelly, 1995), but in the Central European context, local ethnic identities (e.g. Roma) remain understudied from an intersectional feminist perspective. If we include age as a factor in this intersection of identities, we can state that girls are not only "marginalized within the category of children as females", but also within the category of women as minors (Taefi, 2009, p. 347), and possibly members of ethnic minorities.

When looking at the current socio-economic circumstances in Hungary, Siposné states that according to data, housing inequalities, ethnic origin and having a large family are usually closely related, creating overlapping disadvantages. Poverty and social exclusion further threaten the following groups: children under 18, single-parent households, low-educated, unemployed or Roma (in which case the aforementioned risk is three times the average) (KSH, 2016). Furthermore, the Roma population, which makes about 6-7% of the total Hungarian population, is considered the most exposed to poverty, with considerably low levels of education and employment which lead to deep poverty especially in ethnic minority groups such as Roma communities (Siposné, 2020, p. 43). Schultz stresses, in the context of the struggles of human rights advocacy and feminism, that Roma women are the

region's most vulnerable ones, facing constant, multiple discriminations, based on race, class and gender (Schultz, 2012, p. 41 and p. 37). These simultaneous discriminations can be further understood turning to intersectional theory.

In conclusion, adolescent youth should be studied by considering the cultural, institutional, and socioeconomic processes. It is crucial to overcome the misconception of seeing educational difficulties of low-income or minority students as resulting from 'cultural mismatch' and recognize how institutions might lack the knowledge to guide them (Havas & Liskó, 2005, p. 94-95).

Theoretical Framework

The research described here investigates what methods or approaches are adequate to address the needs of disadvantaged girl groups through design tools. In order to create an effective, empowering methodology specifically designed for the target group, it is crucial to take a closer look at their barriers, difficulties and resources, which necessitates an interdisciplinary approach that includes sociological and psychological methods complimentary to gender-appropriate social design tools. In vulnerable communities, the lack of perspective can have a debilitating effect on youth groups, especially girls, as early marriage and a domestic career is their only option in sight. This is particularly true in more traditional or ethnic communities, since the family serves as both the sole economic and social support system for individuals (Czibere, 2012), so any effective method should incorporate the aspect of community and peer support.

This set of circumstances often result in not only early childbearing and leaving the education system prematurely, but several other psychological factors that further hold back individuals from breaking out of their barriers. The lack of support in the education system (especially in rural segregated schools) further deepens the abandonment young girls can experience, and these difficulties can result in a lack of motivation, goal-setting, confidence and agency. Therefore, clearly defined structure, a realistic future planning and safe boundary-setting are necessary in order to address the target group in a meaningful way.

The adolescent phase in the psychosocial theory of development is concerned with identity formation versus role diffusion (Erikson, 1968), as well as agency-manifestation (Zimmerman & Cleary, 2006). According to surveys (Collins et al., 2011) traumatic experiences within the family appear more frequently than in other, more secure social settings (family loss, separation, unemployment, housing crises, violence, etc.) In many cases, these interconnected phenomena contribute to the formation of a role conflict between the world of family (which considers a girl an adult from early adolescence) and the world of school, which still treats them as children in need of discipline.

Since the target group is particularly sensitive, an appropriate ethical approach is required. In her essay 'Nomadic Ethics', Braidotti states that "[a]n ethically empowering relation to others aims at increasing one's potential or empowering force and creates joyful energy in the process", also implying that the approach towards the group must be dynamic, transformative, decentralized, and affirmative (Braidotti, 2013, p343). These guiding principles lie at the core of the method used here, and they take shape in the iterative process that the methodology was created and tested based on participants' inputs as well as the built-in feedback throughout the program [1].

Studies indicate that adolescents of low socio-economic status report lower self-esteem in comparison with their peers of higher socio-economic status (Veselska et al., 2009). Addressing and improving low self-esteem is a key factor in working with at-risk adolescent girls as low self-esteem is widely documented as a correlative factor in depression and anxiety (Veselska et al., 2009), lower health-related quality of life (Mikkelsen et al., 2020), criminal behavior, drug and alcohol abuse, and teen pregnancy (Hartz & Thick, 2005). These factors impact girls more significantly than boys, especially through adolescence, as gender-role expectations impose more limits and stronger demands on females (Hartz & Thick, 2005, p. 71). Increasing self-awareness helps girls identify personal preferences, values and a life purpose and facilitates creating a realistic appreciation and assessment of personal strengths and weaknesses, which further encourages them in setting more realistic goals and enables them to create impact in their lives and surroundings. Therefore, a set of template-based, customizable objects were discussed, personalized and built together with the participants, in order to demonstrate their creativity within a safe structure of self-expression.

Method

The methods are partly based on features of the maker movement, but they also address the shortcomings of mainstream maker practices which are not inclusive enough towards various social groups and identities (Toupin, 2014; Chachra, 2015). On top of that, a majority of humanitarian creative tools are based on collaborative work processes (Design Kit: The Human-Centered Design Toolkit by IDEO, 2015; DIY Toolkit by NESTA, 2014), but most of them don't address the question of power dynamics and the problematic neoliberal concept of self-actualization through various activities. In the FRUSKA model, each assignment is rooted in a different psychological exercise, built up from basic towards more complex ones. The evidence for this parallelism is supported by numerous studies conducted on STEM- and STEAM-based education and maker initiatives, where participants self-assessed as more confident and empowered as a result of participation (Clapp & Jimenez, 2016). Unfortunately, disadvantaged youth, especially girls, are not the main target audience of such programs. The maker movement originally grew out of an initiative by various communities with the aim of increasing the availability of digital manufacturing and communication technologies, such as 3D printers, laser cutters and online community platforms. The maker culture adopts a set of values defined by an open source rationale

1 Statement on compliance with ethical standards
All procedures performed in studies involving participants were in accordance with the ethical standards of the institutional research committee of Moholy-Nagy University of Art and Design. Informed consent was obtained from all individual participants and their legal caretakers involved in the study.

based on the sharing of knowledge and the free circulation of designs, making it theoretically open to anyone interested in open source methods (Eckhardt et al., 2021).

The core capacities identified for the current design methodology are: (a) agency; (b) skillbuilding; and (c) decision-making. The methods used throughout are rooted in social design, participatory action research (Aziz, 2011), feminist group advocacy (bell hooks, 1994) and art therapy (Hartz & Thick, 2005). The overall theoretical framework is based on critical race theory and intersectional feminist theory, which stresses the construction of identity (Crenshaw, 1989).

Results

During a series of four workshops, groups of participants were guided through several themes and assignments, namely: (a) mapping their circumstances; (b) self-reflection, self-image and society's expectations; (c) identifying challenges in their surroundings, designing template-objects; (d) prototyping and executing planned solutions.

The program affords various levels of engagement from the participants and offers them multiple ways to solve a task in order to encourage long-term personal commitment. A well-framed, predictable structure helps with experiencing control throughout the process, which further strengthens the participant's sense of security and increases their agency. Agency plays a key role both in strengthening a developing personality and in goal setting. Psychology defines agents (which are, in the current case, underprivileged girls) as goal-directed entities that can monitor their environment to perform efficient actions and achieve an intended goal, therefore, agency implies an ability on the side of the agent to perceive and to change one's environment. Considerable evidence points towards the direct connection between participating in girls-centered programs and improvements measured in future planning, including reporting concrete goals for the future and effectively articulating plans to achieve those goals. Girls also report more empowerment, a stronger sense of agency, and a greater ability to participate in critical life decisions, as well as increased socioemotional support from peers and adults (Girls' Education Program, Edmonds et al. 2021). Peer experience and seeing positive role models enhances the girls' motivation and prospects for engaging with creative tools, but it also helps them build up meaningful connections and networks outside their limited circles. Besides role models, these new communities foster sharing similar life experiences and tearing down taboos.

Figure 1. Creating templates for customized objects during a FRUSKA workshop. Photo: Noémi Szécsi

Throughout the process, the participants were not only asked to reflect on the proposed themes and their own experiences verbally, but they were also asked to give regular visual and textual feedback. In addition, they completed a pre- and post-workshop questionnaire, which was designed based on a survey by Hartz and Thick (2005). In order to consider basic psychological needs of adolescents, the basics of Self-Development Theory was applied, which posits autonomy, relatedness and competence as essential and universal ingredients for healthy development (Ryan & Deci, 2000; 2017).

Conclusion

The methodology described above aims at addressing the viewpoint of underprivileged girls through the tools of design. The target group's specificities are not yet thoroughly studied in current social design in a way that provides space for target groups to take control in the process, so an intersectional approach is taken by the author in order to create a safe, adaptive and decentralized space for participants. The exclusivity of traditional maker settings is challenged through creating girl-inhabited makerspaces, focusing on agency, skillbuilding and decision making.

As a conclusion, several factors necessary for conducting meaningful social design work with disadvantaged girls are highlighted. The factors, as stated above, include jointly established boundaries, clear structure, a safe amount of personal freedom in expression, discussions respective of the participants' life experiences, and clear understanding of the role conflict that participants endure at the intersection of multiple segments of identity. In order to confirm this assumption, a longitudinal study is currently underway.

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The direction of wayfinding. From the identification of a place to the expression of its meaning

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Abstract
The aim of this Ph.D. research is to study wayfinding systems, in relation to contemporary urban public spaces not considering them with their main function of orienting people towards a destination in a predefined environment but considering them as a tool of communication able to establish and reinforce a sense of belonging of the user to the place. This research situates itself at the intersection of three main disciplinary fields – graphic design, urban planning and social sciences - that I explored, in relation to wayfinding in urban public spaces, through a narrative literature review process. Through this process, while observing how widely have been studied the primary function of wayfinding, I highlighted a gap in the current studies about the involvement of wayfinding systems in the improvement of the perception of a place. As this Ph.D. research is a research for design, the aim is to define better conceptual and operational tools that could enable wayfinding designers to succeed in designing a wayfinding system.

Author keywords
Wayfinding, Communication design, Semiotics, Urban planning, Public space

Introduction
This Ph.D. research aims to study wayfinding systems (Lynch, 1960; Arthur & Passini, 1992), in relation to contemporary urban public spaces (Carmona 2003; Gehl, 2011; Manzini, 2021), not considering them with their main function of orienting people towards a destination in a predefined environment but considering them as a tool of communication able to establish and reinforce a sense of belonging of the user to the place (Lynch, 1960). This research situates itself at the intersection of three main disciplinary fields – graphic design, urban planning and social sciences - that I explored, in relation to wayfinding in urban public spaces, through a narrative literature review process. Through this process, while observing how widely have been studied the primary function of wayfinding, I highlighted a gap in the current studies that led me to the identification of the research questions, objectives and methodology that I will explore in the next paragraphs.

Wayfinding, public space and its identity: a review
Wayfinding is a field of work that situates itself at the intersection of several disciplines. The term has been first coined by Kevin Lynch in 1960 (Lynch, 1960) and used in relation to the architectural and urban planning fields. It was then extended to the design field, which is also involved in the wayfinding activity both from a product design perspective and from a graphic design perspective (Calori, 2015; Gibson & Pullman, 2009) in designing both the physical and digital signs and their content through a design activity that has been defined as wayshowing (Mollerup, 2005). Aside from the design and planning areas, wayfinding also tackles other fields of study, related to the social sciences area. Psychology, anthropology and semiotics are just some of the disciplines involved when studying the human behavior of orientation in space. From this perspective, it is possible to define the wayfinding activity as a problem-solving activity of any person who needs to find his/her destination in an environment, that for the aim of this research is an urban environment. From this perspective, it is possible to say that wayfinding systems are those systems of signs that assist people when dealing with the activity of finding the right way. While they help the orientation process of each user in a complex environment, they have a role in constructing the users' mental image of a place (Golledge, 1999) and in helping them in understanding the structure of the surrounding environment, evoking an already-known image in the observer, a quality that has been defined as the imageability of a place (Lynch, 1960). This recall can help people in applying a well-known model to an unknown place, enabling the orientation and at the same time conveying a sort of familiarity of each user to that place. Wayfinding systems are designed to help a plurality of users, different from each other both for the physical features and for the way of use of the space. Wayfinding systems in fact are not only for inexpert or occasional users of a place but also for frequent users that are already aware of the space in which they navigate. Even these kinds of users need to find the way to their destination. The difference between them and inexpert users is that they focus more on the executive phase, rather than on the decisional one (Arthur & Passini, 1992), and it is right in this step of the process that wayfinding systems are a useful tool. There might be situations in which a wayfinding system is not used by a user to reach his destination, but even if it only has the function of background environmental graphics, a well-designed wayfinding system can talk to the people, establishing a connection and a positive perception of the space itself. Wayfinding systems are, in fact, part of a communication process about a place (Zin-

gale, 2012), but working on a place, from the communication design perspective, often means working on its identity. The concept of brand identity, usually used for companies or institutions, in the last years has been widely applied to places and cities, to make them recognizable in the tourist market and to let them communicate their own way of being to the rest of the world (Parente, 2014). Being mainly a marketing process, the creation of this identity takes place through a top-down process, that is usually guided by economic opportunities and driven by the local stakeholders (Parente, 2014), that, in order to construct a strong territorial brand, usually focus on the main positive characteristics, reinforcing them while undermining the others (Baur, 2013). This process of reduction, from a multiplicity to a singularity, is related to the concept of identity in general terms and not only in relation to the brand identity and the territory but in this case is even more clear that a representation of the identity that recognizes an incisive role for the otherness, removes strength from the identity in question (Remotti, 1996). Moreover, the urban place is something in constant change, a text assuming a semiotic perspective (Volli, 2005), that evolves through time thanks to the interactions and connections of all the animate and inanimate entities present on a territory each of which has its own characteristics. From this point of view, it is possible to see how shaping an identity, reducing this complex and living multiplicity to a fixed singularity would inevitably leave something behind. Apart from the communicative dimension, this process makes us question the way in which a territory, in particular a shared space, is approached, conceived and transformed through this process of top-down creation of an identity, in opposition to the way in which the same territory is perceived by the citizens themselves (Baur, 2013). Communicating the cultural multiplicity could be a point of strength also to reinforce the sense of belonging of each of those entities to the territory of which they are part. To do that, I decided to take into account the chances offered by wayfinding systems, as communication tools with a strong link with the space and a grounded presence on the territory, that for these reasons could be a successful instrument to express the plurality of a place rather than the singular identity, and with it reinforce the people's connection with the place itself.

Research gap and research questions

Given the previous understanding, a point that seems to be missing in the current literature about this topic is the way in which a wayfinding system can be the expression of a cultural multiplicity of an urban public place and reinforce their sense of belonging to the place.

This gap is the one on which I focused to develop the following research questions:

- Given the need for an urban public place to express itself in its plurality is there a way in which a wayfinding system, as a tool to perceive and interpret the place, can have a role in this process?
- And if so, how can a wayfinding designer succeed in this purpose, while designing a wayfinding system for an urban area?

Objectives

Being this Ph.D. research a research for design (Manzini, 2015), the aim is to define some better conceptual and operational tools that could enable wayfinding designers to succeed in designing an efficient wayfinding system. The objectives to be pursued through the different steps of the methodological phase are the following: to define those design tools and other tools that design can borrow from other disciplines, which are more suitable to understand first and express later the plurality of a place. To do that I decided to explore a possible methodology that for its characteristics seemed to be very suitable for this purpose, even if it has not been very much used in the wayfinding field yet: ethnosemiotics.

The methodology: ethnosemiotics

Ethnosemiotics has been first introduced by Algirdas Julien Greimas during the Seventies. In the analytical dictionary that he curated, along with Joseph Courtés (Greimas & Courtès, 1979), we can find a first definition of the term, even if not in relation to our field of action, the urban environment. In general terms, as stated by the word itself, ethnosemiotics connects the two disciplines of ethnography and semiotics. It applies the instruments proper of the semiotic discipline to the ethnographic method of observation. This combination has a substantial impact on the understanding of the possible connections between the actors and the objects of the study analyzed while building the inner structure of the observed phenomenon (Accardo, Liborio, Marsciani, 2015; Donatiello & Mazzarino, 2017; Lancioni & Marsciani, 2007). Because of these features, ethnosemiotics methodology is particularly suitable for research in design (Galofaro, 2020) even if it is not still recognized as a valuable tool when researching about orientation in space. The purpose of this research is to investigate the possibility of using the chosen methodology when dealing with wayfinding design, for its interdisciplinary approach. To do that I explored the several steps that this methodology offers. Starting with the first activities of collection of data from the outside to then moving to the observation on the field through site inspections comprising of several activities: taking notes, shooting pictures, recording sounds and interviewing and interacting with the people. All the information collected should be then organized, classified and compared, to then end up in a consistent analysis of the area with the aim to achieve some first understandings of the studied area, able to highlight its plurality, its controversies and the inner needs of its inhabitants.

Further steps and possible developments

From these first understandings is possible to say that the ethnosemiotics methodology seems to be particularly suitable for wayfinding designers when dealing with public space, not only for its ability to study and interpret a given phenomenon but also for its ability to explore the possible relations occurring among the different actors on the territory. Starting by highlighting steps, methods and tools, the further possible developments of this research are to focus on their transfer from one discipline to the other, in order to explore the possibility to implement the tools of the ethnosemiotics methodology within the professional activity of wayfinding designers.

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Human augmentation: the role of design in the design of on-body interfaces for cognitive-sensorial wellbeing

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Abstract

Human Augmentation is the set of practices and disciplines that involve the use of technology as an integral part of the human body, aiming at assisting, substituting or augmenting human sensorial, physical and cognitive capabilities. Contributions in the field are mostly related to technology-centered perspectives, aiming at providing useful, safe and usable augmentations to address immediate needs, generally to improve and support performance. A human-centered approach on the topic offers new perspectives on the interpretation of human needs, going beyond functionality and usability. Investigating new emerging needs, desires and expectations of users willing to integrate augmentation technologies into their everyday life is essential in defining also novel design approaches. Therefore, involving Design Research and Practice in this field is important for the development of interactive on-body technologies that leverage a human-centered approach. Design-based approaches and tools such as Human-Centered Design (HCD), Design Thinking and Design Fiction can offer a viable basis for this exploration, while a reinterpretation and combination of these might be useful in future design developments in the research area of Human Augmentation. In particular, the topic offers interesting opportunities for design-based intervention with regard to the development of wearable and integrated interfaces that can restore or enhance cognitive and sensorial abilities that are not immediately associated with functional user needs, such as biological capabilities that are innate in humans and might be weakened or extinguished. Through theoretical research and practical experimentation, the intersection of Design Research and Practice and Human Augmentation will be investigated with the aim of offering a contribution to the discussion and development of the matter in the perspective of human-centered augmenting technologies.

Author keywords

Human Augmentation; Design Research; Design Science; Wearable Computing; Human-Computer Integration.

Introduction

Human Augmentation, also referred to as Human 2.0, is the set of practices and disciplines that focus on creating cognitive and physical enhancements as an integral part of the human body, aiming at assisting, substituting or augmenting human capabilities through technology. These interventions usually involve senses (e.g., vision and hearing), physical mobility (e.g., strength, speed and agility), and cognition (e.g., memory, creativity and learning ability) (Raisamo et al., 2019; Huber et al., 2018). Improving and enhancing human capabilities are practices that have been characterizing the evolution of human development since its early stages (Alicea, 2018), but today they are gaining new significance in a context of rapid technological advances.

Human Augmentation is a relatively novel area of research, with an ongoing discussion about its ethical and social implications (Oertelt et al., 2017, Caon et al., 2016), as well as its legitimacy in redefining the concept of the human body, particularly in relation to disability studies (Bose, 2014). The number of scientific contributions and technological development to Human Augmentation has been increasing over the years, with applications ranging from industrial to medical contexts (e.g., exoskeletons, supernumerary robotic limbs, advanced prosthetics, Brain-Computer Interfaces and Augmented Reality Head-Mounted Displays).

Current examples of human-augmenting applications are mostly resulting from a technology-centered perspective on Human Augmentation, with contributions to knowledge and development deriving especially from consolidated research fields such as Computer Science, Engineering and Robotics (Guerrero et al., 2022). With a market growth expected to reach $341.2 billion by 2026 (Markets and Markets, 2022), the increasing demand of human-augmenting products is leading to a consequently growing need for novel frameworks for designers and practitioners working on the design and implementation of these new product typologies (De Boeck & Vaes, 2021).

Human-human and human-environment (whether natural or artificial) interactions mediated by technology prove to be particularly important from the perspective of extending human perception and cognition (Schmidt, 2017). This deserves specific attention when this relationship is lacking (e.g., disorientation, decreased proprioception), is framed within new contexts (e.g., virtual reality environments) or surpasses the natural limits (e.g., sensing the magnetic north).

While substituting or assisting temporary or permanent impairments translates into addressing immediate user needs (such as functionality and usability), augmenting humanity beyond its natural limits could be separated from

solving everyday problems. With this assumption, design tools and methods encapsulating future-oriented approaches are needed (Kymäläinen et al., 2016). This involves redefining what is intended for "user needs", which can be not related to providing solutions to specific issues, but rather to building new ways of being human with cyborg sensing abilities (Ramoğlu, 2019).

Objectives

The research aims to find new design opportunities for Human Augmentation that improve users' sensorial and cognitive wellbeing. These will focus on enhancing human characteristics and rebuilding the relationship between humans and their natural abilities using technology, to facilitate human-human and human-environment communication and interaction.

The research will focus on the opportunity for advancing knowledge in the intersection of Design and Human Augmentation, with the aim to offer a systematization of findings about existing human-augmenting products from a design perspective (especially regarding processes and methods) by analyzing case studies, in order to support the development of the research area towards Human-Augmenting Product Design.

The dimensions of this research are both theoretical and applied. On the one hand, it will focus on the acquisition of theoretical knowledge in the disciplines of Design and Neuroscience through the survey of relevant literature and the direct involvement of target users, companies, research organizations, designers and communities of practice involved in the development and use of technological products for cognitive-sensorial augmentation. On the other hand, the knowledge gained will be subject to experimentation through the design and prototyping of wearables, with possible testing being carried out in relevant environments or scenarios of use. This is expected, consequently, to serve as a basis for the advancement of new knowledge useful to the construction of design guidelines for human-augmenting products.

Moreover, the research will involve users with limited sensory-cognitive abilities, following a participatory design approach, to identify possible needs and expectations. The study will include action-research moments through the involvement of designers and non-designers for brainstorming and prototyping. The goal is to provide designers with a tool for designing technological products that can improve human-human and human-environment interaction, with a view to scalability of the principles thus defined with regard to users with different cognitive-sensory abilities. The research work has the overarching goal of offering a contribution to the topic of Human Augmentation through Design Research and Practice, with the aim of establishing a conversation in a shared development perspective with research groups, universities and communities of practice in order to bring useful outcomes to end users, designers and companies operating in the field.

Methodology

Given the multidisciplinary nature of the research project, the investigation methodology will first be oriented towards desk research of Human Augmentation applications in the field of Product Design, for the construction of a mapping of existing solutions and their technological and User Experience characteristics. Next, the research will cover the field of Neuroscience aiming at building a solid knowledge base that can be useful to designers who are called upon to design increasingly immersive and user-friendly experiences. This will be followed by an action-research phase through moments of participatory design and rapid prototyping to analyze possible desirable future directions of Human-Augmenting Product Design.
In particular, the research will be structured in the following phases:

Phase 1

- Survey of the state of the art of Human Augmentation products (analysis of technological features, User Experience and design processes and methods) through a collection of case studies, experiments and practices;
- Review and analysis of Design Research contributions to the field;
- Mapping of domestic and foreign research centers and universities working in the field of Human Augmentation.

Phase 2

- Survey of scientific research in the field of Medicine and Health (and related) pertaining to diseases or conditions related to the impairment or lack of sensory and cognitive abilities;
- Benchmarking of medical rehabilitation companies and survey of technologies used.

Phase 3

- Design and prototyping of products dedicated to cognitive and sensory Human Augmentation according to a human-centered design approach;
- Experimentation of prototypes and construction of a report on the results.

Phase 4

- Building of guidelines and a framework for design intended for designers, companies and manufacturers operating or willing to operate in the field of Human Augmentation.

Expected outcomes

The methodology and phases of the research will serve for the production of deliverables that can crystallize the knowledge gained in each step, with the aim of sharing them in the form of multimedia materials, both digital and tangible.
In particular, the expected outcomes will involve the following results:

- Offering a comprehensive understanding of the state-of-the-art of Product Design for Human Augmentation, providing a review of the literature, case studies and experimentations, while building an international research network focused on the study and implementation of human-augmenting technologies;
- Offering an overall understanding of the needs and solutions related to cognitive and sensorial issues, providing a review of the literature in the matter of assistive technologies and a report of interviews and on-field observations;
- Applying the knowledge to guide experimentation in an international workshop for Human Augmentation Product Design;

- Transferring knowledge through guidelines and design frameworks.

In conclusion, this research work aims at supporting the involvement of Design Research and Practice in the field of Human Augmentation, with a focus on methods, tools and processes in the perspective of exploring and designing for the augmented needs of humanity.

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A conception toward design narratives for innovation

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Abstract

Narrative has increasingly come to the forefront of both design and innovation management fields due to its essential properties which comprise both a human cognitive process (Polkinghorne, 1988) and a mode of communication (Fisher, 1985, 1987; Bruner, 1986). However, cross-disciplinary arguments among design studies and innovation management from the narrative point of view are yet unexplored, even though their essential importance and potential for impacting innovation. Therefore, this paper aims to conceptualize a theoretical framework of "Design Narratives for Innovation". Based on the approach to building a theoretical framework in qualitative research (Anfara Jr, et al, 2015), the building blocks of the theory are carefully investigated and constructed. Through interdisciplinary conceptualization among design studies, innovation management studies and narrative studies after the contextual review (Gray and Malins, 2004), the conception is precisely stated; that is "the Design Narratives (DN) as worldmaking can facilitate and coordinate the design innovation process of co-evolution of problem and solution". The theoretical framework can perform as "analytical and interpretative framework that helps the researchers make sense of what is going on in the social setting being studied" (Mills, 1993). Then, this theoretical framework can also guide "the way in which you think about, collect, analyze, describe and interpret" the data in the qualitative research, which the researcher plans to conduct as the sequential research activities.

Author keywords

Design narratives; Innovation narratives; Worldmaking; Innovation process, Design process

Introduction

Narrative has increasingly come to the forefront of both design and innovation management fields due to its essential properties which comprise both a human cognitive process (Polkinghorne, 1988) and a mode of communication (Fisher, 1985, 1987; Bruner, 1986). As a "linguistic turn", narrative has been studied as a theoretical view and tool in organizational studies, strategy, innovation, and entrepreneurship (Barry and Elmes, 1997; Bartel and Garud, 2009; Boje, 1995; Lounsbury and Glynn, 2001). However, research on narrative in management has mainly emphasized the company's perspective, largely overlooking the potential counterpart, design, as a key interpreter of the company's narrative (Zurlo and Cautela, 2014). As Bartel and Garud (2009) have stressed, in the context of the innovation process, narrative facilitates coordination among different participants by enabling translation. In this sense, design, as a counterpart of the company's narrative, can play an important role in coordination through creative practice (Lloyd and Oak, 2018; Zurlo and Cautela, 2014).

The Ph.D. research aims to explore how design narratives can have a deep impact on the innovation process. In this short paper, the author builds a conceptual framework to analyze the mechanism of design narratives in the innovation process. This framework intends to be a basic analytical lens for the consequent qualitative analyses in the Ph.D. research path.

CONTEXTUAL REVIEW / THEORETICAL FRAMEWORK

Contextual review and problematizing the central phenomenon

The theoretical framework is based on the growing argument of narrative, which has been significantly nurtured and critically analyzed in both design and management disciplines over the last decades.

In management studies, "linguistic turn" has a long tradition. In organizational studies, narrative has directed several principal research areas such as sensemaking, communication, politics and power, learning/change, and identity (Rhodes and Brown, 2005). Similarly, many scholars in strategy have investigated the narrative perspective, especially in the fields of strategy as practice and strategic change (Barry and Elmes, 1997; Brown and Thompson, 2013). During the past ten years, the growing interest in the innovation and entrepreneurship processes has attracted focus on the relationships between narratives and innovation, and between narratives and entrepreneurship (Bartel and Garud, 2009; Lounsbury and Glynn, 2001; Maclean et al. 2020).

Meanwhile, in design studies, narratives and storytelling have been widely researched with respect to creative and design processes, strategies in productive contexts, participatory design processes, and narrative experience by produced artifacts (Ciancia et al., 2014; Grimaldi, 2018; Lloyd and Oak, 2018; Turner and Turner, 2003; Zurlo and Cautela, 2014). Especially in a company's productive context, Zurlo and Cautela (2014) argued that designers can be considered as "hub-narrators" who are part of the interconnection between the so-

cial-cultural models expressed by the consumption communities and the material production models organized by the companies. These are essential abilities and can potentially amplify, multiply, translate, or change a narration. Therefore, this series of arguments on narrative and storytelling in design studies can potentially release the capacity of the company's innovation process regarding the innovation narrative argument in business studies.

The importance of the relationship between the innovation narrative and a designer's narrative role has been pointed out in design studies (Zurlo and Cautela, 2014). However, the mechanisms of how the design narratives can play their role in the innovation process have been yet overlooked. This Ph.D. research aims at filling this gap: how can design narratives have a deep impact on the innovation process. This gap exists between the extant literature on narrative in management and design studies. Addressing this gap can help us investigate the central phenomenon (Creswell, 2012) to be investigated through the qualitative research method: the narrative usage by design in the innovation process.

Constructing the conceptual framework to look at the central phenomenon

The main assumption is that the Design Narratives (DN) can deeply affect the innovation process. To tackle on the problematized central phenomenon above, a conceptual framework should be constructed as a theoretical lens to approach the phenomenon. Through interdisciplinary conceptualization among design studies, innovation management and narrative studies after the contextual review (Gray and Malins, 2004), the main premises and assumptions are interwoven as followings.

Premise 1: Design as discursive activity

The first premise is related to the perspective on the design activity. One of the difficulties in understanding design is its multifaceted nature. There is no single way of looking at design that chapters the "essence" without missing some other salient aspects, therefore, conceptual design should be considered as a way of "seeing as" (Lawson and Dorst, 2013). In this research, as looking towards the design process from narrative view, there is validity and rationality to rely on a specific perspective of "design as discursive activity"(Dorst, 2006). In this mode, instead of assuming design as problem-solving paradigm, it describes the design as the resolution of paradoxes between discourses in a design paradox. Historically in design studies, many scholars have indicated the perspectives of design as a discursive view (e.g. Schön, 1983; Lloyd, 2000; Bolanda and Collopy, 2004). In parallel, this perspective also overlaps with the series of arguments of business management fields regarding "narrative turn" which emphasized on the perspective of viewing phenomena from narratives and discursive views (e.g. Barry and Elmes, 1997; Rhodes and Brown, 2005). Therefore, this study relies on the perspective of "design as discursive activity".

Premise 2: Narrative as worldmaking

The second premise is based on how to define the term of "narrative". Several essential aspects of this study are needed to be taken into consideration; (1) to aim to explore and build the theoretical foundation of Design Narratives (DN) as a study type of basic research, (2) to rely on the world view of social constructivism (Berger and Luckmann, 1967) and interpretivism, and (3) to tackle on cognitive and social constructing aspects of the central phenomenon of the roles of Design Narratives in design innovation process. Here, the essential theoretical development by narrative scholar David Herman (2013) has validity and reliability to be chosen as the basement of this study; namely, "narrative as worldmaking". Herman (2013) theorized the concept of narrative as "worldmaking" through a transdisciplinary approach to storytelling and the sciences of mind. The idea of narrative worldmaking is a central heuristic framework and the hallmark of narrative experience, the root function of stories and storytelling that should therefore constitute the starting point for narrative inquiry and the analytic tools developed in its service (Herman et al., 2012). Herman et al. (2012) underlines that to focus on narrative worldmaking studies how storytellers, using many different kinds of symbol systems prompt interpreters to engage in the process of co-creating narrative worlds. Herman (2013) suggested two-side approach to narrative worldmaking; narrative as a target of interpretation-Worlding the story- as well as narrative as a resource for sense-making – Storying the world. Thus, this study relies on the definition of narrative as worldmaking with the two-side approach from narrative studies, especially from the nexus of narratology and mind.

Conceptual component 1: Design Narratives as worldmaking

Based on the two premises above, one of the core conceptual components – and the central concept of this research - can be set; "Design Narratives (DN) as worldmaking". This concept is the central proposal of this research to be precisely explored and investigated through whole the series of following research activities. In the Ph.D. research, narratives by design are considered as a worldmaking mechanism, which is composed of two-side conceptual components of "narratives as a target of interpretation" and "narratives as a source for sense-making" especially from "design as discursive activity" viewpoint.

Conceptual component 2: the design innovation process as co-evolution of problem and solution

Meanwhile, the design process or innovation process regarding design should be defined as a part of the essential components of the theoretical framework. Here, the first premise of "design as discursive activity" provides a firm basement for the argument. Dorst and Cross (2001), underlining this perspective, insisted on the model of "co-evolution of problem and solution". This model emphasizes the specific aspect of discursive view that the co-evolution is facilitated with interchange of information between the two spaces. In conclusion, there is certain validity and rationality that this study views design process or innovation process by design as "co-evolution of problem and solution" from "design as discursive activity" viewpoint.

The conceptual framework

Consequently, the conceptual framework can be elaborated with the two core conceptual components based on the previous two premises. The main assumption is precisely updated; that is the Design Narratives (DN) as worldmaking can facilitate and coordinate the design innovation process of co-evolution of problem and solution. To visually simplify this assumption,

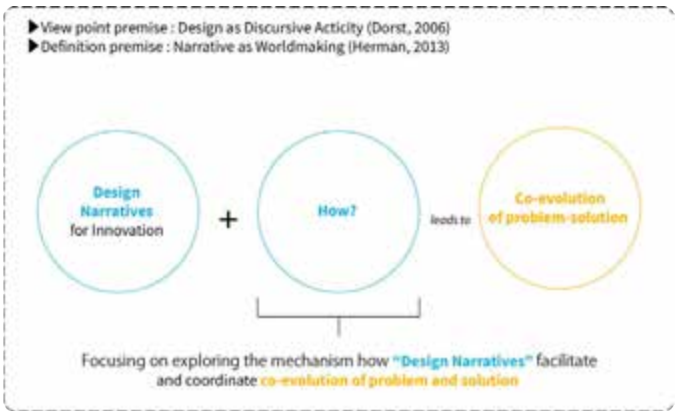

Figure 1. Visualization of the logic structure of the PhD research.

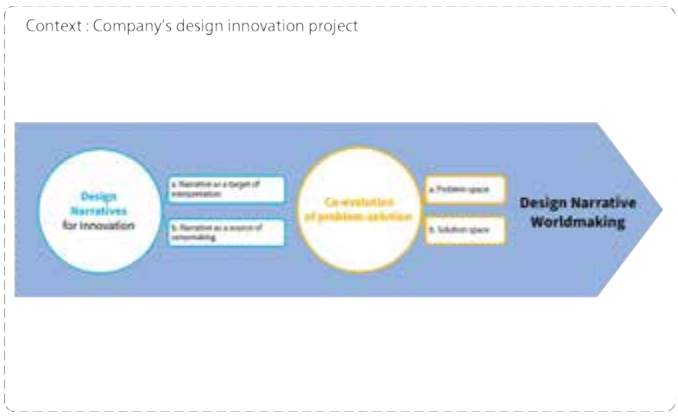

Figure 2. Construction of the conceptual framework to look at the central phenomenon.

figure 1 represents the logical model as well as figure 2 shows a visual representation that the research focuses on.

Conclusion

This paper proposes a theoretical framework of design narratives for innovation, based on contextualized and problematized research gaps (Gray and Malins, 2004). The framework can perform as an "analytical and interpretative framework that helps the researchers make sense of "what is going on in the social setting being studied" (Mills, 1993). It can also guide "the way in which you think about, collect, analyze, describe and interpret" the data in the qualitative research. Especially, since the research gap is transdisciplinary, researchers need an appropriate compass to explore the social setting and the central phenomena. In this vein, the constructed framework-based on the core idea of "narrative as worldmaking" interwoven by narrative scholar Herman (2013)- is significantly meaningful; because Herman's idea was generated from a transdisciplinary approach to "foster a more open dialogue between narrative studies and related fields such as social, cognitive, and ecological psychology, linguistics and semiotics, communication theory, ethnography, artificial intelligence and robotics, the philosophy of mind, and other areas that fall under the umbrella field of cognitive science" (Herman, 2013). Combining with another assumption of the design and innovation process as "co-evolution model", the theoretical framework of "design narratives as worldmaking" can not only perform as a compass of the qualitative research but also can stimulate further research in the areas which is important but yet unexplored to be needed investigation (Anfara Jr et al, 2015).

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Home away from home – the role of design methods in processing trauma of forced migration and loss of place

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Introduction

If design has such an interdisciplinary and diverse methodology, why couldn't we use it also to support the complex challenge of recovery from trauma? While there are several studies about the positive effects of occupational therapy (OT) (Reed and Sanderson 1999, Kashner et al. 2002, Resnick and Rosenheck 2008, Creek 2010, Desiron et al. 2011) and art therapy (Reynolds et al. 2000, Slayton et al. 2010, Haeyen et al. 2020), the potentials of design in therapeutic work is still only at the beginning of its discussion (Illarregi et al. 2022, and Meinel 2014).

Since January 2013, the author has been working with young refugees and asylum seekers as a volunteer of a Hungarian association called Útilapu Hálózat, where she founded the Open Doors working group with her graphic designer partner, Ágnes Jekli. Open Doors was created with the aim of using the methodology of participatory design to improve the integration opportunities of young refugees and to support intercultural dialogue.

The research is going to introduce the connecting point between the process of recovery from trauma and the process of design in order to prove that design has a relevance in trauma therapy. It aims to find connections between migration studies (1), trauma studies (2) environmental psychology (3) and design methods (4) in order to develop the base methodology of "design therapy" and by that a new approach to support processing the trauma caused by forced migration.

Method

The research process relies on three methods. The first is a review of the relevant literature in order to create the context: the psychology of migration and the nature of trauma, material culture and cultural anthropology, symbolism, psychology and, within that, environmental psychology. The second is in-depth interviews with young adult forced migrants, which had 4 focus: the objects and material culture (1), the topic of the place called home (2), the public places for encounters (3) and the wider geographic places like the city of Budapest and Hungary (4). The third is the author's 10-year fieldwork experience, including creative workshops and projects with refugees, as well as consultations with professionals working with refugees.

The in-depth interviews respecting 5 main conditions to filter the population. The first condition was that all the interviewees have to consider themself as forced migrants: their migration happened by push factors and their life was in danger. The second condition was that the interviewees had to be between the ages of 18 and 40. The third condition was for all the interviewees to be born outside Europe: all the members of the population experienced extreme culture change. The fourth was that all the interviewees already lived in Europe for at least two years, including at least one year in Budapest: it means that all they already have a general experience about Europe and Budapest by everyday life. The fifth condition was that they already have a residence permit and/or recognized refugee status: their protection is legally guaranteed. During the interviews, an interactive model was followed (Creswell and Creswell 2018). By the interactive method the goal was to overcome language barriers and to avoid confusion by one-sided conversations. The challenges of language barriers were supported by visual games and tasks (pictures, maps, drawings). By dialogue and visual games, an informal and deep conversation could develop.

The research also relies on the author's 10 years of field experiences, which she gained in the home of unaccompanied minor refugees in the Childcare Center of Fót, in other adult detention centres in Hungary, as well as international study visits in Switzerland, Belgium and Palestine. She facilitated short (half to 1 day) creative workshops, and long (1 week to 3 months) design themed projects. The short workshops include such as textile silk printing, bookbinding, furniture renovation, and mural painting. During the long-term projects, several indoor and outdoor public spaces were designed and renovated, also media (photo, video) training and placemaking design camp. Regardless of whether we are talking about short workshops or long projects, the goal is always to involve young people in the designing and implementation process so that they can make their own decisions, acquire new competencies, develop their creative problem-solving skills and also develop community. The experiences gained in the field are complemented by ongoing consultations and discussions with professionals working with refugees (psychologists, teachers, social workers, project coordinators). The experience and results of the 10 years were documented in the form of photos, videos and diary entries. (Sztompka 2009)

The psychology of migration and the trauma of loss of place

Forced migration is a traumatising event. (Silove et al. 1997) The traumatic reaction occurs when the self-defence system is overloaded and stops functioning: the individual can neither fight nor escape (Herman 2015). The traumatic events of forced migration are the push factors (war, persecution, disaster), the experience of multiple losses (of loved ones, home, possessions and existence) and the change of one's culture in the new environment (Hautzinger et al. 2014).

Migration generates cultural changes for both the migrant and the host country. (Horvát-Milityi 2011) Upon arrival in a new society, the migrant loses the gestures and codes that help our problem-solving ability in social contacts. (Croatian Militancy 2011) As a result of torture, the victim's personality is damaged, and an emotional vulnerability develops: a large proportion of victims show signs of post-traumatic stress syndrome (PTSD). (Silove et al. 1997) Traumatic events create profound changes in physiological arousal, emotions, thinking and memory, and they can even disconnect these normally integrated functions. People who have experienced trauma feel and act as if they are detached from the present: their perception becomes inaccurate, their present is dominated by intense fear, helplessness and loss of control.

Restoring control of the traumatised person is now a primary goal. (Kardiner, Symonds, Strak, Flitcraft) The recovery process consists of 3 stages, but it does not have a linear line. The first stage is to ensure the safety of the survivor. In the second the survivor recalls and tells the memory of his trauma and mourns the losses: by this the memory can be integrated into the person's life. In the third stage the survivor must create their own future, form a new self, establish new relationships, and find new faith. (Hermann 2015)

People form emotional bonds with the environment they live in and use (place attachment), and these meaningful places develop over time into a part of the person's self-definition (place identity). (Dúll 2009) There is a consensus that place attachment develops because the place enables "the expression of action control, creativity and competence". (Dúll 2009, 133) Acquaintance and activity with a place create place attachment, social actors, possession, sense of security and self-determination play an important role as well. (Dúll 2009, 239) "The forced abandonment of an important place breaks one's sense of continuity, thereby separating the two close components of identity: spatial and group identity." (Fried 1963, cited by Dúll 2009, 122)

Design therapy - the structured development of place attachment

This research explores the connection between the loss of space and design. While the response to trauma is to restore the individual's independence (1) and control (2), in the case of loss of place, meaningful places must be found (3) and place attachment must be developed (4): we must find connection to these needs in case we want to use design for recovery. This research considered design as the process of planning.

Design Thinking (DT) constantly and methodically keeping the users' points of view in the centre (Human Centred Design). The strength of the non-linear process is that it is possible to return to earlier stages and develop the project with new experiences. It does not use general problem-solving schemes, but starts from the currently established context based on cognition. It can be used in cases where there is no previous knowledge. (Brown 2009) Design and creativity are inseparable. (Taura and Nagai 2011) Given that design is nothing more than a process of creative problem solving (Brown 2009), we can acquire a well-structured coping pattern through it.

Based on both the above and the author's observations, victims must become part of the design process in order to gain access to all its benefits. Participatory design turns the usual roles upside down and expects the user to create the context, find connections, make decisions and test the final result. In this case, the designer takes on the role of facilitator to support the participants in navigating their own path and solving their own challenges. (Armstrong and Stojmirovic 2011) The author of this article has been using participatory design for 10 years with young refugees. According to the professionals working with them, thanks to the design sessions, the refugees started to work in a community, they started to personalise their rooms independently, and participation in the programs was a motivation for them. Many refugees remember these projects years later as supportive activities that helped them focus on the present moment against the past and which broke their isolation.

According to these results, design process can be relevant for therapy work in five ways. Trauma deprives the victim of a sense of power and control, while design encourages participants to take initiative, carry out plans and make decisions on their own. (1) Flashbacks of traumatic memories keep the victim in the past, while working on design process makes participants focus on the present. (2) Trauma creates helplessness, design process calls for action. (3) Traumatic events question the most basic human relationships, design process develops collaborative skills in the frames os teamwork. (4) Trauma paralyses, while design process results in concrete actions. (5) Design processes play a role in all three stages recovery. The safe environment must be created with the active participation of the victim. In the second, non-verbal tools of design can help restore memory, while the mourning process can be improved by the development of self-expression. In the third, creative problem solving can positively influence all areas of life, be it the continuation of studies, employment or connection to mainstream society. In the case of people traumatised by loss of place, it is recommended to include the aspect of place attachment and place identity in the therapeutic process. (Dúll 2009) We have previously clarified the conditions necessary for the development of place attachment and several are guaranteed during the design process: we can talk about action control (as a result of decision-making), creativity (brought to life in the entire process), ownership (by the product of the process), and the experiences and memories (experienced during the whole process).

Next steps

The intent of this practice based PHD research is to explore the connections between migration studies (1), trauma studies (2) environmental psychology (3) and design methods (4) in order to develop the base methodology of "design therapy" and by that a new approach to support processing the trauma caused by forced migration. Based on the results so far, it is relevant to investigate the therapeutic possibilities of design. More examination is needed about conditions of place attachment that cannot be clearly developed by any design process,

like: local knowledge, activity with the place, the community, the process of adaptation, security and personalization. Furthermore, it is advisable to examine the different scales of place attachment (geographic spaces, public spaces, private spaces, objects) in order to clarify the design processes aiming them. The author is working on a design therapy toolkit. Her goal is to collect those active tools (workshops, training) that can be associated with the design process to serve the therapeutic process of forced migrants and other populations who experienced the loss of place and home (children in state care, homeless people, prisoners ect.). The target group of the results will be professionals (social workers, therapists, educators, youth workers, NGOs) working with people who experienced the loss of place and home.

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Decoloniality and healing: confronting inter-generational trauma/ideologies through architectural preservation and education

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Abstract

Historic architecture is often preserved as tangible history that is useful for assessing flawed histories. However, in the case of British Colonial Bungalows, they are continually destroyed. Lagos, Nigeria, for example, was one of the most prominent cities from Nigeria's colonial era due to its role as the main administrative base for colonists in the country at the time. Today, Lagos –currently the country's commercial capital– faces capitalist pressures linked to accelerated development. This has come at a price to its historic urban fabric. Lagos is a rather small coastal state/city, and the need for viable land space continues to balloon. In recent years, this has ultimately led to the destruction of British Colonial Bungalows for the development of newer building projects and infrastructure.

Even though Nigeria has somewhat embraced this residential architectural typology by means of replicating its design principles as neo-colonial residential architecture, the country has ironically continued to turn a blind eye to the destruction of the original bungalows from its colonial era because of their links to the country's traumatic colonial past. This is despite the fact that these buildings hold rich primary evidence and teachable history. Backing reasonings behind the replication of design principles, but a sense of apathy towards the preservation of original British Colonial Bungalows in Nigeria is highlighted by architectural historian, Cordelia O. Osasona, in her write-up *Colonial Architecture in Ile-Ife* (Osasona, n.d.). In "Nigerian Architectural Conservation: A Case for Grassroots Engagement for Renewal," she points out that although apathy to historic preservation in Nigeria is a commonplace mindset, it is only seen as acceptable when it does not facilitate the idea of unprogressiveness (Osasona, 2017).

Moreover, Osasona also notes how failures are still encountered even when preservation efforts are attempted, by suggesting that these failures are due to knowledge gaps about how to facilitate historic preservation practices, logistical, financial, and ideological limitations in Nigeria. Although this reasoning could be agreed upon to an extent, a counterargument notes that Nigeria already has developed policies to safeguard material, as well as non-material heritage by means of its *National Commission for Museums and Monuments Act* (National Commission for Museums and Monuments, 1990). But, as is also commonplace in Nigeria, policies have a high likelihood of failure, owing to the disconnect that exists regarding how the Nigerian government as well as its agencies' work with the country's public (Peter, M. & Philip, D., 2013).

Considering these points, the proposed research seeks to develop strategies to preserve British Colonial Bungalows in Nigeria, while acknowledging the ongoing apathy that exists toward preservation in the country. It also seeks to develop ways to use these residential buildings as an educational tool for younger generations to confront and evolve beyond post-colonial trauma. This assertion reinforces the idea that as we care for architecture, it can, in turn, help us heal.

The approach for conducting this research would mainly be centered on qualitative research methodologies including historical and phenomenological observations, as well as comparative analyses that would then be used to inform policy and transition design-based interventions that are linked to preservation and adaptation.

Author keywords

Architecture; Design; Policy Recommendations; Post-Colonial Trauma; Preservation; Stakeholders

Background

Intergenerational trauma is a terminology that is used to describe generational challenges that are experienced in families. This kind of trauma often results as a translation of trauma from specific historical events (Duke, n.d.). The normalization of exploitative ideologies that are linked to traumatic histories—such as colonialism across generations—is an example of how intergenerational trauma can present itself. Colonialism can be described as the domination of people by means of subjugation (Kavita & John, 2017). And, when examining colonial histories in countries, the British Empire provides a prominent and relatively recent example of this phenomenon, which spanned several continents, including Africa. It also provides an example that sheds light on mechanisms of oppression as well as their adverse impacts that have continued to become more evident across generations.

The built environment is often a useful tool for examining a country's history and national identity. In Nigeria, British Colonial Bungalows are artifacts from the country's colonial era, which help to establish a theoretical framework that highlights colonial influence in Nigeria before and after its independence.

As homes can be attributed as being starting points for the human development of ideological principles and beliefs, examining these bungalows in Nigeria is useful to establish a nexus for assessing flawed colonial-era ideologies and inter-generational trauma which have continued to linger and have been normalized by Nigerians to date. And, by preserving these buildings, they are able to act as a continuous reminder to avoid repeating generational mistakes.

To develop a broader analysis that would then be used as a steppingstone for facilitating this research's agenda, some questions that would be helpful to examine include:

- How is the British colonial legacy understood across different generations prior to and after Nigeria's independence in 1960?
- What is the state of the existing colonial architectural fabric in Nigeria, specifically the Colonial Bungalows?
- How can the sense of apathy regarding efforts at preserving and learning from colonial history-using Colonial Bungalows as a focal point in Nigeria- be mitigated?
- How can policy and architecture facilitate sustainable long-term historic preservation within coastal states like Nigeria, in a manner that acknowledges the expanding risks posed by climate change?

Data Collection

Data collection for this research plan would be centered on the following:

- *Historical & Archival Research:* To fully comprehend the dimensions that are necessary to promote the premise of this paper, one must examine the existing landscape and challenges that are related to this discourse through historical/archival data. This archival data would include works from the International Center for the Study of the Preservation and Restoration of Cultural Property (ICCROM). In addition, existing historic literature as well as photographic documentation from The National Archives, UK would also prove relevant. This phase of historical data collection would occur during the Fall and Summer of the 1st year of this proposed research plan and would be used to inform a historical literature review and other short pieces. In addition, literature on resilience, policy, and historic preservation in relation to architecture will also be examined during the summer of the 1st year and 2nd year of this research plan. This would be used to produce further background information, also through literature reviews and short pieces.

Figure 1. Sample Ph.D. Timeline

- *Phenomenological Observations/Surveys:* Insights from human subjects would play a pivotal role in this research. However, prior to initiating research that involves humans, IRB (Institutional Review Board) approval would first be required, and this would be initiated during the Spring semester of the 1st year of this research plan. A representative group of Nigerian citizens in Lagos will act as the unit of analysis for this study, using a survey and interviews. Links to the survey for this proposed study will be dispersed through text messaging with the assistance of a survey company and the Lagos State Land Ministry, which holds contact records of property owners/residents in Lagos. This use of a survey would allow for the anonymity of respondents but also allow them to indicate their interest in partaking in subsequent in-depth interviews.

Lagos, Nigeria's densest city acts as a relevant location for human subject data collection because the city holds prominent significance in Nigeria. It was one of the earliest British colonial settlements in Nigeria; was also the country's first Federal Capital Territory; is currently Nigeria's commercial capital and has Nigeria's most diverse populace being the country's melting pot. Surveying would be developed as cross-sectional, and focus on three sample population groups:

1. Nigerians who reside in Ikoyi, Lagos,
2. Nigerians who reside in Ikeja, Lagos,
3. Nigerians who do not reside in these areas.

Ikoyi and Ikeja were selected as groups to focus on since they are both prominent hosts of several of the remaining British Colonial Bungalows still present in Nigeria. Selecting Nigerians who do not reside in these areas for this research as well would be helpful to give a representative sample of perspectives on the views of apathy towards the preservation of colonial artifacts in Nigeria. The goal of this phase would be to collect 50 responses from each group totaling 150. 10 participants from each group would also be selected from each of these three groups to conduct in-depth interviews. This work would be developed over the course of the Summer of the 3rd year and the Fall of the 4th year of this proposed research.

- *Fieldwork:* Depending on the potential risks to participants that would partake in phenomenological observations and surveying, fieldwork that is focused on comparative analyses of the British Colonial Bungalows within Nigeria, as well as those in similar post-colonial contexts would be considered as an alternative means of data collection. Ikoyi and Ikeja, Lagos, Nigeria would be of particular interest when conducting fieldwork for this study. This is because they are both prominent areas that host the remaining British Colonial Bungalows that are still present in Nigeria. They have histories of being dense colonial residential areas during the British colonial era in Nigeria. Comparing these British Colonial Bungalows with those in cities from other British post-colonial contexts like Singa-

pore, India, etc. would allow for the assessment of similarities and differences among them, as well as areas where proposed research interventions–from the Nigerian context–could be replicable.

Outcomes/Research Interventions

The final output of this research will be a dissertation that includes a collection of short written pieces—including literature reviews and case studies. It will also include an accompanying visual exhibition during the 5th year of the research plan to promote ease of engagement and encourage interaction with research findings. Since existing challenges to the premise of this research are focused on interdisciplinary schools of thought centered around architectural history, and policy, as well as challenges linked to the fields of education, resilience, and historic preservation, this proposed research would help to establish interdisciplinary discourses regarding the role of architecture and education for addressing inter-generational trauma that has resulted from British Colonialism. Moreover, this research would also be useful for contributing to future theoretical discourses on the impacts of British colonialism, especially in Africa. This is because to date, the topic is still largely under-researched, and the existing information that can be obtained is mainly from western/westernized voices.

Moreover, the challenges posed by the apathy of Nigerians towards preservation provide a significant opportunity to assess the impacts of colonialism in Nigeria that led to this commonplace mindset while harnessing inclusive cultural, technological, policy, and design-focused strategies to tackle them through preservation and adaptation. With the aid of the responses gathered throughout the course of this proposed study, research interventions would include the following:

- *Policy Recommendations:* Government-issued policy interventions and effective implementation strategies are relevant for ensuring the successful preservation and restoration of historic/cultural property. Analyzing the context behind apathy toward preserving colonial-era architecture in Nigeria, and the root causes of policy failures in Nigeria would allow for the creation of effective context-specific policy recommendations to be implemented in Nigeria. These recommendations would focus on addressing existing challenges to preservation policy implementation in Nigeria, and steps to be taken within its educational sector to encourage learnings on the legacy of colonial history, as well as the importance of preserving colonial artifacts as a learning tool for future generations. These recommendations would also act as a framework for other post-colonial contexts with similar challenges that are related to confronting and learning from the British colonial legacy.

- *Transition Design-Based Interventions:* Transition design acknowledges that we are currently living in transitional times that prompt the need for societal transitions to more sustainable futures. This understanding is relevant for solving wicked problems like issues linked to climate change. The most prominent cities in Nigeria that still hold the remaining colonial bungalows from the country's British colonial past are along or close to the country's coast. Examples of these areas include Lagos and Ile-Ife. Considering that, this proposed study will also focus on developing design-based solutions. These solutions will not just center on the adaptive use of these buildings to act as a learning tool, but will also include strategies to make Nigeria's urban fabric, in general, resilient to climate change-instigated risks of natural disasters.

Conclusion

Beyond the scope of this research, understanding and developing solutions to resolve the trauma caused by colonialism in Nigeria – through the lens of British Colonial Bungalows and their symbolic legacy – can be advantageous when tracing other British post-colonial contexts with similar challenges where this building typology still exists. This provides an opportunity to replicate solutions to issues like those to be examined in Nigeria, within other related contexts. The British Colonial Bungalow not only holds a key for piecing together a long line of material, cultural, historical, and architectural heritage that has transcended continents, but it also provides an opportunity to echo a sense of healing from the trauma that they represent to diverse contexts because of these links.

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The ephemerality of an organic material and its implications: a context-specific study with Invasive exotic species (Japanese knotweed) waste in Genk, Belgium

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Abstract

"Our thinking is not prepared to face existence, to face the infinitude of the finite, to live and think from the medium" (Marder, 2016).

We, as humans inside of a human centered system called Anthropocene are constantly facing our own individual limitations. If we want to improve our relation with our own ecosystem, to live life together in harmony, in collaboration and with respons-hability (Haraway, 2019) we have to start thinking from the outside, de-centering linear systems and understanding round cycles and us, as part of a whole. In this occasion, we propose a nature centered design experience, experimental, artistic, and intuitional research focused on the reuse of invasive species plant waste from the Japanese knotweed applied to an artistical-experimental material research, in a specific area of Belgium, a different research space than usual. Our conclusions will focus on the sensitive and emotional characteristics of the resulting material, proposing its ephemerality and fragility as a communication tool that promotes circularity.

Under the title 'What doesn't belong here', the collaboration between the PhD student Antía Iglesias from the University of Vigo in Spain, and the research group Inter-actions of the LUCA School of Arts, campus C-mine in Genk, was born. This collaboration focused firstly on the interactions between non-human agents and design processes, taking as starting point Iglesias' main thesis, the reuse of waste derived from Invasive alien species applied to creative practice; aiming to decentralize human-centered design, looking for the creation of a material prototype.

Introduction

What follows is a description of a research experience carried out from March to June 2022 in Genk in Belgium. First weeks of the research stay were used to get to know and comprehensively understand the new working environment and its possibilities. Previous works of the host research group were already focused on the Japanese knotweed (JK) plant species. The publication *Not in my backyard!* is a compendium of the research carried out in the specific course 'Shifting grounds', part of the Product Design master's degree at LUCA School of Arts. Its, and our approach, was focused on working in collaboration with, or becoming-with (Haraway, 2016) the invasive species Japanese knotweed.

Invasive Exotic Species and the Japanese knotweed

As defined by the European Commission, Invasive Alien Species (IAS) are plants that are introduced accidentally or deliberately into a natural environment where they are not normally found, with serious negative consequences for their new environment. They are usually fast-growing and easily spreading species, historically used as ornamental plants, cattle feed, for cultivation, or for timber.

Japanese knotweed is a plant native to Southeast Asia; Japan, Korea, and China. It was introduced in Europe in 1830 by the German botanist Vin Siebold as a fodder plant in the Netherlands, both for livestock feed and as an ornamental plant. It is a perennial herbaceous plant with above-ground stems up to 3 meters high and a flowering period from August to September. The color of the stem as well as the reverse side of the leaves is an intense fuchsia mottled with light green. Its reproduction by rhizomes favors a fast and efficient dispersion. Fast growing allows it to occupy a large part of the land, choking out the native species, this puts the biodiversity of the affected areas at risk.

The problematic

Connotations of working with invasive species range from the ecological and environmental, social, economic, and political spheres to its artistic reformulations. 'It is interdisciplinarity in the broadest sense of the word, examining the relationships between ecology and economics, politics and history, design decisions and land use planning, as well as the relationships between people and the ecosystems that sustain them' (Orion, 2015 pp 9). It is possible to see how society is currently divided and that there is a void in the specific knowledge that derives in an uninformed community. For the residents of the affected areas, these species are a pest to be eliminated by uprooting or pruning the land adjacent to their homes. For municipalities and local authorities, the extraction plans involve workloads, time, and economic funds that are never sufficient due to the persistence of the species in re-appearing, and usually post-treatment of affected areas is prejudicial to autochthonal flora (Orion, 2015).

Context network

The first step was to contact institutions that had a direct relationship with this and other invasive species. We met the *Maasvallei rivier* park, an organization located in the river Maas basin. This organization's specialization is the restoration of natural environments. We could observe how to control invasive herbaceous populations through the introduction of wildlife, such as wild cows and horses that feed on these species, and regulate the area in a semi-controlled manner. This process of 'rewilding nature' is being promoted in certain areas of the country as it promotes the renaturation of post-industrial areas, such as the old sand quarries surrounding the rivers in the Flemish region.

We also contacted *Timelab*, in Gent, and the *Knot Factory* project. This group of engineers and designers works under the premises of reshaping community land, rethinking industry, and redefining cultural spaces. This team sought to develop circular materials for decentralized production, achieving an open-source material called *Knotplex*, a biodegradable binder made entirely from JK.

Moreover, we get to know the work of the company *Knotweed paper*, based in Slovenia. It was created by Trajna, an interdisciplinary collective focused on creative research and circular economy, specialized in finding sustainable solutions for the management of invasive plants. With this aim and with the collaboration of a former local paper mill, this team develops semi-kraft paper from the waste generated by the extraction of the Japanese knotweed plant in the surrounding area of Ljubljana.

Laboratory research and experimental results

Fieldwork was focused on two points, the understanding of the species and its implications and the development of a material from this raw matter. How can we create art from plant waste and how can we reflect invasive species problematic's in global/local ecosystems? Methodologically, the process was approached as an artistic experimentation with scientific behaviors that helped to maintain an objective vision and clear guidelines.

Workshop space was an improvised laboratory, an empty room in the basement of the LUCA School of Art, C-mine Campus. It was ventilated and with two large tables. The working tools: a bathtub measuring 100 x 70 x 30 cm, a domestic glass mixer, an electric cooker, various bowls, scissors, and wooden frames covered with tulle cloth. Raw matter was collected in the vicinity of the village of Genk and samples were divided into its parts, stem, skin, and leaves. We obtained two materializations of the plant: a paper-type support and the pigments from its color palette.

Considering this project was limited to a concrete period, it was decided to reuse all paper used to embody theoretical research, as a cellulose source. This recycled material allowed the non-cooked fibers to adhere to each other.

The raw matter was mechanically processed by separating the fibers into transmutable pieces of max 2 cm in length and mixed with the recycled cellulose in proportions (30%-70%; 40%-60%; 50%-50% of cellulose and fibers from different parts of the plant). This mixed mass was introduced into the bathtub with different proportions of water and natural glue. Then, using the wooden frames (paper formers), each paper-like sheet was produced and leave to dry over a flat surface. Finally, samples were coated with a homemade varnish based on linseed oil, beeswax, and pine resin. In addition to providing durability and imperishability to the material, the use of the oil favored transparency in the areas with a higher concentration of cellulose, recreating organic textures that helped to maintain the natural discourse linked to the material.

The resulting samples were cataloged according to the source material and the ratio of recycled cellulose to pure raw material. Due to technical limitations, it was not possible to carry out physical-mechanical tests on the material, so we focused our attention on the optical and poetic characteristics, those that allow us to recreate and reflect ephemerality.

Visually the material maintains the tone of the leaves of the plant. Also, interspersed in the middle of the fibers, we can find annotations, temporary traces of words that constantly refer us to the conceptual origin of the material. The sheets, measuring approximately 25 x 35 cm and 0.10-0.30 mm thick, bestow a visual reminder of its organic origin, understanding its ephemerality as a powerful communicative resource.

The object/artifact resulting from the research was a prototyped bio-compostable pillow made of a pressed material, manually sewn with 100% unbleached cotton thread, filled with dried leaves of the species, and in several sizes (Figure 1).

Figure 1. Japanese knotweed pillows and raw matter.

Figure 2. Japanese knotweed color palette in its powder structure.

The developed color research was carried out using the lake pigment method. A lake pigment is made by precipitating a soluble dye with an inert base to create an insoluble pigment (Jacqui Symons, 2019). By developing a chemical reaction on the dye, obtained by bowling different parts of the plant material for at least one hour, we obtained a color palette from moss green to a huge range of yellow variations and light browns (Figure 2).

Conclusions

The aim of this research was, on one hand, to develop a material whose storytelling capacities could connect us with the natural cycles, remembering us of the finite nature of resources and, on the other hand, to standardize or develop a guide on how to understand and work with the subject of invasive species, understanding their significance, origin, possibilities and all the implicit connotations. A method that is applicable to other ongoing projects related to art co-creation and organic waste.

It is after describing the whole process of creation and relying on the words 'we must grow from the medium' (Marder, 2016) that we tried to integrate ourselves within the ecological cycles. The concept of ephemerality is fundamental: as plants, the material is not born or died it is in an infinite cycle of births and deaths within an interconnected network of knowledge and learning (Marder, 2016).

It is by setting up relationships in our academic system that we can approach the idea of collaboration and interdisciplinarity inherent to nature. Ecology, from the Greek *oikos* - house and *logia or logos* - treatise, constitutes the study of the habitat of living beings.

If we go a little deeper into the term coined by Ernest Haeckel in the 19th century, we approach the concept of *niche*, which relates to the interdependent characteristics of living and inert beings that coexist with the species. We, as IAS inhabit a niche that is not only ours, altering the living cycles of others. Orion already reflected on it 'If we are to restore and enhance populations of native species, then we must restore our sense of belonging within the ecosystems that we depend upon. We must reimagine restoration as a practice that takes place in all ecosystems, especially those from which we derive daily needs' (Orion, 2015 pp8). By accepting the finitude of objects and seeking their reintegration into the natural world rather than the artificial, human-invented perpetuity, we can become nature. Making people aware that this is possible is a first step, and by using the languages of art and design, prototyping, and physical experimentation we can move closer to more desirable and environmentally friendly futures.

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Visual communication bridging intercultural barriers

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Introduction

The increase in the number of asylum seekers and refugees over the last decade has been one of the challenges for our society. Barriers to integration are exacerbated by xenophobia and stereotypes against foreigners, thus creating conflicts between members of the host society and newcomers. Refugee youth arriving in Hungary face serious problems: the loss of home and community, the traumas suffered during the journey, the cultural differences, and the lack of a common language all make their social integration into the host country extremely challenging. Social inclusion requires frequent contact with the local society, and they need new tools (cultural knowledge, language skills, intercultural skills) to overcome their disadvantages.

This PhD research explores the intercultural aspects and possibilities of visual communication, with the aim of pointing out the benefits and barriers of graphic languages in a multicultural context. The theoretical research has a practical background in the Open Doors project, which creates a complex programme for unaccompanied refugee and asylum-seeking youth in the country using visual communication, architecture and design. The aim of the programme is to help refugee youth to integrate successfully into Hungarian society, to develop their means of self-expression and their quality relations with the majority society.

Open Doors Hungary is a community-based design project that creates a complex programme for unaccompanied refugee youth in Hungary using visual communication and design. The programme is designed to help refugee youth successfully integrate into Hungarian society, and develop their means of self-expression and quality relations with the majority society. The Open Doors project was founded by the author and her architect partner Erzsébet Hosszu in 2013 and is run in the frames of a Hungarian association Útilapu Hálózat.

Since 2013 the Open Doors project has been working with refugee youth through weekly creative sessions, intensive workshops, and camps based on the integrating role of creativity and art. The refugee youth become part of the design process through these activities, and their choices are the basis for the final result. As a global language, visual communication can be a tool for intercultural communication, storytelling, and self-expression, while working in an intercultural team develops new competences, and creates shared ownership and community.

This PhD research aims to explore the possibilities or the tools of graphic design and creativity in direct work with refugee youth and to summarize the theoretical and practical results of the project in a methodological guidebook.

Intercultural communication

Cross-border migration processes always involve an encounter with a new culture. In addition, the issue of interculturality may arise within national borders, in the case of small geographical movements or movements between different social groups, which also entail interaction between two different cultures. Thus, the issue of social integration and its relationship with culture concerns a much wider audience than refugees and asylum seekers.

Culture can be seen as one of the major integrating and socializing forces, defined by Haviland (1987) as the set of rules and norms of a society that are considered to be correct and accepted by the members of that society. The more integrated the culture itself, the greater its integrating power, since "the very essence of culture is to ensure the integration of society". The concept of culture is closely related to communication.

Intercultural communication is nothing other than the interaction of people from different cultural groups. This does not necessarily mean different national groups, but in the era of globalisation and in the midst of migration processes, there is a growing need for intercultural competences. We no longer need to cross a national border to encounter another culture, and learning culture is as essential to successful interaction as learning a language, and cannot be avoided in our everyday conversations and work.

"To have an effective and smooth conversation with a foreign partner, or to read a foreign novel, or even to understand an advertisement, or to be successful in marketing, these are all essential skills." (Hidasi, 2004)

Culture is therefore not an innate quality, but an acquired and learned set of knowledge and norms. This fact makes it possible to learn culture and acquire intercultural competences.

Visual communication

"Words divide, pictures unite."

Otto Neurath's famous quote is also the hypothesis of this PhD research. Visual communication, the language of images, has the potential to bridge language barriers and promote intercultural understanding. But is this not too ambitious a statement? Do people from different cultures and social groups really understand the same things in the same way?

This research intends to find and define a visual language that can bridge cultural and linguistic barriers. But to define this, we need to understand the barriers of visual language, the barriers to universal understanding.

This research explores the possible aspects that may make it difficult to read images from a cross-cultural perspective. To analyse the 'reading' of images, we need to examine their relation to written language by examining semiotic aspects.

The dominance of verbality and the written medium over visuality in our modern society is evident. Literacy and language represent a specific historical stage in the formation and development of different civilizations, the ability to read and write has separated and distinguished social classes, and the social significance of literacy is still decisive today. But how do we relate to visual literacy?

While the perception and recognition of images is indeed a universal ability, reading them and decoding their meaning is far from being so. Understanding the pictorial signs that make up visual language is a social process, one that presupposes a social, historical and geographical context, and one that requires prior experience and knowledge.

"Like verbal communication, pictures represent an understanding of the world acquired by members of a certain group, and thus the meaning readers construct from a given image may depend largely on knowledge they share with group members." (Kostelnick,1993)

According to Charles Kostelnick (1993), there are three levels of social context that influence the perception of images:

1. cultural context - i.e. the shared worldview and values of the group members
2. conventional context - i.e. members of the group share a particular discipline or visual language of a particular discipline or special topic
3. immediate context - i.e. the situation in which the participants use the particular image

Several studies (Kostelnick, Gibson, Goodman, Jones & Hagan) introduce the concept of the "naïve eye", i.e. the reader who is not yet familiar with the world of images, the "visual illiterate", so to speak. These studies disagree as to whether the perception of images is analogous to the perception of real objects (James J. Gibson, 1954) or whether it is necessarily a learned skill (Nelson Goodman, 1976). Gibson, and later supported by Jones and Hagan (1980), argue that the 'naïve reader' of images, such as members of intact cultures isolated from the modern world, or young children, needs very little experience to perceive and recognise images, and thus considers this first stage of image reading to be a plausibly universal ability. In contrast, Goodman rejects the notion of the 'naïve eye', arguing instead that visual communication also embodies a convention-based language that changes from time to time and from culture to culture.

Writing with images

Although most of the existing writing systems of our world are not primarily pictographic in nature, our everyday lives are images, including functional images, which are often as challenging to read as verbal writing systems are to decipher. The reading of images can be challenging both at the level of 'letters', i.e. individual pictorial signs, and at the level of 'sentences' and 'texts', i.e. pictorial compositions or collections of narrative images. The factors discussed below, the cultural context, including in particular spoken and written language, the context of the conventions recognised by the group, and the immediate context of the situation, all influence the cross-cultural interoperability of visual communication at all levels.

The perception of images and the identification of their elements are, for the most part, truly culture-independent, but their reading is already highly dependent on the cultural and linguistic context and the writing system used by the language in question. The reading of images in different cultural contexts is therefore influenced by a number of factors, such as the writing system of the culture, the direction of reading, the degree of abstraction, and the symbolic meaning of the basic forms, signs, and colours.

Method and practice

In the past years, many new studies are written on the global role of visual communication (Radtke (2020), Murdoch-Kitt (2022), Pater (2016)) This practice-based research connects theory and practice and uses a mixed-methodology approach: on one hand, the author will process the existing literature on the topic of intercultural visual communicaton, on the other hand, this research examines the experiences of young refugees with visual communication, exploring its potential as a tool for facilitating intercultural understanding and integration through a practical social design project, Open Doors Hungary. Since 2013 the author together with her architect colleague Erzsébet Hosszu has been working with refugee youth through weekly creative sessions, intensive workshops, and camps based on the integrating role of creativity and art. Through these activities, refugee youth becomes part of the design process, and their choices are the basis for the final result. As a global language, visual communication can be a tool for intercultural communication, storytelling, and self-expression, while working in an intercultural team develops new competencies, and creates shared ownership and community.

Minor refugees are a special group, as their situation is not only determined by the inherent characteristics of being a refugee, but also by the fact that they are protected by the childcare system. Their long and dangerous journey and the uncertainty of the asylum application process only exacerbate the so-called "post-traumatic stress disorder", which may have been caused by the trauma of losing their roots or their human connections at home.

The programme aims to achieve a two-way integration process, thus an important element of the programme is the active involvement of members of the host society. Open Doors Hungary's methods include active, creative and community action, non-formal and interactive transfer of culture, cooperation and dialogue between refugees and their Hungarian peers.

Current results and next steps

During the past 10 years, the author has organized 8 (media) camps and weekly creative sessions, where young refugees and their Hungarian and European peers got to know different visual communication tools and created common messages in the form of videos, animations, photos, posters, booklets, murals. Design thinking and the creative process provided an opportunity for interactive cultural exchange, sharing of values, safe and open discussions, and community building.

The findings of this study suggest that visual communication can be an effective tool for bridging intercultural differences among young refugees and the members of the host society. Visual aids served as a tool for mutual understanding, and self-expression and also tools for learning new languages and new skills.

The research will further analyze the role of visual languages from a semantic and semiotic point of view, and will categorize the factors that influence intercultural understanding. Furthermore, the research will explore the role of social media and digital communication in intercultural encounters and its effects on cultural norms and tabus. The research will further analyze the role of visual aids in language learning and the transmission of culture by images.

Besides the ongoing theoretical research, the author will summarize the experiences of the Open Doors project using visual communication and graphic languages to improve interaction and communication between refugees, migrants, and the members of the host society. The result will be a methodological toolkit, that collects the different methods used during the workshops and programs of Open Doors Hungary based on the tools of visual communication. As intercultural communication is not limited to the interactions between refugees and the host society, the methodological toolkit has a wider audience and can be used in other target groups, such as youth with communication difficulties, mixed background classrooms, or the employees of multinational workplaces.

Figure 1. Open Doors media workshop (Photo by the author)

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Feeling the future car: designing for driving pleasure in the era of co-driving

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Abstract

Due to the emergence of future transportation technologies represented by autonomous driving, people's manual driving will be transformed into a state where people and vehicles drive together, or as a term used in this PhD research: co-driving, which implies that we need to pay attention to the impact of the artificial agency of vehicles on the sense of agency of drivers. In addition, the traditional state of kinesthetic integration of driver and car in driving is considered an important source of driving pleasure (Sheller, 2004), and the prominence of car agency means that the agency involved in the activity of driving will be redistributed, which will break this driver-car assemblage (Dant, 2004, 2014) in driving practice (Shove et al., 2012). At the same time, intelligent & connected vehicles are also thought to offer increasingly multisensory, multimodal interactive experiences (Tan et al., 2020), which may in part also provide design materials for innovative new patterns of people's driving pleasure.

This PhD research focuses on the above-mentioned future driving scenarios and aims to draw on a combination of methods from Reflective Lifeworld Research (Dahlberg et al., 2008), Anticipatory Ethnography (Lindgren et al., 2021; Lindley et al., 2014) and Research through Design (Zimmerman et al., 2007) to explore:

1. How does access to driving pleasure correlate with driver's need for sense of agency in different driving contexts with/in autonomous vehicles of different levels of automation?
2. How can we design for people's driving pleasure in the future co-driving practice based on the above understanding?

Taking a practical approach to conducting this PhD study, the focus would be on the so-called smart cockpit (Sun et al., 2018) as the context of human-machine interface (HMI). As such, this PhD aims to generate a guideline/set of principles on designing for future car HMI for driving pleasure with a focus on the driver's sense of agency in different driving conditions with corresponding design tactics.

Author keywords

Driving Pleasure; Co-Driving; Sense of Agency (SoA); Social Practice Theory; Design for Human-Robot Cooperation; Human Computer Interaction (HCI)

Research Background

This is an industrial PhD program based on the cooperation with a local car design consultancy, with the original aim of exploring the design of future automotive user experience for driver emotions in future mobility context. Such a context involves disruptive technologies including autonomous vehicles (AVs) and electric vehicles (EVs).

In the era of manual cars, human agency is highlighted in the human-car relation (Dant, 2014). However, with the emergence of AVs, car driving will be transformed into a state where people and cars drive together, which is called co-driving (Walch et al., 2016) in this PhD and brings about the redistribution of agency in existing driving practice (Shove et al., 2012) and the impact of the artificial agency of cars on the sense of agency (SoA) of drivers. Here, SoA refers to "the feeling of controlling external events" (Wen et al., 2019, p. 2). As such, AVs does harm to the driving pleasure of human drivers (Casidy et al., 2021; Eckoldt et al., 2012). Specifically, AVs subvert the kinesthesis of driver's taking the car as an extension of the human body to feel the motion in the manual driving mode (Kim, 2021).

Besides, it has been shown that different driving contexts have an impact on whether drivers choose to use ADAS features (Orlovska et al., 2020), and driving pleasure means differently for human drivers in different driving contexts, whether for manual driving (Hagman, 2010) or autonomous driving (Bjørner, 2019). But in extant literature, the relationship between driving pleasure and the needs of SoA in different driving contexts is still vague.

This PhD research focuses on the future co-driving social practices and exploring implications of designing for people's driving pleasure in the future co-driving practice with different needs of SoA in different driving contexts.

Apart from the AVs technology, as the main factor that motivating this PhD research, the ethical consideration on sustainability focuses this research on EVs for their environmental friendliness. As such, it is hoped to contribute to the popularity of EVs by improving the user experience of co-driving practice. In addition, this study can be a case to explore other practices related to car-usage from a social practice perspective, such as car sharing practice.

Theoretical Roots

By recognizing the agency of future cars in the co-driving practice, this PhD research posits itself in the emerging entanglement HCI wave, which highlights the attention on

non-human agency (Frauenberger, 2019) and recognizes the potential contribution as for the more-than-human design (Giaccardi & Redström, 2020).

To be more compatible with the ontology of co-performance, this PhD study also considers co-driving as a social practice (Shove et al., 2012), which is treated as a unit for understanding and analyzing society (ibid.). Moreover, the co-driving practice can be taken as a specific example of co-performance (Kuijer & Giaccardi, 2018) by driver and future cars, which, as Kuijer and Giaccardi suggest, "considers artefacts as capable of performing and exerting agency together with people in the carrying on of social practices." (2018, p. 4). Besides, co-driving can also be taken as a type of *human-agent/machine collaboration* (Bratman, 1992).

Research Questions

Two main research questions (RQs) are motivating this PhD research:

1. How does access to driving pleasure correlate with driver's need for sense of agency in different co-driving contexts with/in autonomous vehicles of different levels of automation?
2. How could we design for people's driving pleasure in the future co-driving practice based on the above understanding?

Research Methods & Expected Outputs

Given the constraints of people's access to high-level AVs, the RQs can be divided into two phases, *present* and *future* with corresponding research approach, as shown in Figure 1.

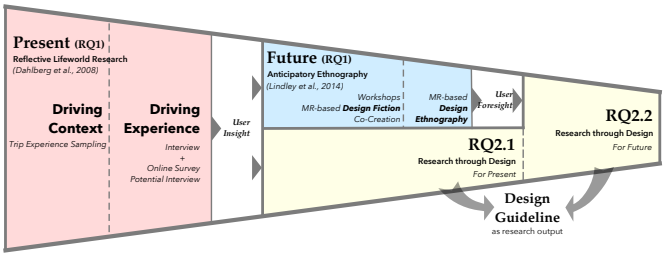

Figure 1. Research methods for elements among research questions.

For the present phase of RQ1, this PhD research would be based primarily on Dahlberg et. al.'s phenomenological approach of reflective lifeworld research (2008) to understand how SoA affects people's driving pleasure in different driving contexts under the influence of currently available low-level AV technologies. For the future, anticipatory ethnography (Lindley et al., 2014) based on design fiction and design ethnography (Pink et al., 2022) would be conducted. Built on the set of design fiction prototypes, design ethnography methods including in-experience observation and post-experience interview with participants.

With the findings from RQ1, RQ2 would be explored via the research through design approach (Zimmerman et al., 2007). As a result, this PhD aims to generate a guideline/set of principles on designing for future car HMI for driving pleasure with a focus on driver's SoA in different driving contexts with corresponding design tactics.

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Mediterranean landscapes in emergency: nature and culture

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LANDSCAPE; TERRITORIES IN EMERGENCY: MIGRATION; FLOWS; MEDITERRANEAN SEA

Abstract

The research project Mediterranean Landscape in Emergency: natural and social habitats, funded as a research grant on green issues, aims to activate processes of direct support to communities to build reception networks and generate processes of social and economic interaction.

The phenomenon of migration represents an ever-current issue capable of developing tensions and conflicts within the host countries due to the ever-increasing and massive number of people and flows that by moving cause transformations. «The stranger, who enters an already inhabited space, modifies the spatial familiarity, transforms it, disturbs it with anomalous elements» (Zanini, 1997, pp. 60-61).

The phenomenon, of worldwide attention, affects every country since, «on the unstable surface of our planet, [...] migrating becomes an essential strategy of adaptation and flexibility» (Calzolaio, Pievani, 2016, introduction).

The objective of the research is the study of the rewriting of the inhabited space characterized by strong hybridizations, redefined in its figuration by the temporary occupation of flows of people in movement, and marked by the temporary or permanent inclusion of groups of people relocated in communities already consolidated in order to develop operational criteria (applicable and replicable) for the reconfiguration of inhabited landscapes towards actions that go beyond reception as an emergency and participate in the construction of new multi-ethnic and shared landscapes.

The approach used plans to achieve the goal by identifying strategies to be implemented in both the agronomic and cultural fields.

The first strategy provides for the rethinking of agricultural activities with the specific objective of conserving biodiversity.

The other line of action intends to use culture as a factor of sustainable development. The increase in diversity in emergency territories is a prominent feature as the changing trends of migratory flows have generated a coexistence of different ethnic groups, religions and cultures, a resource becoming the driving force of the small internal centers of the national territory, because cultures are fluid sets of norms. (Collier, 2016).

The strength of the research lies in the physical, geographical and social characteristics of the investigation context, able to highlight how the achievement of an applicable and replicable strategy does not depend on the conditions of the context but on the effectiveness and efficiency of the strategy itself.

Introduction

The research project 'Mediterranean Landscape in Context of Emergency: natural and social habitats' was funded as a research grant on green issues.

In the research, landscapes in emergency are those territories that host a large number of people who, abandoning their countries of origin, move in search of new places to live. (Attili, 2007). In particular, we study the forced settlements of families and individuals in smaller urban centers inhabited by consolidated communities and which, for over thirty years, have been characterized by depopulation phenomena. The slow abandonment of these centers in favor of urban models, spatial images of a time that expands to infinity, and "does not aim at eternity but at the present" (Augé, 2004 p. 92), is one of the most also addressed and discussed in the 2030 Agenda, which among its sustainable development goals calls for the identification of intervention strategies aimed at knowledge and awareness of the need to promote sustainable, balanced and inclusive development. The rethinking of lifestyles can give new life to centers that have undergone marginalization processes over time. (Balbo, 2015)

Past policies focused on strategies for the reactivation of minor centers to revive that perception of "place without context [...], churches without parishioners, museums without visitors; castles without castellans; food without agriculture» (F. Barbera, D. Cersosimo, & A. De Rossi, 2022, p. X), precisely because «what's worse than a crowded village where you have to queue to enter the shop 'artistic craftsman?' (F. Barbera et al 2022, p. XVI). The research theme aims to create a connection, a close relationship between humanity and the environment, between culture and nature. (Berizzi, Rocchelli, 2019).

Methodologies

The theoretical research is carried out to focus on the analysis of the investigation context, the Valle del Patrì on the Sicilian Tyrrhenian side characterized by the presence of internal areas, inhabited centers in the process of depopulation located along the bed of the river itself, for which the rethinking of the use of the territory represents a resource both in terms of repopulation and economic development.

In this first year, based mainly on the search for bibliographic sources, the starting point identified was the analysis

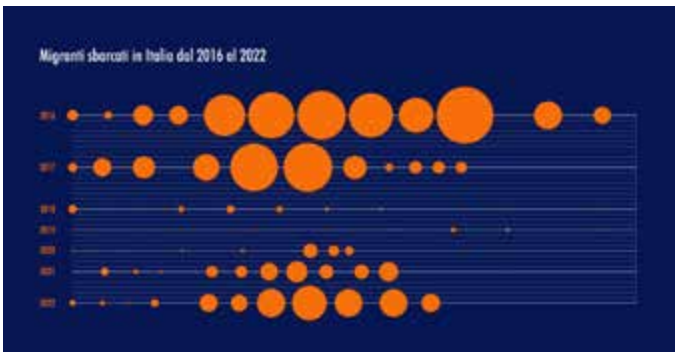

Figure 1. Personal elaboration on data from the Ministry of the Interior, link http://www.libertaciviliimmigrazione.dlci.interno.gov.it/it/documentazione/statistica/cruscotto-statistico-giornaliero (12/2022).

of the phenomena migratory flows, in order to identify what are the causes and effects that push man to move. (Acconcia, Mercuri, 2019) (Colombo, Sciortino, 2004). This analysis was first conducted on a statistical and numerical basis in order to identify the data relating to flows in the Mediterranean. (Fig. 1).

The central Mediterranean route represents the most active and most consistent migratory flow in terms of numbers of landings with arrivals mainly in Italy and Malta. This route, in the period January - October 2022, recorded a significant percentage increase of 60% of crossings compared to the previous year, putting a strain on the Italian reception system. To this analysis it was necessary to add a more in-depth study of the countries of origin: Tunisia, Egypt, Syria, Afghanistan and Bangladesh. (Fig. 2) (Fig. 3)

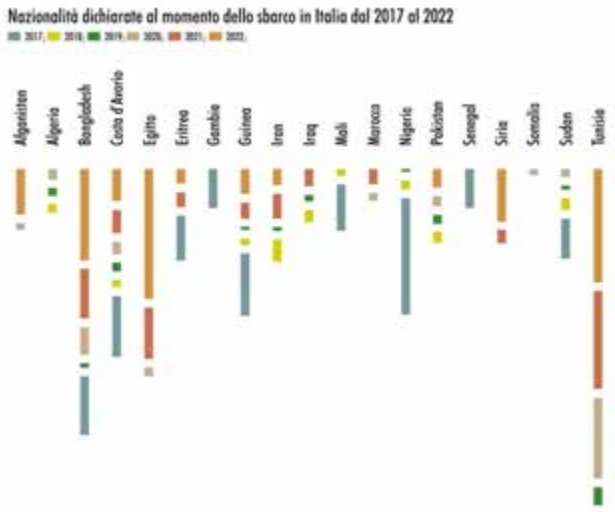

Figure 2. Personal elaboration of data from the Ministry of the Interior, link http://www.libertaciviliimmigrazione.dlci.interno.gov.it/it/documentazione/statistica/cruscotto-statistico-giornaliero (12/2022).

The non-linearity of the research path foresees that the theme of migratory phenomena will certainly continue to be investigated gradually restricting the area of analysis from the Mediterranean territory to the context of investigation specifying, in order to be able to identify the best strategy to implement, the target of area reference.

It was necessary to investigate the issue of reception by identifying the different types of structures present on the national territory.

Figure 3. Main migrant routes in the Mediterranean.
Source: personal elaboration on Frontex data, link https://frontex.europa.eu/media-centre/news/news-release/eu-external-borders-in-october-number-of-irregular-entries-on-the-rise-7CiZBL (12/2022).

A further study conducted within the research was performed by comparing the main inclusion strategies implemented by some cities in which the phenomenon of migration was particularly relevant, structuring real inclusive models especially on the national territory. (Tedde, Teano, 2022). Cities that are profoundly different in their emergency management, are united by the overlapping of several themes. (AA.VV., 2021).

Theoretical research, departing from the complex issue of migratory phenomena, necessarily had to address the issue of territories, internal areas, to identify their common weaknesses and possible strategies for relaunching by leveraging inclusion and the presence of groups of people relocated to small centers undergoing depopulation.

Internal areas, as defined by the National Strategy of Internal Areas, a national policy for territorial development and cohesion whose aim is to combat the marginalization of smaller centres, are «areas significantly distant from the centers offering essential services, rich in important environmental and cultural resources». All the centers of Valle del Patrì fall within the list identified by the National Strategy of Internal Areas.

These internal areas have gradually undergone a process of marginalization marked by demographic decline and aging with a drop in population, an increase in the social costs of de-anthropization, the costs deriving from the damages generated by the non-use of territory such as hydrogeological instability. Furthermore, the small size of the centers does not allow the organization of services in the area. Other factors of fragility concern urban accessibility, an issue closely linked to the absence of facilities such as services and infrastructures which undermine the livability of the place as it does not favor travel, compromising the individual's time management. The progressive reduction of services also reduces the well-being of the local population and the attractiveness of places towards potential new residents. Possible collaboration actions between local and migrant actors for the construction of a sustainable and inclusive development strategy were identified through case studies. The fields of action identified were: the brand policy, i.e. linking the identity of the place to the productive vocation by creating micro economies of local supply chains and the reconnotation of the places that triggers development and innovation processes of the territory through research and experimentation laboratories.

From case studies identified on the national territory, the research was extended, on a European level, to the identification of practices and strategies aimed at promoting the construction of more inclusive and cohesive societies.
The knowledge of these positive practices is essential to be able to develop a new and creative, tested and validated strategy capable of bringing benefits in the short, medium and possibly long term.

Strategies

The identification of the strategy to be implemented takes into account two combined lines of action; on the one hand, in the agronomic field, the rethinking of agricultural activities favors the recovery of biodiversity, and fights, through an adequate degree of land use, the reduction of employment, the fight against climate change, on the other, the construction of intercultural networks to promote lifelong learning processes, fair education, education to respect the multiple individual expressions, a source of exchange and creativity.

The modality of collaboration of the doctoral path undertaken, between the University and the world of work, has allowed, in the agronomic field, the carrying out of a period of six months, still ongoing, at a farm and zootechnical company located in the context of the investigation, allowing an accurate knowledge of the territory involving the migrant populations present.

On the other hand, the idea that culture is a global public good, as defined by the UNESCO Mondialcult 2022 Conference, has made it possible to identify as a first step the creation of a community map, which identifies the diversity of the territory. The inhabitant, resident and guest, becomes a constitutive part of the place in which he lives, a direct testimony of knowledge and values to be transmitted to future generations. (Dematteis, Ferlaino, 2003). Community mappings become real resources that involve the local community, inviting it to investigate and become a potential supporter of the processes of transformation of spaces, inevitably favoring the development of a sense of responsibility for one's own community. The use of creativity and culture in the context of regeneration can bring innovative solutions to imagine the minor centers of the future also through punctual actions to be replicated in multiple contexts, as in the event, announced by UNESCO, Open Street Days, now widespread in more than 400 cities, where citizens are encouraged to develop a new mentality on the issue of mobility open to sustainable solutions, taking possession of public driveways, to raise awareness and stimulate public debate on the issue of environmental sustainability as a fight against change climate.

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Key performance indicators for measuring and evaluating users' sensory perceptions and behaviors in learning spaces in higher design education

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Abstract

The research aims to develop a comprehensive list of key performance indicators (KPIs) that can be employed by designers and businesses in determining the sensory performance of learning spaces, particularly in higher education institutions (HEIs) of design learning. It answers the question of how sense-based performance in learning spaces could be understood, measured, and evaluated and how the field of interior design could create tools for measuring and customizing students' sensory experiences in learning spaces. The research fills the gap created by the non-existence of comprehensive research that identifies a unique set of KPIs for learning spaces based on sensorial metrics in interior space evaluation studies that have sought to identify a set of KPIs to measure the performance of learning spaces. The importance of the research would be manifested in the strong connection between the performances of research and teaching spaces and the sensorial performances of those who use them. A four-phase mixed-methods research (MMR) methodology is employed in the study. Each phase is chronologically arranged, encompassing field research and experimental research, with Politecnico di Milano (PoliMI) design school as a field of experiment. The research is expected to provide guidelines for designing and managing the sensory performance of learning environments. Therefore, potential beneficiaries will include interior designers, architects, engineers, contractors, facilities managers, and policymakers in educational establishments. The initial study findings within PoliMI learning community regarding the sensory experiences in various classrooms at the design campus revealed that sight is the most significant sense of all. Furthermore, lighting, ventilation, and acoustics are the most effective interior design elements that have an impact on the sensory performance of the learning space.

Author keywords

Learning Spaces; Sense-based Design; Key Performance Indicators (KPIs); Human Behavior; User Experience

Introduction

Higher education institutions are constructed facilities to host and support academic-related activities, such as teaching, learning, and research. These facilities typically accommodate a variety of faculties with various specializations (A. O. Abisuga et al., 2019). Additionally, they have a range of spaces, including offices, lecture halls, classrooms, open areas, cafeterias, libraries, studios, workshops, and laboratories. The effectiveness of these learning environments affects staff and student behavior, health, and productivity (O. Abisuga et al., 2015, 2016; Leung & Fung, 2005; Vafaeenasab et al., 2015). Therefore, it is essential to understand students' perceptions of their physical learning spaces to meet their needs.

Students engage their five senses—sight, touch, smell, taste, and hearing—to perceive, gather, and analyze data from the learning environment. Each of these senses serves a purpose by collecting data from the environment and relaying it to the brain, which analyzes the information (Kaleem, 2022). When the brain receives information about the environment via perception and cognition, such as light, aesthetic shapes, textures, colors, patterns, acoustics, odors, objects, and furniture, the brain responds with what is known as "spatial behavior" (Mostafa, 2008; Zhang, 2016). Together, these mental processes enable the students to respond to their surroundings, affecting their performance (Kaleem, 2022).

A KPI is a measurement tool used to evaluate and determine the performance of interior spaces (Lavy et al., 2014); however, a thorough literature review indicates that no holistic design KPIs are in place to meet students' sensory performance at higher levels of design education. This study addresses this gap by providing KPIs for measuring and evaluating users' sensory perceptions and behaviors in learning spaces, which are considered a roadmap that designers and businesses can follow and use from the start of the design process, not just during the user experience phase.

This is achieved using a sequential exploratory mixed methods approach, including literature review, field research, and experimental research. First, a thorough literature review is needed to identify potential KPIs specific to the sensory performance of learning spaces. Following this, a qualitative phase was represented in field research, specifically at PoliMI School of Design, the research's experiment field. The third phase is experimental research, which aims to ensure the collected data and test initial KPIs before finally reaching the research outcomes as proposed KPIs.

Literature Review

Although research into the design of learning spaces is receiving more attention (Perks et al., 2016), more needs to be understood about what students consider a high-quality learning

environment (Riley, 2013; Wilson & Cotgrave, 2020). In HEIs, architects, estate/property managers, and teaching staff do most of the research on space design and often make recommendations based on pedagogical or technical considerations; students' perspectives are rarely explored in this study (Cleveland & Fisher, 2014). This demonstrates the necessity of improving the design of learning spaces and considering sensory preferences during the design process (Patel et al., 2022).

On the other hand, as the number of new learning spaces has increased, academics have begun to look into ways to evaluate these new environments. Many of these methods are discussed in two Australian books where researchers suggest various tactics for figuring out how these novel spaces function (Alterator & Deed, 2018; Imms et al., 2016).

An interior space's condition is measured using KPIs, which are used to identify the space's specific quality and performance (Kim et al., 2005). According to Lavy et al. (2014), it is the key to comprehensively evaluating the effectiveness of a built facility. It systematically measures a space's quality, excellence, and overall performance. Ultimately, it is designed to improve performance in existing places and future initiatives by providing information about what works and does not (Sanni-Anibire & Hassanain, 2015).

However, Cleveland (2016) criticizes current guidelines for learning space evaluation for failing to consider the learning environment's social or human aspects and urges the development of new prospects that directly link pedagogy and space. Similarly, Oliver (2016) notes that existing evaluation models frequently occur in the distinct fields of architecture or education. According to Lavy et al. (2014), choosing a set of KPIs is vital to providing efficient performance evaluation measures for the facility in consideration, especially the sensory performance parameters.

Problem Statement

Though previous research has sought to identify a set of KPIs to measure the performance of learning spaces, comprehensive research that identifies a unique set of KPIs based on sensory metrics still needs to be made available in interior space evaluation studies.

This gap has been visually illustrated through an interdisciplinary research map showing the interconnected disciplines covered during the literature review, as shown in figure 1. Design, social science, and neuroscience are the three main disciplines represented on the map. Several fields have been investigated in each discipline, such as interior design, performance-driven design, and sense-based design under the design discipline; psychology, sociology, and anthropology under social science; and cognitive neuroscience under neuroscience. In each field, a group of areas collectively reflect it from the perspective of the study scope. The goal of the map is not only to show the corresponding fields and areas in the realm of the research but also the disconnected ones, which form the research's central gap. A disconnection between performance-driven design, learning space design, and sensorial design has been revealed, depicted in red lines, supporting the necessity for KPIs for designing and evaluating the sensory experience in learning spaces of HEIs.

Figure 1. Positioning map showing the connected and disconnected parameters in the scope of the research. Source: figure created by the author

Outline of Objectives

The study investigates the connection between the physical learning environment and sense-based design. Therefore, the fundamental goal is to create KPIs for measuring and assessing users' sensory perceptions and behaviors in higher education learning spaces. These KPIs are considered a tried-and-true methodology that designers should follow both academically and professionally. Sub-objectives are set to achieve the research's primary goal, which includes identifying students' sensory needs and preferences, defining sensory performance criteria that have a strong and significant relationship with the physical learning space, and understanding which design elements and strategies best meet these sensory needs to positively influence behavior and impact students' learning, educational performance, individual, and social well-being.

Research Questions

By answering the following research questions, this study fills a void in the literature on how to design learning spaces using KPIs for measuring users' sense-based performance. The research's main question is how the interior design field could develop KPIs for measuring and customizing the experience of the senses in learning spaces. Sub-questions are also developed, including:

1. What are human behavior's sensorial qualities that should be measured in learning spaces?
2. How could those qualities be measured? Who can measure it? What are the evaluation criteria?
3. What could interior design KPIs be created based on those measurements? How could applying it affect the involvement of the human body in the experience of learning space?
4. How can designers and companies use/follow those KPIs to design learning spaces?

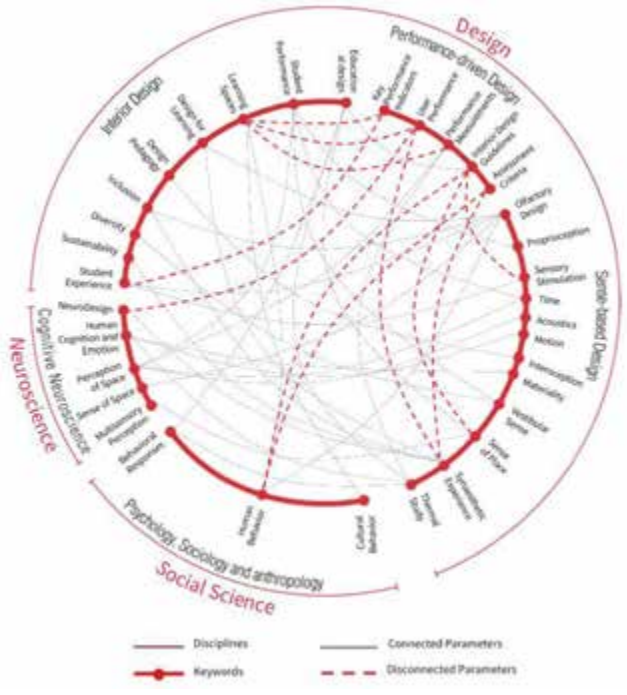

Figure 1. Positioning map showing the connected and disconnected parameters in the scope of the research. Source: figure created by the author

Research Methodology

A mixed-methods approach has been adopted to achieve the study's desired objectives. It is defined as research in which the researcher collects and analyzes data, integrates the findings, and draws inferences by interweaving qualitative and quantitative data so that research issues are meaningfully explained (Creswell & Piano Clark, 2007; Tashakkori & Creswell, 2007). It enables researchers to answer research questions with sufficient depth and breadth (Enosh et al., 2015), integrating post-positivism and interpretivism frameworks (Molina-Azorin & Fetters, 2016).

Subsequently, the research employs a four-phase approach arranged chronically, as shown in figure 2:

- Phase 1: Literature Review
  It consists of the following three stages: collating previous publications to gather a broad list of an initial set of unique KPIs relevant to the sensory performance of universities' learning spaces; Following this, previous studies and results will be categorized into relevant groups before being analyzed by excluding redundant KPIs and ensuring a set of specific and measurable KPIs.
- Phase 2: Field Research
  A qualitative study is adopted, aiming to understand and mentor the social behavior of groups of students and educators, particularly at PoliMI, by observing and interacting with others in their natural settings (Queirós et al., 2017) under different sensory variables. Therefore, it includes direct observation, participant observation, and qualitative interviews with academics and professional experts (architects and building designers).
- Intersected Phase
  Initial KPIs are developed during this phase using observation and statistical analysis methods.
- Phase 3: Experimental Research
  The third phase is experimental research, which fundamentally relies on an appropriate hypothesis test to determine whether the collected data is statistically significant and to ensure the indicators' inclusion, validation, and clarity.
- Phase 4: Interpreting Results
  It represents research outcomes as proposed KPIs to be followed and used academically and professionally.

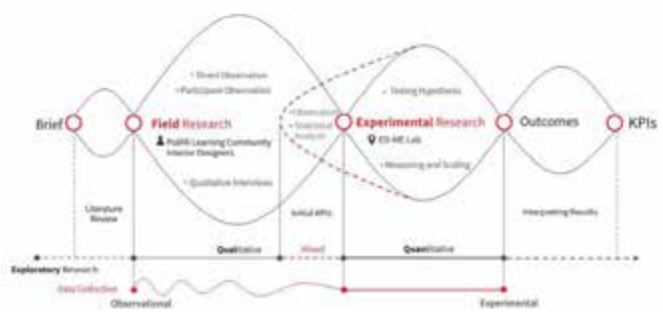

Figure 2. Research methodology phases arranged in a chronological order.
Source: figure created by the author

Conclusion

The main essence of the current research is to support designers and companies in the interior design field with a comprehensive set of KPIs unique to the design, evaluation, and measurement of learning spaces in higher design education. The key to achieving this goal is to understand the sensory characteristics of human behavior in learning spaces to be measured, by whom, and with what criteria. Additionally, the method by which designers can use these KPIs for existing and future design projects The study adopts a mixed-methods approach to collect, analyze, and test data, providing the intended results. It started with a literature review consisting of collating previous publications, grouping previous studies and results, and analyzing the previous studies' findings. According to the expected outcomes of the ongoing research, measuring and assessing the performance of the learning spaces of HEIs from a sensory perspective will be guided by the targeted KPIs. As a result, the guidelines enable stakeholders in higher education to understand the needs of their community by actively participating in the development of more sense-based design solutions through a systematic framework. The first round of research findings inside the PoliMI learning community on the sensory encounters in different classrooms at the design campus showed that sight is the core sense. In addition, a learning space's sensory performance is most significantly influenced by lighting, ventilation, and acoustics, which are also the most efficient interior design components.

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Study of textile handcrafting practices on women creator's psychological well-being: a narrative review

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Abstract

It is a well-regarded fact that a woman's well-being impacts her household members as usually she is the primary caregiver for her family. Also, factors such as success, happiness, and health of the family members have been observed to be directly related to mental health and physical wellness of women. Holistic craft as a means of self-expression has brought women deep happiness like in Flow (Csikszentmihalyi, 1991). In many, if not all cultures, textile making has historically been or is presently central to the role of women. It has helped create and sustain the women's self-image while protecting the ego as escapism in the case of some big loss, significantly providing ego-uniting experiences in a quest for creative improvement and self-expression. Hence, it is significant to study the impact of textile value addition techniques on women practitioners' psychological well-being. The aim of the study is to review the related studies. In this narrative review, this study explores hand-textile craft's role and impact on women creators' well-being. This paper identifies how textile crafting can help these individuals. The paper explores the relationship of hand-textile craft of women practitioners and their well-being through narrative analysis methods. The search strategy included a combination of keywords including, mental wellbeing, women textile crafters, feminism craft etc in journals like occupational sciences, The design journal, and Art Therapy. Published articles were reviewed in English in the period of 2000-2020. Literature review portrayed the connection of textile crafters and wellbeing through development of cognitive skills, raw materials used, meaningful handcrafted gifting, social and cultural dimensions, and connection with self-image.

The data from this study could be used to conduct further experimental studies in regional countries and subsequent data can be used in rehabilitation centers.

Author keywords

Well-Being; Textile Crafting; Indian Women Creators; Connecting with Self; Life Satisfaction

Introduction

Hand textile crafting today is no longer a necessity for obtaining everyday items and clothing; instead, it has transpired into an inner desire to create things by hand for leisure activities (e.g., Burke & Spencer-Wood, 2019; Gandolfo & Grace, 2010). Textile Crafts such as knitting, crochet, weaving, and needlework focus on repetitive actions and a skill level that can constantly be refined further. According to the famous psychologist Mihaly, this allows us to enter a "flow" state, a perfect immersive state of balance between skill and challenge. Csikszentmihalyi (1991) also discusses life management concerning the concept of flow. On the other hand, the craft can be related to the happy stress experience (Frankenheimer, 1999) because making a new artefact, learning a new technique, or making variations on a pattern can make one feel one has achieved something of value. With what is increasingly referred to today as "mindfulness" being a much-desired quality for many people, it is not surprising that crafts are much sought-after for their mental and even physical benefits. The Women, specifically, as it has been observed, have been spending more time and energy on various forms of textile-based craft making as leisure. In the entire craft process, certain sensory aspects such as meaning of the activity are incorporated into the making as well as in the finished product. These are important as these aspects help in the development of the craft maker's self-development as well. (Pöllänen,2015; Genoe & Liechty, 2017; Jackson, 2010). It also eventually structures their place in the ever-changing world (Collier, 2011). Claire Wellesley, in her book Resilient Stitch: Wellbeing and Connection in Textile Art, explores the notion of resilience in textiles and its importance for mental well-being, community, and engagement with the environment. Relaxation, better moods, and satisfaction in ordinary craft has helped in recreation for the women.

Craft's particular benefits for mental health are backed up by the results of the BBC's great survey test, published in 2019. Textile crafts such as embroidery, crocheting and knitting have the highest participation rates of all the arts – more than music and painting – according to the UK government's Taking Part survey, which shows the potential impact that craft making could have. Another study showed that participating in sewing as a leisure activity contributed to psychological well-being through increasing pride and enjoyment, self- awareness, and 'flow' in younger women. (Craft Council, 2020).

In a country like India, textile crafts are inculcated culturally and practiced widely. Our ancestors have been involved in textile crafts such as knitting, crocheting and embroidery; hence, the traditions are passed on. A mother or grandmother would impart some skill to their female younger generation. Broadly defined, textiles encompass a variety of fibre-related materials that are made from plants (e.g., cotton or linen), animals (e.g., wool, alpaca, or silk), or synthetics (e.g., nylon). Fibers are felted or spun into yarn, dyed, knitted, crocheted, or woven. The material is then joined by sewing, hand stitching, or tying, into a finished piece that may be embellished by various methods such as beading or surface design. Over decades, textile crafts have become an essential and integral part of our cultural heritage. Weaver Kabir Das quoted weaving as a medium of thought and expression. Mahatma Gandhi too claimed that working on the spinning wheel (Charkha) was a deeply meditative activity: its music was like balm to his soul. "The message of the spinning wheel is much wider than its circumference." For Gandhi, the charkha had a therapeutic use too - it was a nerve relaxant and could help in concentration, and in controlling passion. (Kapoor, 2017). Women may also engage in these activities for leisure or gifting purposes within their family or friend circles.

This study examines how mindful practices of textile craft making such as knitting, weaving, Crocheting and embroidery etc. can impact the well-being of women practitioners. The data is collected by 'narrative analysis' method. The aim of the study is to review the related studies of *textile craft's role in women creators' well-being. Research question of the study can be formulated as below:*

RQ: Is there a direct relationship between handmade textile practices and psychological wellbeing of the women hand textile craft-makers?

Material and Methodology

This was a review (narrative) study, in which literature in English was evaluated using electronic search in databases of ScienceDirect, Occupational Sciences, and Art Therapy etc. in

Table 1. Compilation of results from papers reviewed for the study

S.no	Researcher	Purpose	Sample Size	Sample Type	Tools	Results
1	Sinikka Pollanen (2015)	Elements of crafts that enhance well-being.	59	Female textile craft makers (Age 19-84 yrs.)	Written Narrative	Raw materials, artefacts, sense of achievement, cognitive skills etc.
2	Ann Futterman Collier (2011)	Impact of Hand-crafted textiles on women.	821	Female textile leisure crafters (Age 18 & above)	E-Survey & wellbeing scales	Textile handcraft correlated with better emotional & cognitive adjustment in older women
3	Savneet Talwar (2018)	Wellbeing of women who work of textile design studio	25	Members of creatively empowered women design studio	Case study	CEW Design studio through textile crafts enhances life skills and cultivate a sense of community.
4	Marty Grace Enza Gandolfo Chelsea Candy (2009)	Evaluating Quality of life of mothers who takes out time to practice textile handcrafting	3	Mothers who used textile craft as self-expression and as escape/ relief from demands of mothering.	Semi structured interviews	craft making is an expression of love, helping them nurture through the things they make. Finding relaxation, handling challenges, relief from stress and joy of self-expression, playing important role in well-being.
5	Sara Nevay, Lucy Robertson, Christopher S.C. Lim & Wendy Moncur (2019)	Crafting textile connections	6	Female (Age 16 & above)	Workshops, Interviews & wellbeing scales	Study demonstrates increase in well-being following participation in textile crafting and explores new territory for well-being studies.
6	Jill Riley (2008)	Evaluating enhanced sense of well-being through creative textile making	7	Members of British guild of weavers, spinners, and dyers.	Interviews & Participant observation & notes from workshops	Engaging in creative hand craft textiles contributes to individual sense of self, sense of belonging which contributes to our quality of life, perceptions of health & well-being.
7	Tzanidaki, D. & Frances Reynolds (2011)	Exploring the meanings of making traditional arts and crafts among older women.	12	Old rural women of Greece (Age: 65 & above)	Semi structured interviews	Older women perceived artmaking as promoting continuity of self, social status, and spiritual well-being.
8	Gail Kenning (2015)	Relationship between Craft-based Textile Activities & Positive Well-being.	16	Female textile leisure crafters (Age: 45-90)	Unstructured interviews	Engagement in Textile craft activities were expressed as Health & Well-being, Self-identity, Community Sharing and belonging; Learning, growth and transition.
9	Sinnika Pollanen (2006)	Role of Textile craft making in mental health.	60	Female textile Leisure crafters (Age 19-84)	Free essay Narrative	Craft as a hobby increases the feeling of empowerment. Means to self-expression, sense of personal growth.
10	Lisa Raye Garlock (2016)	Art Therapy and Narrative Textiles	20	survivors of gender-based violence	Training module on narrative textiles & observation	Traditional art therapy groups making story cloths in community provides connection with others and cope with traumatic events.

the time range between 2020 and 2022. Search in the databases was made using key words of "Hand Textile Crafting and Well-being" and "Women Creators" and "Textile Crafting and Social Connections" and "Creative Well-being" and "Psychopathology" and "Social Factors" and "Life Satisfaction" and "Feminism Craft Well-being" and "Functional". Out of 50 articles, 10 articles were included in the study. These had conducted research on textile crafting well-being, and were of cross-sectional, cohort, case–control, interventional, and review article types. In addition, articles were selected based on wellbeing assessed among women in India and internationally. Articles with improper material regarding the adequacy of sample size, research design, and statistical methods were excluded from the study. The articles reviewed in the study were more qualitative in nature. Few studies indicated quantitative analysis where the questionnaire was circulated via emails.

The articles were evaluated by the researcher in terms of inclusion criteria. In case of meeting the inclusion criteria, the articles were reviewed, and contents related to the subject were extracted. Thus, the main results of each study with the article's specifications under the relevant title were noted. After collecting, the material and content were categorized based on scientific content in their respective area subsets

Results and Discussions

Below is detailed overview of the papers reviewed for the study.

Articles' assessment showed that the connection between women's well-being and textile handcrafting can be categorized in five factors, namely, development of cognitive skills, raw materials used, meaningful handcrafted gifting, social and cultural dimensions, and connection with self-image.

Development of cognitive skills

[1, 2] The role of the craft and the relationship between the craft and its maker vary across cultures, geographic groups, and gender. A common thread is that craft practitioners are often emotionally invested in these activities. (Kenning, Fiddling with Threads, 2015) Many continue to make it through all stages of life until old age. Positive stress in ordinary craft enhances the sense of time management.

Raw materials

Although materials are an indispensable condition for making, according to the narratives, they may have other meanings for craft makers. The raw materials were described in the narratives as a source of inspiration. The craft makers could also express their values and creativity through the materials. The data also revealed how touching the material and the process of making had deepened the possibility of expressing the makers' feelings. It was quoted in the narrative that "I remember how during the worst part of my sickness I had to go and shop for the textiles; the strong colored clothes especially seemed to give me strength".

Meaningful handcrafted gifting

It was identified that the most noticeable features of the narratives were accurate descriptions about artefacts that were made during the long-term craft making. Articles elaborated on how the craft makers described how much time, energy, and warm feelings were connected to the making process and the finished products. Self-made personalized gifts are given and accepted with love. 5It is much more impersonal to buy something "finished". Time is limited, but gifts to family members must be self-made with love. (Pollanen, Elements of crafts).

Social and cultural dimensions

In this study, the context of making crafts was the home. The narratives only touched on the possibilities of making crafts in organized contexts or in the social setting of a group that is wider than the craft maker's own family. Nevertheless, most of the narratives described features that can be connected to social connections and culture. The narratives revealed that the social dimension of crafting was intertwined with emotionality. "[5] Even though crafting was done alone, it nurtured the feeling of togetherness with family members, relatives, and friends. As visible objects, the crafts had symbolic meanings to family members". Thus, in addition to being considered concrete and visible evidence of kinship and love, crafting was perceived as strengthening family ties. The fact that the product was made for the home or for some dear person indicated that the human connection made the making-process and the product meaningful. (Garlock, stories in the cloth).

Connection with self-image

[11] The findings by Jill Riley indicate that a sense of self comes from an intrinsic need to make textiles that are closely connected to one's personal background, an affinity for materials, skill mastery, passion for rhythm and process, spiritual commitment, and continuity with the past. It is related to sharing occupation and working together as a part of a group. This brings about a sense of belonging, which in turn enhances the quality of life and perceptions of well-being.
[6] Lisa Raye Garlock elaborates the importance of narrative textiles through her training program "Common Threads" -A recovery programme for survivors of gender-based violence."
[7] Working with fabric can be particularly comforting and meaningful, especially if there is personal and cultural history and relevance. Story cloths create lasting pictures filled with memories, connection to loved ones and effective way to work with trauma survivors"

Importance of the study

This study will be useful for furthering the Make in India initiative, and the Skill Development schemes of the Indian government, and accomplish Women Empowerment as described in the SDGs declared by the UN. It will also enable strengthening grassroots support to Indian women artisans and thus carry their legacy forward in a sustainable manner.

Conclusion

Most of the articles reviewed in the study have targeted respondents that were self-identified textile handcrafters who had good experience in the craft like knitting, weaving, spinning, and sewing. Different psychological patterns have been observed from the various papers. While conducting the review, it was observed that there have been numerous studies inquiring about the role of hand textile crafts on women's well-being, but it has been observed that the studies confirming its impact pertaining to the region of India are scarce. The analysis method that has been employed in the study is ma-

jorly descriptive and quantitative. While gathering the review it has been observed that data on experimental studies is limited. Literature review on hand-textile craft with respect to well-being covers intellectual categories who are practicing textile craft for leisure with varied age groups. However, limited information is observed from illiterate or other sections of the society. Gap identified in the study by the researcher has helped the researcher to further gather the information from various groups of women creators from diverse sections, strata of the society and those who have never practiced any craft. Researcher is progressing primary research on the same as further scope of the study.

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Cross-case analysis on the integration of extended reality (XR) with the design and planning of the built environment

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Abstract

This paper serves as an introduction to the Ph.D. research project through four recent case studies, which are then utilized towards a multiple case study analysis in the form of a cross-case report. The focus of the study is on Extended Reality (XR) technology as a means of qualitative user data in the design and planning of the built environment. The Ph.D. project is based on a literature review on status of smart cities and related architecture and design research, currently calling for more integrated case study data on developing participatory design practices for cities. The goal of the thesis is therefore to contribute to the field of smart cities research in highlighting the potential role of extended reality (XR) technology in creating more immersive and interactive urban environments which may enhance democratic decision-making ability among citizens. We note how XR created the ability for users to understand design proposals at scale, and to interact with proposals and create their own designs on-site. The use of XR impacted final design outcomes in all studies, suggesting XR as a potential tool for increasing a qualitative understanding of user experience in the design and planning process. We conclude with a discussion on opportunities and barriers for the implementation of XR in participatory urban planning, pointing to the need for a more coordinated and holistic approach to both XR technology development and planning policy if the technology is to be developed such use.

Author keywords

Extended Reality, Mixed Reality, Interaction Design, Architecture, User Experience, Virtual Environment, Phenomenology, Design Theory

Introduction

Urbanization, digitization, and the development of democratic and participatory decision-making processes are all powerful contemporary trends which require new research. As cities are increasingly more populated and complex to manage, city governments search for tools to conduct planning of urban areas in an efficient and sustainable way (Montes, 2020). One new tool, Extended reality (XR) - a frontier technology consisting of augmented (AR), virtual (VR) and mixed (MR) reality (Milgram & Kishino, 1994) - allow for 3d objects and models to be placed in a real-life context and interacted with by users, thus offering obvious use cases for architecture and planning domains (Kato & Billinghurst, 2002; Barfield, 2017; White and Nikolic, 2018; Hillmann, 2021). In current literature, researchers claim numerous benefits of introducing XR to design and planning, but also identify the need to determine the best practice in design curricula (Milovanovic et al., 2017;Martín-Gutierrez et al., 2017; Hakkila et al., 2018; Mohamed et al, 2019). In parallel, the real estate and construction sectors, not traditionally been known for being innovative, have slowly been ramping up innovation, particularly because operators and users were keen to see more data and analytics applied to the user experience and reporting (Olander & Landin, 2005; Grunevald et al., 2022), signaling a transition from 'product push' to 'client first' concepts and particularly the use of XR in the design process. In this way, the focus on client-first user experience concepts that embody deep insight into user expectations and interactions could influence on the urban planning sector which heavily relies on the real estate sector to enact its plans.

Here it is important to note that the UN Habitat recommendation focuses specifically on integrated XR with governments and municipalities to further study how XR influences not only business domains but also the fundamentals of democratic decision-making in planning (UN Habitat, 2019), particularly in response to the UN Sustainability goal (SDG) 11 of increasing democratic participation in planning. However, while XR is being extensively researched, few cases attempt to implement XR in real-life planning and design scenarios with municipalities and state actors. For example, a Piumsomboon et. al (2018) study found that while AR has been studied extensively over the last few decades, most studies are conducted in laboratory settings and do not involve pilot testing. Here, finding solutions to the interweaving of new digital tools in response to unprecedented urban growth, population expansion, and an increased focus on sustainability, is increasingly relevant (Ertio, 2015) perhaps even more than technology research alone. In addition, managing the complexity of decision-making amongst an increasingly digital citizenry, creates both challenges to traditional techniques and methods, while opening pathways to new ways in which to engage users with planning through digital tools (Landry, 2016). Therefore, the lack of integrated case work forms the basis for new research.

Materials and methods.

To research the problem of XR implementation into design and planning thoroughly, the thesis utilizes a multiple case studies approach consisting of a series of cases studying the use of XR is participatory design and planning with different user groups and in different types of settings. Here, we will present a multiple case study analysis based on the Yin (2013) multiple case study design model, based on four of the most recent cases in the Ph.D. project. Often deployed in design research methods, a multiple case study is a research study on multiple cases to understand the similarities and differences between the cases and to be aimed to generalize conclusion over several units (IGI, 2021). The design of such a study through multiple case design is a research methodology in which several instrumental, bounded cases are examined using multiple data collection methods. For the Ph.D. project, following the Yin (2013) model, this meant not only conducting several cases but designing the cases structure in relation to each other, but also developing common data collection strategies in order to draw cross-case conclusions regarding the use of XR in the design and planning of the built environment more generally.

Following the development of theory, the Yin (2013) model calls for the design of a data collection protocol and the selection of cases. For multi-case research, the cases need to be similar in some way, for example the study of a program in many sites (Stake 2006). As displayed in table 1., we selected cases with different types of design and planning schemes – which were then allocated with choice of XR hardware and software deemed appropriate for the case. Each case studied a specific user group typical to that type of scheme in the real world – for example, for the 100 000 trees project, the existing user group from the physical planning scheme was utilized in the study of XR for that same task. The data collection protocol was then designed using various methods from user interaction such as observation, screen recording, interviews that were conducted as similar as possible across cases to understand users' interactions and experiences with XR.

Cases

Case study 1 - Case Study of the Design of the 2022 Nordic Pavilion Exhibition at the Venice Biennale.

The first case study documents the design process of the physical and digital versions of the heritage-valued Nordic pavilion at the Venice Biennale. The case facilitated a multiuser collaboration in mixed reality (MR), studying the technologies' influence upon user interactions and design decision making. The case study documents how artworks and positions of artworks were tested in various configurations within the MR model by curators and designers to simulate the spatial experience of the design options. Several key design decisions were made based on the unique vantage points offered in MR. The MR model was then used to generate 2D technical documentation and installation instructions, which were installed on site.

Figure 2 and 3. Left: Conducting design review in MR inside a studio from case study 1 Right: Youth participant places trees on site through AR in case study 2

Figure 4 and 5. Left: Local participant from participatory planning workshop in Mauritz Hansens gate explains their proposal through the AR application in Case study 3. Right: Figure 5 The participants were surveyed on their cognitive-emotional response to the wall types through interviews, go-along interviews while inside VR, and through screen-recorded observation in case study 4.

Case study 2 - Augmented reality as a participation tool for youth in urban planning processes: Case study of the 100 000 new trees project in Oslo, Norway.

The second case study consists of field work with AR between 2020 and 2021 over five weeks, with five different groups of youth participants from eight different districts of Oslo, who were tasked with planning a portion of Oslo's 100,000 new trees.

Case study 3 - Utilizing XR in the participatory planning of a car-free street; Case study of Oslo, Norway and the 'Living Streets' project.

For this third case study, we partnered with Oslo Municipality and the City District Administration of Frogner in conducting

Table 1. Case studies in cross-case analysis; technology domain, user group, methods, and case study report publication type

Case no	Title	Technology	User group	Methods	Case study report, Publication, year
1	**Mixed Reality in Multiuser Participatory Design: Case Study of the Design of the 2022 Nordic Pavilion Exhibition at the Venice Biennale**	3d scanning, VR, Oculus Quest 2, HTC Vive, Arkio	(Sami) artists and curators	Observation, Screen recording, Interviews	Buildings (MDPI), 2022
2	**Augmented reality as a participation tool for youth in urban planning processes: Case study of the 100 000 new trees project in Oslo, Norway**	AR, iPad Pro, iScape	Local youth	Observation, Screen recording, Interviews	Frontiers of Virtual Reality, Augmented Reality Special Issue, 2023
3	**Utilizing XR in the participatory planning of a car-free street; Case study of Oslo, Norway and the 'Living Streets' project**	AR, iPad Pro, iScape, Augment	Local adults and youth	Observation, Screen recording, Interviews	Repurposing Places for Social and Environmental Resilience. 2023 Proceedings
4	**Evaluating the user experience of architectural archetypes through XR**	VR, Arkio	Youth	Observation, Screen recording, Interviews	The International Association for the Study of

participatory planning for the Living Streets project, specifically the street of Mauritz Hansens gate, which is undergoing planning approval for conversion from a car street to a car-free 'Living Street'.

Case study 4 - What is the role of architectural history and theory in the future? Evaluating the human experience of architectural 'archetypes' in virtual reality (VR)

The goal of this fourth case study was to evaluate whether implied experiential qualities in architecture were experientially transferable through to a virtual environment. Therefore, the research team studied the seminal literature in Evensen (1987) Archetypes in Architecture and modeled full-scale replicas of the 8 wall archetypes in the publication within a virtual environment.

Findings

Our findings are developed in the form of individual case study reports, submitted to peer-review, and published as individual cases in the corresponding journals. Through utilizing the Yin (2013) diagram we then form cross-case conclusions in this text. Across cases, we found that XR influenced the user experience and decision-making processes in each case in a variety of different ways. In general, XR is particularly useful when conducting field work that allows users to see and create designs and interact with proposals, creating a form of qualitative user data that can be directly integrated into the final design. This allowed users to create their own designs in situ and to present their designs to an audience, leading also to those designs being directly implemented into the future built result (Reaver, 2022; Reaver, 2023). Further, our findings depicted a high degree of transferability between the XR models and the physical results, suggesting that there is some transferability between the spatial experience of XR over to the real world at a cognitive level.

There are several differences between AR and VR which are worth noting. While it is claimed that digitization can help planners make more informed decisions and improve the quality of their designs and to support decision-making in real-world settings (Hasler et al, 2017), we find that the nuances between the technology domains are important to articulate and develop rather than pushing a general notion of digitization regardless of technology choice. For example, we found that Virtual reality (VR) is more useful for precise spatial studies in high detail, such as in construction and in heritage work (Reaver, 2019), but is also a specific type of technology with relatively high costs involved (Reaver 2022). This type of technology appears useful in performing pre-occupancy studies with users before construction, planning exhibitions, changes to existing buildings, and other similar types of use at interior or building scale. In extension of this argument, we found that AR is a highly intuitive tool for users in design and planning in urban settings, and we found that the use of AR impacted final design outcomes. The use of AR aided users' ability to generate their own planning proposals on site at scale, and in addition, users experienced an increased sense of confidence in displaying their design intentions and appreciated being given control of the planning process.

Some of our more notable findings concern the use of a technology like XR in an environment in which most of the development in conducted by private technology companies, creating difficulties in preserving user privacy, understanding black boxes, and generating secure and viable user data. We notably had to create fake user accounts in order to protect user privacy in accordance to research ethics standards, which also created difficulties with the Terms of Services (TOS) with the XR tools. Silverman and Cambell (2021) have noted that while we historically have let societal, judicial, and legislative forces produce rules for new technologies, XR is outpacing this watch-and-wait approach. For example, some proponents of regulation argue that XR technology has the potential to be misused or abused in ways that could harm individuals or society, and that regulations are necessary to prevent these harms from occurring.

Conclusion

It is important to reiterate that the studies were chosen to study how XR influenced normal everyday users in typical planning and design contexts. Here, it has been claimed that digital technologies can be used to engage the public in the urban planning process by making complex planning concepts more accessible to the public (Saner et al., 2019). The cross-case analysis allowed us to study this notion in some detail. The data from the cases suggests the involved users found the XR tools to be a productive medium in understanding design proposals, proposing their own designs, and in influencing final design outcomes. This aspect of the studies was shown to influence the decision-making of the responsible authorities in the planning process, perhaps showing how digitization and XR can influence co-design and participatory design by creating new forms of qualitative user data.

One could argue that the use of XR in the design and planning of the built environment seems to follow trends in technology development and design methodology towards the integration of user into the design process more in general. Here, we believe that XR could be one of several tools and should not be viewed as the only way in which to increase qualitative user data in the design and planning of the built environment. As we have shown some of the technical and regulatory difficulties regarding XR today, we believe there is a strong need for the to develop conceptual and methodology ideas for understanding virtual and non-virtual environments in a more holistic and empirically grounded manner than current practice before recommending any further expansion of the technology. It also seems critical that regulators and public institutions are afforded more insight and control over the development of XR if it is to be used for such types of use involving everyday citizens. Here, we think that some of the interesting work being conducted at the intersection of human cognition, embodiment within space, and the phenomenological experience of space such as Pykett et. al (2020), Naghibi et al., (2023), and many others have demonstrated, could help move such research forward.

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ECOSYSTEM SERVICES: AN INTERPRETIVE PARADIGM OF URBAN AND TERRITORIAL HERITAGE. STRATEGIES, GUIDELINES, AND VISION FOR SUSTAINABLE CITIES.

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Abstract

The current challenge in urban contexts is to achieve a sustainable balance between urban and rural areas, especially in conflict situations such as wars or natural disasters, where connectivity between ecosystems can be disrupted, causing a significant impact on ecosystem services (ES) provided by affected areas. For example, vegetation destruction can cause soil erosion and reduce water absorption capacity, increasing the risk of floods and avalanches. In a world plagued by the danger posed by climate change, it is necessary to reflect on the opportunities offered by ES that natural capital provides. How? This is the task of those, such as architects and designers, who can implement new paradigms of energy sustainability for resilient communities. It is a new opportunity that we must not miss for the ethics and mission that we have as builders of well-being. Cities are often places of conflict, where people struggle for limited resources, such as green spaces, water, clean air, and food. However, creativity can help solve these conflicts by finding new solutions that consider multiple interests and needs. For example, public art and music can be used to raise awareness about the importance of ES and to promote biodiversity conservation. Such initiatives can also contribute to strengthening the sense of community and improving people's psychological well-being, creating a positive impact on urban quality of life. While ecological connectivity and the promotion of ES are essential to create sustainable, resilient, and livable cities, the creation of green corridors and the promotion of urban biodiversity are just some examples of how connectivity can be promoted to improve the quality of the urban environment and the resilience of the city. But how can we integrate these concepts into urban design? My research aims to suggest some key strategies. First, it is important to consider ES in urban planning from the beginning so that they can be appropriately integrated into urban design. Second, ecological connectivity must be promoted in urban design through the creation of green corridors, the promotion of urban biodiversity, and the use of green infrastructure such as green roofs and walls. Finally, it is important to involve the community in urban design to arrive at solutions appropriate to local needs and expectations. This green balance is essential to ensure the conservation of biodiversity and the production of ES that positively influence human well-being. My doctoral thesis focuses on the use of ES in a specific area of the Metropolitan City of Reggio Calabria (Calabria, Italy) to interpret urban and territorial heritage and understand how they can contribute to the sustainability of the city. The goal is to create a replicable model for enhancing green in urban, peri-urban, and extra-urban contexts, increasing the ecological functions of ecosystem services, and raising community awareness of their importance. The research methodology will follow a transdisciplinary and participatory approach, involving the community in the evaluation process.

Author's keywords

Ecosystem services - Strategies and guidelines - Environmental and social assessment - Natural capital - Biodiversity - Environmental resilience

Introduction

The processes of urbanization and chaotic growth of cities have taken place in most countries of the world. Almost 80% of the European population lives in cities, and it is estimated that by 2030 these regions will have even more inhabitants. This exerts enormous pressure on the natural environment and leads to the loss of components necessary for the proper functioning of ecosystems and human life. The impact of urbanization on ecosystem services has been emphasized, and it is important to consider ecological values in activity planning. Green areas in cities are important for human well-being as they perform ecological functions and provide ecosystem services. Seven different types of urban ecosystems have been identified that generate a range of ecosystem services: street trees, grasslands/parks, urban forests, cultivated land, wetland, lakes/sea. These systems generate a range of ecosystem services. The concept of ecosystem services has changed the perception of the importance of nature for human societies and transformed it into a vision of the environment as natural capital. However, the challenge is to increase society's awareness of the value of natural capital. (K. Pukowiec-Kurda, 2022).

Study area and methodology

The doctoral thesis aims to investigate the use of ecosystem services (ES) in a specific area of the Metropolitan City

of Reggio Calabria, whose territories are currently subject to various risks, mainly due to the low human presence and the lack of attention to the resources and values present. There is strong pressure for the transformation of coastal areas for the construction of holiday homes, while many villages and rural areas - which constitute our urban heritage - are being abandoned. In addition, the lack of care and management of forests, which cover over 30% of the total surface area of the Metropolitan City, leads to deliberate fires and the loss of an important resource. This contributes to a decrease in biodiversity and the loss of ES, causing damage to the environment and the quality of life of residents (Fallanca C, Taccone A., and Corazziere C. 2019). The use of the interpretative paradigm of SE becomes a unique opportunity for territorial and urban planning to create human settlements that, through new methods and approaches, can lead to greater integration of natural ecosystems into the city, greater environmental resilience, and the creation of more sustainable cities for residents and future generations. The interpretative paradigm refers to a way of seeing and understanding these ES as an integral part of the urban and territorial heritage and understanding how to transform cities from consumption cities to sustainable cities. The general scientific theme focuses on the development of strategies aimed at identifying a methodological system that is replicable and adaptable to contexts similar to the case study under investigation. The general objective is to develop a model for the "Enhancement and implementation of greenery" within urban contexts in order to improve/maintain the ecological functions of ES. The strategy will be identified through the elaboration of guidelines related to the development of SE within a vast territory such as that of the Metropolitan City of Reggio Calabria. These will take into account the effects of climate change and aim to achieve the objectives of the Agenda 2030 to build a resilient future. In other words, the goal is to look at the design and management of territories with an ecosystemic and strategic vision on the role of green spaces in cities, so that they can withstand future threats and pressures and provide essential ecosystem services for human well-being in a sustainable way. (Soil consumption report (2022), Taccone A. and Fallanca C. (2021), K. Jax, A. K. Bresch, S. Riediger (2020), A. L. Marques, A. T. B. Alvim and J. S. (2022), D. Poli (2020).

The ecosystemic vision of urban greenery is not just a matter of conservation, but also promotion. In fact, through greater awareness and appreciation of green areas, it is possible to promote an improvement in the quality of life for people by providing a healthier and more comfortable environment. For example, the presence of trees and other plant elements can help reduce air pollution, improve air quality, and reduce the perceived temperature for people. This can help mitigate the effects of climate change and create a more comfortable environment for the population. In this context, ecosystem services (ES) can play an important role in contributing to the improvement of connectivity and creativity in times of conflict. For instance, urban and peri-urban greenery can become a space for meeting and dialogue among diverse communities, promoting social cohesion and mutual understanding. Additionally, the presence of green spaces, the promotion of urban agriculture and biodiversity can reduce the level of stress and tension in the population, contributing to a better management of emergency situations. Furthermore, connectivity and creativity can be fostered through the creation of bike and pedestrian paths, green corridors, and the enhancement of green spaces as venues for cultural and recreational activities. In this way, ES can become a tool for promoting innovation and creativity, contributing to a higher quality of life and the construction of a more sustainable and resilient society. The aim is to understand the various ways in which ES contribute to the well-being of people and the environment, develop innovative solutions for optimizing and utilizing specific assets in order to minimize environmental risks, and for the management, conservation, implementation, and reintegration of such services. It also involves developing a more sustainable and balanced approach to urban and territorial heritage, to the benefit of all stakeholders. To achieve this goal, research can involve a range of activities, including the mapping and evaluation of ecosystem services (Santolini R., Morri E. 2017b), analysis of trade-offs and synergies between different services, stakeholder engagement, and the development and experimentation of management strategies. The research project will use a transdisciplinary and participatory approach, involving the community in a "participatory evaluation" process. This will lead to more informed and sustainable decisions, as different perspectives and knowledge are taken into account. This will demonstrate that environmental resources have social and environmental value, as well as economic value. Currently, the prevailing approach is focused on the economic aspect, ignoring the negative effects on the ecosystem. Therefore, it is necessary to reverse this paradigm and protect ecosystem regulation and support services, evaluating first how the ecosystem works and then how it can be used. We are talking about the environmental and social values of urban parks, such as carbon capture, thermal regulation, mitigation of the urban heat island effect, and benefits for the mental and physical health of the population (WWF, 2022). Policies and actions must be coordinated to achieve these objectives, and investments from various sources indicate the urgency of intervention. Trees are an essential element of the One Health system (ISS, 2022), and their health impacts environmental, animal, and microbial health. Living near green spaces, such as forests and parks, has been shown to have beneficial effects on people's gut microbial flora, underscoring the importance of trees in cities. There is a lot being done to achieve city sustainability, from urban areas to large areas, and this is confirmed by the huge amount of measures and actions related to the National Recovery and Resilience Plan (PNRR) that plans to plant 6.6 million trees by 2024, and the EU plans to plant around 3 billion trees by 2030. (MASE 2022) The research will be structured in phases. The evolution of the concept of ecosystem services in recent decades will be analyzed, and the main themes and objectives of the research will be studied, emphasizing that regarding the two main theories on the value of ecosystem services, namely the theory of economic value and the theory of ecological and social value, this research intends to adopt the ecological and social aspect. Giving importance to this aspect and focusing on ecological and social evaluation and conservation of the services that ecosystems provide to humans and the environment, to contribute to sustainable management of ecosystems and ecosystem services for more sustainable and resilient cities. In the first phase, the following will be carried out: analysis of historical data, analysis of scientific literature, collection of data and information on the characteristics of the territory and the ecosystem services offered, for example

through studies already conducted and geographical and satellite data. Identify and map areas that provide the most important ecosystem services and that need to be protected and enhanced, using spatial analysis and modeling techniques (e.g. QGIS, ArcGIS, etc.). In this phase, the use of artificial intelligence could also be envisaged to: analyze data and identify any deficiencies or critical areas where ecosystem services are not adequately provided (e.g. for data processing for creating predictive models [federated learning/machine learning] - analyzing user feedback, for example through social media analysis or other geospatial data sources. The phase will conclude with the analysis of virtuous case studies. In the second phase, we will proceed with: identifying and involving local stakeholders/placemakers, such as residents, associations, businesses, and public institutions, as well as researchers to create a research network that shares knowledge and perspectives on ecosystem services and their relationship with urban sustainability. Participation techniques such as questionnaires, workshops, and focus groups will be used to study the relationship between the community and the urban and territorial heritage, the use of natural resources, and the impact of urban development on the environment and communities. These actions can provide information on the community's perceptions regarding the urban and territorial heritage and the ecosystem services used. This second phase will conclude with the definition of specific research objectives based on the results of data analysis and the community's needs, and they will be consistent with them. Moreover, they will be formulated in such a way as to ensure that the research is relevant and useful to the end-user. The objectives should be shared by all stakeholders, ensuring that all stakeholders and placemakers are committed and involved in the research. In the third phase of the project, a highly structured and well-defined approach is planned. First, strategies and guidelines for a sustainable city are designed, taking into account the results of the analysis phase and the defined objectives. This step is crucial to define the objectives and actions that must be taken to achieve them. Next, the implementation of the designed strategies and guidelines is carried out, involving stakeholders and placemakers through co-design processes. This participatory approach is essential to jointly define strategies and guidelines with the aim of integrating ecosystem services into urban and territorial planning. In this phase, it is important to adopt a transdisciplinary approach, considering the needs and perspectives of different categories of actors. Finally, once the strategies and guidelines have been implemented, the effectiveness of the actions taken is evaluated. This is done through a series of environmental, social, and economic sustainability indicators. These indicators are crucial to understand whether the actions taken have actually achieved the set objectives and have been able to produce a positive impact on the community and the environment. This ensures the continuity and sustainability of the project over time.

Conclusion

In conclusion, the research emphasizes the importance of adopting an ecosystemic vision of urban and peri-urban green areas, in order to conceive green spaces as a natural capital of our cities, such as tree-lined streets, green roofs, neighborhood green spaces, as well as larger areas in peripheral fabrics such as large urban and territorial parks, agricultural green spaces, and green areas around rivers, schools, and hospitals. This requires strategic actions aimed at protecting and enhancing green areas and their urban and territorial heritage, creating a better future for all inhabitants. The proposed strategy involves the identification of a replicable and adaptable methodological system for similar situations to the study context, in order to identify the ecosystem services present on the territory, those that are lacking and those that are needed, understanding the risk of their loss and their counter value. This emphasizes the importance of considering synergies between different ecosystem services and finding alternative solutions to compensate for the loss of one of these. For example, if a green area is converted into a building area, it is important to find an alternative to maintain a certain level of ecosystem services, such as CO2 absorption or noise pollution reduction. This holistic approach is essential to ensure sustainable and long-lasting urban planning. The expected result at present is therefore the elaboration of guidelines related to the development of ecosystem services in order to ensure sustainable development and the safeguarding of the natural heritage of the territory.

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Characteristic analysis of future-oriented design based

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Abstract

This paper focuses on the future-oriented design form, analyzes its characteristics from the perspective of cognitive context theory in contextual Lingustics, and then proposes and emphasizes the important role of "mutual knowledge" in constructing future context by establishing a cognitive model of future context. Therefore, establishing "mutual knowledge" can help people quickly grasp the characteristics and challenges of the future-oriented design and promote public understanding of design intentions. Designers and the public cooperate and consult in a "cognitive co-creation" way under the action of mutual knowledge. In the future-oriented design process, designers need to not only make efforts in future positioning, fictional scenes, and prototype design but also pay attention to context cognition, context reset, and context creation. Meanwhile, they should also actively establish "mutual knowledge" with the public, promote the public's reasoning and internalization of future context with the help of relevant theories of cognitive context, and better understand designers' intention hypothesis, thereby effectively guiding the public to perceive the future.

Author Keywords

Cognitive Context; Mutual Knowledge; Future-oriented Design; Characteristic Analysis.

Introduction

As the futurology method is constantly penetrating into the research process of design, the object of design is no longer limited to the problems that already exist in the real world, but the presupposition of various possibilities in the future, so many new future-oriented design ideologies are formed, including Speculative Design, Futures Thinking, Design Fiction, Experiential Futures, and so on, which focus on the enlightening significance of unrealistic future imagination to the present. As it aims at the presupposition of unrealistic problems, the future-oriented design process not only brings challenges to both designers' imagination and creativity and the public's understanding. In other words, it aims to understand the intentions and assumptions beyond reality on the basis of reality, and then form identity and resonance. To solve this problem, the author will make a further analysis and discussion with the help of the relevant knowledge of verbal communication in Contextual Lingustics.

Theories Related to Cognitive Context

Context is closely correlated with the construction and interpretation of meaning (Zhou Shuping, 2011). Firstly, context can be used to explain the impact of various factors outside the design on the design, thereby restricting the design to a certain extent; Secondly, context can explain the "Variation" phenomenon of design in the understanding process, that is, people have different views on the same design in different contexts, so the meaning of design needs to be identified in a specific context; Thirdly, context can provide additional information and further explain the design, such as eliminating ambiguity, determining the reference, giving implication, generating associative meaning, etc, so the incompleteness in the process of design communication needs to be supplemented by context; Fourth, the context has a generating function. Due to the annotation and supplement of the context, the design shows the potential to transcend its own attributes, so it can bring new value.

Moreover, in the article *On the Characteristics and Functions of Context*, Chen Zhi'an and Wen Xu hold that restrictive and explanatory functions are the most basic for context (1997). If the design is separated from the context, its value and significance will be ambiguous and migratory, so only when it is understood by combining with the context can it stabilize. Based on the above reasons, we need to pay attention to the understanding, creation, and expression of context in the design process. In linguistics, studying context aims to understand the correctness and applicability of rhetoric, but for future-oriented design, paying attention to context can provide scope constraints and references for designers' work and reflect on the appropriateness of design behavior.

Dan Sperber and Deirdre Wilson put forward that context should be regarded as a psychological construct, and the physical information of the outside world, the previous discourse, the expectation of the future, the scientific hypothesis, the religious belief, the anecdote memory, the cultural concept, the inherent view of the speaker's psychological state and so on should be included in the context scope (Sperber, D.& Wilson, D., 2015). The context is based on a series of assumptions in the listeners' brain, and only when various objective contextual factors are cognitively filtered can an effect be produced on the generation and understanding of the discourse meaning. Therefore, context is an internalized reasoning cognitive process.

In the cognitive process of context, some contextual factors such as background knowledge, time and place of communication are relatively stable, and others constantly change in communication, especially mutual knowledge, which continuously expands in actual communication. That is, the knowledge that is not shared by both parties becomes mutual knowledge in the process of communication, thereby becoming the basis of further communication (Sperber, D.& Wilson, D., 2015). The public can neither achieve effective communication and recognition nor be affected by action and consciousness if they understand the future-oriented design intention only by using the existing knowledge framework and cognitive conditions. Therefore, designers need to make efforts to establish mutual knowledge with the public in the actual communication process and help the public internalize contextual conditions, thereby accelerating empathy. Mutual knowledge refers to the common knowledge of both sides. Thus, both sides should not only share this knowledge but also know that either side has such knowledge, aiming to enhance mutual understanding. The establishment of mutual knowledge is dynamic and can be superimposed on each other, and each round of cognition forms new mutual knowledge. Based on this, a new round of deeper understanding is a progressive process.

Characteristic Model Analysis of Future-Oriented Design

Cognitive Process of Future Context

In the traditional design process, designers need to abide by objective context conditions, but in the future-oriented design, they need to create hypothetical context conditions beyond the reality. The public needs to internalize the above contextual relations and contextual content and experience the following contextual cognitive process (see Figure 1).

The contextual conditions assumed by designers can be understood as "new information". After receiving the new information, the public will associate their psychological schema and produce a series of psychological processes for the input information, including selection, analysis, matching, and fitting. Later, after filtering the psychological schema, new information will be transformed into old information and known information, which will be internalized by the public as a new cognitive basis to understand other new information, thereby constantly establishing new understanding and forming a new cognitive context. Therefore, the mutual transformation of old and new information can promote the renewal of the public's internal knowledge and experience, which in turn affects the reconstruction of psychological schema. Designers can create stable contextual elements. However, the public realizes their psychological process in a dynamic way, and their understanding of contextual conditions and hypothetical intentions is constructed in a spiraling form.

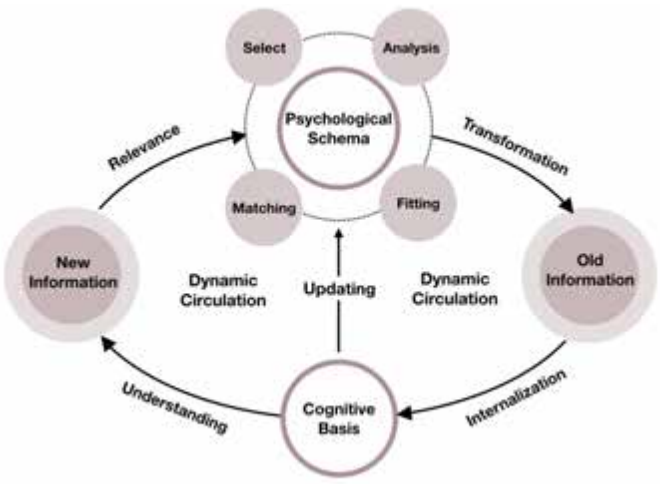

Figure 1. Cognitive process schema of context.

In the process of future-oriented design, the public will no longer evaluate based on the current needs and subjective likes and dislikes, but designers will attempt to change the original concepts, attitudes and ideas of the public, that is, the cognitive basis, and then understand on the premise of full internalization of context. Only when the context is internalized and perceived, that is, the new information provided by designers changes the public's old contextual assumptions, can the contextual effects be produced and contextual conditions with new cognitive foundations can be formed. The old contextual assumptions are constantly revised, enriched and optimized to form the basis of information processing and discourse derivation. In addition to the cognitive process of context, it is also necessary to discuss the specific context content, that is, the context object of cognition in more detail.

Important Role of Mutual Knowledge

The factors involved in meaning generation and meaning understanding are the elements of context (Liao Meizhen & Han Dawei, 2012). The design meaning for non-realistic problems is the contextual premise that needs to be created urgently, that is, guiding the public to fully understand the meaning of creating the future, including the meaning of imagination, the meaning of inspiration, and the meaning of reflection, which can be defined as subjective future contextual conditions.

In addition to subjective contextual conditions, there are also objective contextual conditions, such as macro future context and micro future context. The macro future context refers to the positioned future types and world view construction; the micro future context refers to the specific future scene and the specific environment of the design prototype, such as time, place, character, event, motivation, and demand. Only when the macro and micro future contexts are combined can the role of the design prototype be clearly judged. Macro context, micro context and design prototype are intertwined and explained to each other. If the public understands the future only from the prototype itself, they will doubt and then reject and confront. If the close relationship between the three is internalized under the premise of mutually intertwined objective context, the concerns will be dispelled, and designers' intention hypothesis will be understood more comprehensively and accurately, thereby forming an objective evaluation of the design results. Subjective contextual conditions and objective contextual conditions are fully internalized through cognitive reasoning, that is, there is mutual knowledge between designers and the public (see Figure 2).

The object of the future-oriented design has changed from known to unknown, from present to future, from reality to

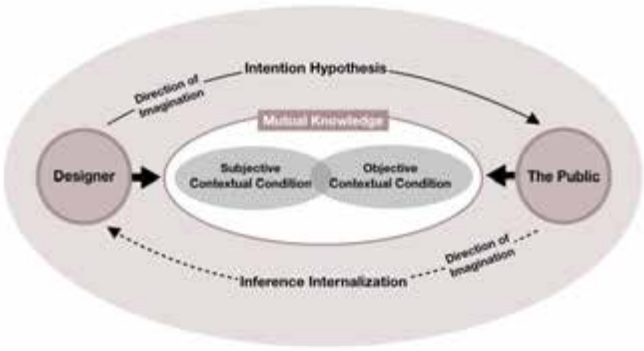

Figure 2. Mutual Knowledge in the future context

beyond reality, so designers need to create new subjective and objective contextual conditions, that is, mutual knowledge. Mutual knowledge is not only a prerequisite for the public to understand the presupposition beyond reality with realistic cognition but also an effective way to deal with cognitive challenges. The more solid the mutual knowledge is established, the stronger the public's sense of identity with the design, and the more it can promote the refresh of its old information, thus forming a new judgment.

The subjective and objective contextual conditions are known, observable and decidable in the traditional design process, but in the future-oriented design process, the macro and micro contextual conditions are fictitious, beyond reality, based on speculation, unobservable, and not completely-specified, which are challenges for building mutual knowledge.

Conclusion

In this paper, the theories related to Contextual Linguistics are used to help designers realize that the contextual factors, contextual levels and assumed conditions of future-oriented design are more abundant and complex than problem-solving-oriented design. Mutual knowledge, as an important part of future-oriented design, emphasizes the unity of the context world, the physical world, and the psychological world. The context world is a hypothetical background that is dependent on design. The physical world is a physical prototype that is completed using real-life conditions. The psychological world is a public understanding and evaluation of the design. In the future, how to stimulate mutual knowledge will be the focus of designers. Moreover, the concept of mutual knowledge also redefines the relationship between designers and the public. Therefore, since designers no longer have all the power to take initiative, the public is not only a key participator in building mutual knowledge but also an important provider of future context. A complete context has a close correlation with the participation of the public in various fields who have various identities and different cognitive experiences. Designers and the public cooperate and consult in a "cognitive co-creation" way under the action of mutual knowledge, which will greatly inspire the future-oriented design method.

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Digital wellbeing and design

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Abstract

The aim of the doctoral research is to develop the links between the development of digital media literacy (as practices for reducing exposure to online risks), digital well-being (as practices for creating a healthy relationship with technology) and different design theories and research methodologies.

The research focuses on the emotional effects of the cognitive, emotional, mental and physical effects of the digital media environment, and approaches the examination and processing of users' feelings related to the digital environment; on one hand, research on digital (media) literacy and online risk exposures (mainly with the device itself - overuse and data, artificial intelligence, privacy; and the risks associated with obtaining information: in relation to hate speech, disinformation and the information bubble phenomenon, and in connection with "new technologies". Can any kind of system be related to collective concepts such as security, trust, intimacy, and what results can be generalized from these in relation to the effects of the digital environment?

Industry must also take responsibility in this area; they need to review their existing approaches and practices; primarily in the areas of meeting the need for immediate fulfillment of needs, informing users, their freedom of choice, security, and the use of their data; and these are also design decisions. That's why a multi-stakeholder approach is a must.

The research will use a mixed method approach: qualitative data analysis (interviews, "love letter method"), developing a "Digital Wellbeing Questionnaire", and reflects on the research through a critical / speculative design university course.

In addition to the presentation of the theoretical framework, the preliminary, partial results of the research and the connection to the development of media literacy are also presented.

Author keywords

digital wellbeing; media literacy; self-determination theory; positive technology

Introduction

Living within the complexities of our information and media ecosystem is often challenging. We live in a world mediated by technology and information, we are surrounded by digital devices and applications, platforms and algorithms building and operate them. We are transformed by these media, whether we have invited them into our lives or not.

The main goal of the user-centered, technology-related design is to encourage use of digital media. Features that make digital technology or media useful (reliability, mobility, user-friendly approach, and fast processing) can endanger our productivity and innovations, foster involvement, immersion, and engagement. As we know, this content is often specifically and scientifically designed to attract users' attention. Design decisions – using the behavior model for persuasive design (Fogg, 2009) – are driven more by the commercial requirement for data and attention, than by consideration of user's best interests. That's why self-control in using digital technology is simply not enough for us to cope with side effects of information overload, also we must consider industry's responsibility.

The methodology of digital media literacy is based on the premise that the development of user awareness can provide protection against the "harms" (risks of using it) of digital technology; however, this approach is proving not to be enough in today's media environment. As Lewis (Lewis, 2021) explains, media literacy has focused mainly on developing the skills to access, analyze, evaluate, and create media messages, and has not focused sufficiently on the impact of the actual technological medium, how it enables and constrains both messages and media users. "A new dimension of digital skills is arising as a result of the massive diffusion of mobile connectivity and of the consequent availability of an overabundant number of information and social relationship options in daily life"(Gui et al., 2017).

The concept of digital wellbeing should give an approach to observe our relation to technology in the context of emotions and this should help "giving back the control" to the user. As self-control in using digital technology is simply not enough for us to cope with side effects of information overload (Lewis, 2021.), "We need to control digital stimuli and filter them so that they can serve our personal aims and well-being." The opportunities and risk exposure of young people in the online media environment is influenced by many factors. That's why we need to consider not only the types and amount of online media use and risk exposure, but also focus on the user's subjective experience (Feerrar, 2022; Gui et al., 2017). Rather than thinking about a right or wrong way to engage online, digital well-being "recognizes the nuance of individual experience and a range of possible choices" (Feerrar, 2022) and provides a new approach for users to understand media life (Deuze, 2011), also for media literacy education based on user's different experiences .

The doctoral research focuses on the emotional effects of the cognitive, emotional, mental and physical effects of the digital media environment, and approaches the examination and processing of users' feelings related to the digital environ-

ment; on one hand, research on digital (media) literacy and online risk exposures (mainly with the device itself - overuse and data, artificial intelligence, privacy; and the risks associated with obtaining information: in relation to hate speech, disinformation and the information bubble phenomenon, and in connection with "new technologies". Can any kind of system be related to collective concepts such as security, trust, intimacy, and what results can be generalized from these in relation to the effects of the digital environment?

Presentation of the doctoral research

Research questions

- How do users feel when using digital media devices and platforms? Are there specific needs and frustrations, is it possible to disperse these complex feelings?
- How do these emotions compare to known, online risk factors , anxiety-inducing or intangible?
- How does online emotion regulation would help to cope with online risks?
- What design practices and patterns can be recognized to support user awareness and digital well-being in mediatized spaces?
- How different stakeholders (users, designers, owners, regulators) think about digital wellbeing and the real needs and frustrations of digital media users?

Theoretical framework

- **Digital media literacy:** The ability to understand, access, evaluate, and analyze information created online or digitally, to communicate and participate in civic life as competent media consumer, contributor, and creator of media in the online community. (Chilsen, 2018; Smith & Livingstone, 2017)
- **Digital wellbeing:** Digital wellbeing is a term used to describe the impact of technologies and digital services on people's mental, physical, social, and emotional health. (Betham, 2015), "The impact that digital technologies, such as social media, smartphones, and AI, have had on our well-being and our self-understanding of what it means to live a life that is good for us in an increasingly digital society" (Burr & Floridi, 2020).
- **Positive psychology / Self-determination theory:** Self-determination is a broad theory of human motivations, both intrinsic and extrinsic. A core tenet of the theory is the existence of three basic psychological needs for competence, autonomy, and relatedness that energize human behavior across domains (Ryan & Deci, 2000).
- **Positive computing** is a technological design perspective that embraces psychological wellbeing and ethical practice, aiming at building a digital environment to support happier and healthier users, based on self-determination theory (Calvo & Peters, 2017).
- **Critical and speculative design:** It confronts commercial and traditional design practice. Through the design of critical objects and speculative narratives. "Instead of thinking about appearance, user-friendliness or corporate identity, industrial designers could develop design proposals that challenge conventional values." (Dunne & Raby, 2013)

Data collection and analysis method

- **"Love and breakup letter method"** (Martin & Hanington, 2012) This method is especially useful for usability research, where it reveals the kind of emotional relationship people have with their technological device. This is a qualitative method which enables the researcher to receive an in-depth description of emotional experiences. The data collection provides rich data, which will be processed by content analysis, using the Atlas.ti software. With this, the "mapping" of hidden and often contradictory feelings should be revealed, and probably connected to prior knowledge about online risk and possibilities, digital media control methods. Asking about the user's experience on "behavior", "communication" and "knowledges sharing" would like to connect the results with terms as "trust", "gratitude", or feelings as FOMO, concerns as body image or privacy.
- Developing a **"Digital Wellbeing Questionnaire"** based on Self-Determination Theory's Basic Need and Frustration Scale (Vansteenkiste et al., 2020) for teens and adults. It should be connected to other scales measuring digital media use and feelings (FOMO, social media anxiety) and with a media use questionnaire. Assessing the subjective sense of digital well-being can contribute to understanding user's motivations and frustrations. The Basic needs and frustrations sub-theory of Self-determination theory plays an important role in research on the uses and effects of interactive media (Rigby & Ryan, 2018). Stimuli of digital media can lead to both satisfaction and frustration of basic psychological needs (Schneider et al., 2022).
- **Critical design course** at the MOME-Budapest University to be part of a creative, artistic research-based approach to the results.

Preliminary results

Love and breakup letters – mapping feelings about digital technology

In the first phase of the research, the measuring instrument was completed, and the survey was completed in three focus groups among 39 people, mostly women aged 40-60, who rarely use online platforms. Several basic feelings (joy, gratitude, anger, pride) were identified in the text. Digital devices (phone, laptop) are mostly seen as partners, while platforms cause more frustration. Several phenomena of technology stress have been identified, such as information overload, acceptance anxiety, nomophobia, FOMO, and availability stress. The research will continue with the involvement of additional target groups.

Digital wellbeing among 12-14 years old

The goal of this research phase is to examine the possible relations between the factors of satisfaction and frustration and online risk; also, to validate the Digital Wellbeing Scale. In this research, we used the Basic Psychological Need Satisfaction and Frustration Scale (BPNDFS) (Vansteenkiste, M. et al. 2020)., translated and adapted to the digital environment. Using data from a cross-sectional survey of 300 Hungarian pupils (age 12-14), the theoretical model demonstrated adequate reliability and validity. Five clusters were set up: "satisfied", "average", "not interested", "rollercoaster" and "com-

petence-frustrated". The results show that the degree of satisfaction is mainly shaped by the feeling of competence, but frustration is by the lack or poor quality of connectedness. Connections can be explored between satisfaction/frustration and online risk exposures, such as social anxiety and higher levels of frustration.

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Appropriation and appreciation of Austrian and Indonesian puppetry

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Abstract

Austria contributed to the most important development of rod puppetry in Europe since Richard Teschner initiated to development of his rod puppet inspired by Indonesian *Wayang Golek*. He modified the Javanese rod puppet technology and fashioned his own exotic and rare marionette figures. Through his *Nawang Wulan* puppet version, Teschner tried to represent the original story of *Nawang Wulan*, with his appropriation and appreciation for the artistic object. His representation of other cultures can be regarded as a form of cultural appropriation. Through this research, the secular and religious aspects of cultural appropriation can be discussed. Teschner's puppets can become a good example that shows cultural appropriation is not something that should be avoided in making art, instead it can inspire artists to make new creations and still represent the artistic entity.

Author keywords

Cultural appropriation; puppets; aesthetic; *wayang golek*

Introduction

Historically, puppetry seems to have existed in most civilizations since it represents one of the most primitive instincts of humanity. It may certainly be said that puppet theatre has everywhere antedated written drama and writing of any kind (Speaight, 2017). Puppetry is essentially folk art, and its origins are generally thought to lie mainly in the East. Asia is the source of many of the ideas and techniques of the puppetry of the West since it was highly sophisticated at a very early date (Currell, 1974). In many traditions, puppets are articulated objects, engineered to receive and express motion. It also acts as an existential mirror, reflecting the precariousness of our condition as living subjects (Guy, 2013).

Austrian Puppetry and Indonesian Javanese Influence

In many parts of Europe, puppetry was well established by the thirteenth century, and free exchange between the countries there has produced similar trends and styles in puppetry. Austria contributed to the most important development of rod puppetry in Europe since Richard Teschner, an accomplished puppeteer and stage designer, initiated to development of his own very intricate type of rod puppet, often with a complicated system of control strings inside the supporting rod.

Whereas, in Indonesia, people always refer to *wayang* theater when they think about traditional puppetry. *Wayang* is a classical Indonesian Javanese puppet theatre that uses the shadows thrown by puppets manipulated by rods against a translucent screen lit from behind (Britannica T. E., 2018). It has roots dating back over one thousand years and holds a significant meaning to Indonesian society. The term '*wayang*' means 'shadow' in Javanese, although it also means 'imagination' and indicates 'spirit' (Widyokusumo, Darmawan, & Wijaya, 2012). Unlike *wayang kulit* which is a two-dimensional figure, *wayang golek*, is a three-dimensional wooden figure which originated from Sunda, West Java (Suryana, 2002). The term '*golek*' means 'wooden doll' in Sundanese (Panitia Lembaga Basa dan Sastra Sunda, 1981). However, other Javanese pundits say that the term '*golek*' means 'look' or 'search' since *wayang golek* puppet facilitates the search for meaning by spectators in a way that shadow puppet cannot (Cohen, 2007).

Inspired by *wayang golek* brought by Dutch explorers from Java in the 1920s, Teschner opened an artistic small rod-puppet theatre called *Figurenspiegel* (Magic Mirror) later in Vienna (Currell, 1974; Britannica T. E., 2021). He modified the Javanese rod puppet technology and fashioned his own exotic and rare marionette figures. Although, in contrast with *wayang* theatrical form that traditionally very discursive, Teschner presented his dreamworlds of puppet theatre with mute figures since he was adamant that puppets be made from wood and should not speak. He designed his stages that allowed for the most intricate changes in lighting and back projection (Cohen, 2007; Joseph, 1920). Teschner's work influenced leaders of the 20th-century puppet theatres throughout Europe and the United States (Britannica T. E., 2021). The work has also been compiled on videos and revivals can be seen at the Theatre Museum in Austria today.

Appropriation and Appreciation

Puppetry has carried on the essential characteristic of the country that produces it, reflecting the national temperament and psychology of its society (Currell, 1974). Through this research, I tried to analyze visual forms of Austrian rod puppets and how far Indonesian *wayang* had influenced them. Moreover, I would like to find the depth of understanding between two cultures and how this aspect can be shown in the visual form of the puppets.

Figure 1. Nawang Wulan puppet by Richard Teschner (1912)

Figure 2. Wayang golek puppet

During my primary visual observation, there are some interesting findings regarding the form of Teschner's puppet with the original Javanese *wayang golek* puppet. Through his *Nawang Wulan* puppet version, Figure 1, Teschner tried to reconstruct the original *wayang golek* puppet from Java, Figure 2, and modified it with advanced technology to make a more complex movement. Although, he kept the anatomy of Javanese puppets as his *core* influence i.e., the thin, flexible limbs of the puppets that still gave the feeling of the original forms of *wayang*. Most puppeteers believe that Teschner's appropriation of *wayang golek* is in many ways authoritative (Cohen, 2007). Furthermore, after my interview with Angela Sixt, the curator from Theater Museum Vienna, researcher got some interesting points that led her to the importance of cultural appropriation between Austria and Indonesia. Like most Western puppeteers, Teschner mainly referred to the naturalist style for visual forms and facial expressions in his puppets, which imitated or depicted human features. However, the bone structures and head proportions of his puppets were still following Javanese *wayang golek*. Based on Sixt's information, Teschner found the 'unique' anatomy of *wayang golek* fascinating. With the obvious 'caricature' size of the head and thin arms, he thought it was an exotic and rare visual figure, which was acceptable since it was a puppet. Based on Teschner's understanding, puppets can be designed based on imagination and fantasy (Sixt, 2022). Therefore, in his puppet version, *Nawang Wulan* was a puppet with a unique head and body proportion with better and more beautiful facial features. The original artwork opens up new perspectives. It excites the imagination in new ways. (Young, 2006). The representation of other cultures is often regarded as a form of cultural appropriation (Young, 2008).

Figure 3. Artistic Appropriation (Wijaya, 2023)

Referring to Teschner's understanding of visual forms, I define his approach as part of artistic appropriation. He tried to represent the original story of *Nawang Wulan* with his appropriation and appreciation for the artistic object. Artistic appropriation, Figure 3, like found object art, is defined as "the purposeful copying, borrowing, and altering of previous imagery, objects, and concepts as an aesthetic method (Art in Context, 2022). In this case, Teschner was an *outsider*, a non-member individual (Young, 2008) of Indonesian culture, who tried to do artistic appropriation by borrowing and altering the cultural object.

As an *insider*, a member of Indonesian culture, I understand Teschner's secular perspective of artistic appropriation. While Teschner, as an *outsider* and as a Westerner, was fascinated by the rare and unique proportion of the puppet, Indonesian *wayang* puppet artists do not focus on the 'ideal' proportion, instead, they deliberately create 'distortion' figures, such as larger head size and smaller body proportion. The aesthetic value of *wayang* relied on its symbolic meaning and must be created by following '*pakem*' or Javanese-specific rules (Suryana, 2002). Furthermore, the main reason why Indonesian puppet artists/makers focus on 'distortion' is based on a religious perspective. *Wayang* puppets were used as the best medium to disseminate the religious ideas of Islam in the ancient Javanese kingdom and society. Islamic resistance to the representation of living beings ultimately stems from the belief that the creation of living forms is unique to God (Department of Islamic Art, 2001). Since it is forbidden to depict human form for Muslims, the *wayang* puppets must be created in a certain way, to show that it represents human but does not look like a human (Widyokusumo, 2021).

Artists can appropriate culture i.e., tangible (object) appropriation and intangible content and subject appropriation (stories, styles, motifs, design; subject matter) (Young, 2008). Through his work, Richard Teschner had shown a sample of tangible (object) appropriation, although he did not appropriate the subject matter, which in this case, the story and religious perspective since he had no knowledge about these matters as an outsider of Indonesian culture. I cannot say Teschner produced existentially authentic puppets, but I believe that he did an aesthetic success with his creation. As Young stated, artists represent their own experiences in their work. In representing their experience, artists represent what is already theirs. They do not represent the experience of anyone else (Young, 2006).

Conclusion

Through this preliminary research about the connection of Austrian and Indonesian puppetry from a cultural appropriation perspective, I, as an *insider*, acknowledged that Teschner, as an *outsider*, had produced a great work aesthetically. He enhanced the technology of his puppets, which made them unique and had more possibilities for dynamic movement. Although he did not essentially know about the religious subject matter, he managed to appropriate his puppets without offending Indonesian culture. He kept the most essential aspect i.e., the proportion of the original *wayang golek* puppets. Teschner's creation can become an example that cultural appropriation is not something that should be avoided in making art, instead, it can inspire us to make new creations and still represent our entity. Thus, I will conclude with Young's statement, "Personal authenticity is an aesthetic merit. All things being equal, a work of art is an original expression of an artist's genius is more valuable than a derivative one (Young, 2006).

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Reinventing the gastronomic experience: using interactive digital environments to raise awareness of food-related cultural heritage

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Abstract

Food is a resource that provides a multi-sensory experience. It is experiential and becomes emotional, ritualistic, and symbolic. A two-way cultural exchange exists between food and people. On one hand, each culture's cuisine is part of society, and gastronomy can influence the way we perceive food and society. On the other hand, people have enhanced their pursuit of food experiences, emotions, service, and culture. This paper focuses on which elements of an environment can be designed to deepen people's perceptions of food culture and whether it positively impacts their experience of learning about food stories. Recent developments in digital technologies have caused them to frequently intervene in the creation of food environments, such as digital twins used to enhance the offline and online food experience. However, these studies tend to rely on research techniques or a single physical environment to search for data. At the same time, they have largely been unable to deepen people's understanding of traditional food culture based on the perspective of environmental experiences. Therefore, by considering multi-sensory and immersive experience design, this study extensively considers the combination of food types and regional culture. It also seeks to determine whether the display of food processing and the creation of scene-based narrative space can stimulate consumers' multi-sensory experience. Moreover, it explores whether the creation of visual color, atmosphere, and taste integrated with culturally-focused food stories can add new value to food experiences. Specifically, the research questions are layered and start by seeking to identify the environmental factors that influence visitors' or consumers' perceived food experience while in an interactive food space. Secondly, it aims to figure out how food heritage and culture are reflected in food environments. Finally, it intends to explore whether the food experience's value is enhanced when people enter a food culture-centered environment and learn about its underlying stories. This research plan starts by highlighting existing theory and describes the research background. Furthermore, it intends to select qualitative research methods while collecting sources related to stories about food culture. On this basis, data was collected by conducting focus groups, and cases were critically compared to discuss current research possibilities and expected outcomes. The purpose of this study is to promote traditional diets, enhance their popular appeal, strengthen people's identification with food culture, and improve their experience of food by considering food stories.

Keywords

Food culture; Interactive spaces; Dining environments; Multi-sensory experiences; Cultural Heritage

Introduction

"Gastronomy is a territorial symbol, a sample of both culture and nature that defines us as human beings with roots in a certain destination. The typical gastronomy that is associated with the particular context consists part of the heritage of societies"(Fusté-Forné, 2016). In contemporary society, there is a two-way cultural exchange between food and people. "New" consumers are highly complex and demanding. Accordingly, what they seek in food consumption goes beyond the means to get food to include the related experience, emotion, feeling, service, and culture (Wu, Liu, Huang, & Yu, 2021). Meanwhile, gastronomy can shape the way we think about food and society. In much the same way that art confronts us with objects that are contrary to well-established aesthetic expectations, the dishes served in restaurants might challenge and moderate the way in which food is perceived (Bröcker, 2021).

Although many interdisciplinary researchers have shed light on a series of emerging design spaces for food interaction amongst human beings through their work, they have largely overlooked how, from the perspective of environmental experience, people's understanding of traditional food culture can be deepened. For example, in many contemporary and emerging food consumption and display spaces, the combination of cuisines and the regional cultures underpinning the food is considered. In light of the above, this paper explores whether displaying the food processing process and the creation of scene narrative spaces can provide a multi-sensory experience for consumers. Moreover, it will discuss whether the creation of visual color, atmosphere, and the taste of en-

* The study aims to be a cotutelle degree with the Tshwane University of Technology and Ghent University but at the time of writing this is still being established.

vironmental atmosphere integrated with the cultural story behind food imbue the food experience with new value. The purpose of this study is to promote the traditional diet and revitalize it with new charisma, reinforce people's recognition of food culture, and render the experience of tasting food more enjoyable through the provision of food stories.

This research report starts with the literature review, which probes the new theories and the interdisciplinary research methods used to investigate the study subject. It is proposed to carry out select qualitative research to thoroughly investigate the issues at hand through interviews, narrative analysis, and other methods, addressing the unsolved problems and putting forward the expected research results.

Literature review

There is a growing body of evidence that the environment affects our perception of taste and even mediates how we understand food culture (Wu et al., 2021). Based on the multi-sensory, immersive experience design principles, a multi-sensory dining experience is designed to simulate all five of the primary senses of guests, both during the meal and beyond (Velasco & Obrist, 2020). Food is inherently experiential and is steadily becoming more sensual, ritualistic, and symbolic (Hall, 2003).

Early research in this domain focused on the impact of factors on people's food experience, such as lighting, color, hearing, tactile perception, and smell in the environment. Oberfeld et al. (2009) identified a strong relationship between ambient lighting and people's perception of a glass of wine, indicating that it tasted 50% sweeter when tried under the red ambient light compared to other lighting colours. Similarly, the ambient light of the environment has also been found to mediate the perceived flavor of food and beverages (Oberfeld, Hecht, Allendorf, & Wickelmaier, 2009). One study has shown that manipulating the pitch of background auditory stimuli could moderate the way in which people taste food (Crisinel et al., 2012). In addition, the tactile exploration of tableware in the environment revealed that plate texture also alters people's perception of food (Biggs, Juravle, & Spence, 2016). Finally, some researchers have emphasized the impact of scent on the virtual reality experience (Flavián, Ibáñez-Sánchez, & Orús, 2021).

In recent years, new technological tools are increasingly used in the creation of food environments. By definition, virtual reality (VR) is a sensory-enabling technology that facilitates the integration of sensory inputs to enhance multi-sensory digital experiences (Flavián et al., 2021). Grossenbacher and Lovelace (2001) define synaesthesia as 'the conscious experience of systematically induced sensory properties that most people may not be able to experience under comparable conditions'. This definition also allows for the incorporation of some authors' views who believe that synaesthesia constitutes a delicious form of edible 'edutainment' (Charles Spence & Youssef, 2019).

A number of practical projects that support the effectiveness of the contemporary food environment experience have been put forward in the literature. For example, Vi et al. discussed LeviSense, which was the first system to integrate all five sensory modalities into a single platform based on the suspended food. Specifically, they used the system to demonstrate how different combinations of light and smell affect users' perceptions of taste qualities, namely, intensity, pleasure, and satisfaction (Vi et al., 2020). With regard to physical environments, in September 2014, the Náttúra dining concept developed by Kitchen Theory was applied in London, aiming to immerse diners in the Nordic experience while transporting them to a variety of different nature-inspired environments (Youssef & Spence, 2021).

However, an equally important, albeit low-profile, topic (at least so far) is the design of cultural environments for food. Throughout history, culinary heritage has been a fluid channel facilitating cultural exchange (Pascual & Orduna, 2020), with the typical cuisine associated with each environment constituting a part of its social heritage (Fusté-Forné, 2016). Shepherd (1999) was one of the first scholars to explore the relationship between psychological attitudes and dining behaviours. More recently, Cuevas et al. (2021) pointed out that there are multiple factors capable of moderating eating patterns, including culture, socioeconomic status, dining environment, and hedonism. These factors underscore the significance of culture, which is evolving and transforming consumption, ranging from owning objects to experiences (Scalise Sugiyama, 2001; Shepherd, 1999).

Broadly speaking, numerous authors have applied multi-disciplinary theories to produce the relevant evidence, contributing their different opinions from interdisciplinary perspectives.

With regard to museum environments, Kim et al. found that gastronomic tourists seek to build knowledge and access gastronomic experiences when visiting gastronomic museums and restaurant complexes. To be precise, they observed that each experience is made up of both tourist and environmental factors, with environmental factors specifically contributing to the gastronomic experience of museum restaurants (Kim, Park, & Xu, 2020). In folklore terms, food has been adopted as a totem of meaning to impart different information in Chinese culture on many occasions. For example, the traditional foods eaten in China to celebrate birthdays are noodles and peaches, both of which represent longevity (Ma, 2015). However, in relation to tourism, there is little discussion in the scientific literature about how to enhance the connection between food tourism and memory in the technical context (Biggs et al., 2016). In line with the above, research in multiple fields has highlighted the importance of cultural experiences, including the acquisition of knowledge and perception of local identities and cultures moderated by local food and 'foodways' (Kim et al., 2020).

A review of the previous research shows that it was inclined to delve into the data by examining technology or a single physical environment, as can be seen with Batat's questioning of whether augmented reality (AR) technology has positive or other far-reaching impacts on consumers' dining experience (Batat, 2021). As such, our contemporary understanding of the design of cultural environments for food remains incomplete. However, the research gaps identified here present a solid base for this study to investigate which elements of

the environment can be designed to deepen people's perceptions of food culture. Additionally, it sets the stage to investigate whether there is a positive effect on the food experience when food stories are learned by consumers.

Research Questions

This study takes the form of an exploratory, open-ended piece of research. The research process will be split into five stages: (i) Desktop research, including the construction of a knowledge network map and research framework through theoretical literature review and stakeholder analysis; (ii) Interviews, including, through engagement tools, the use of questionnaires and in-depth interviews to gather information; (iii) Case studies, such as the LeviSens system; (iv) Data analysis, which may include the creation of a design prototype to evaluate and test the applicability of the proposed process; (v) Conclusions and reflections, suggesting possibilities for future development. This study will take Chinese time-honored restaurants as an example.

This study is provisionally based on the following research questions:

- RQ1: What are the various environmental factors that influence the visitor's or consumer's perceived gastronomic experience in a food interaction space?
- RQ2: How are culinary heritage and food culture reflected in the food environment?
- RQ3: Is the value of the food experience enhanced when people enter an environment with food culture and learn the stories behind the food?

Figure 1. Summary of the research question process.

Methodology

Despite the usefulness of quantitative research, qualitative research methodologies are necessary to guide researchers to better understand the important social and environmental factors affecting food choices and eating habits (O'Kane & Pamphilon, 2016).

This study uses qualitative research to explore people's subjective feelings about their experience of a Chinese catering cultural environment. Semi-structured open-ended questions were used to draw out specific themes, whilst rich descriptive data was collected using examples of different environmental experiences (Jordan & Gibson, 2004). In the data collection process, the point describing similar answers repeatedly heard by the interviewer is referred to as 'data saturation' (Grady, 1998). Some studies have specifically focused on data saturation to determine the ideal number of participants in qualitative research (Lemke & Schifferstein, 2021).

Some research methods that may be used in this study include:

1. **Literature analysis**
   The survey results are counted, classified, and summarized based on the quantitative analysis of the literature on the combination of food types, furnishing layout, decorative color, smell, and environmental background music on people's experience and perception in many current studies.

2. **Narrative inquiry methodology**
   Narrative inquiry has evolved from its origins in sociology and anthropology in the early 20th century with 'realist' orientations. In the present day, it is used in a multiplicity of disciplines and professions. Its use involves the adoption of a range of orientations, including 'constructivism', 'post-modernism' and 'post-structuralism' (Wansink, 2004). The first step is to gather materials related to food culture stories, similar to creating a mind map. Then, the three key elements of the story are selected to understand how spatial awareness tells the story.

3. **Focus group interviews**
   Focus groups are conducted to collect data as they are a valuable way to gain insights into people's attitudes, experiences, and views on a topic in a social context (Wilkinson, 1998).

A simple interview will be designed to record participants' feelings about the tasting experience and their daily eating status after learning the story of the food in front they consume in a food culture setting. A minimum of two control groups will be used for comparison.

Conclusion

This study expects to adopt the principles of multi-sensory and immersive experience design as the foundation; however, intervention in the food environment remains a complex topic. For example, food design often involves consideration of the way in which food is presented (e.g., packaging or meal utensils) and the context in which it is consumed (e.g., on the street, in a specific setting, in a restaurant with a specific theme)(Schifferstein, 2010).

Focusing on the field of multi-sensory perception and experience, Hekkert and Schifferstein (2008) defined subjective product experience as the awareness of the psychological effects caused by interaction with products, including the degree to which all senses are stimulated and the meaning and value consumers vest in products (Hekkert & Schifferstein, 2008). The feelings and emotions triggered and the benefits conveyed by food packaging design in different fields must also be considered (Schifferstein, Lemke, & de Boer, 2022). It should be noted that these are the parts that I did not understand sufficiently during the research period. Also, we need comprehend the different ways in which food stories can be presented in the creation of space from a more environmental-spatial perspective.

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Developing cultural heritage sustainability from the perspective of participatory sentimental souvenir design

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Abstract

Souvenirs provide benefits to cultural heritage (CH) protection from economic and social perspectives; they work as narratives and emotional ties to trigger memories for tourists while strengthening local identities. Though, kitsch, homogeneous and poorly made souvenirs seem to disappoint tourists and locals alike and raise concerns regarding authenticity. Meanwhile, after souvenirs are brought into people's domestic lives, they have a great chance of being devalued. Existing souvenir research is more concerned with shopping behaviours, with few researchers focusing on the emotional value of souvenirs and their impact on people after purchasing them.

This research explores souvenirs from two perspectives, namely authenticity and being sentimentally attractive. Both the perception of authenticity and sentimental attractiveness are essentially formed subjectively. Sentiment in this research refers to long-term cherishing that is less 'intense' than emotion and is more memory-related. The significance of this research resides in its exploration of sentimental souvenirs rather than studying souvenirs in terms of shopping behaviour. There is a lack of theoretical research on the sentimental perception of (CH) artefacts, leading to a knowledge gap in this research area. The aims of researching sentiments and authenticity with regard to souvenirs are to help make designers more sensitive to sentiments before engaging in souvenir design and determine design inquiry suggestions.

This qualitative research explores the perception of souvenir authenticity through semi-structured interviews and focus groups with designers, locals near Taylor's Bellfoundry and souvenir owners. Thematic analysis has been utilised to analyse the audio transcripts of the interviews, followed by focus groups to explore the roles of authenticity and sentiment in souvenirs.

The first part of this study has been to investigate authenticity perception through a set of interviews with craft artisans and designers. The second part offered participatory design workshop and a focus group which were conducted at Taylor's Bellfoundry in Loughborough. This is a major bell-casting (CH) site in the UK, which started casting bells in the 14th century and is still actively manufacturing them. The participants were residents and Taylor's Bellfoundry museum staff who are familiar with the foundry's history and culture. The aforementioned interviews and focus groups are part of the main study.

Sentiments in souvenirs were explored in the participatory workshops and interviews. Different themes have emerged from the thematic analysis. The most important finding is that in the case of Taylor's Bellfoundry, the perception of authenticity is linked with history, ethnography, workmanship and aesthetics as well as with personal memories. These memories include personal stories, craft skills and sensory memories. Authenticity allows locals to have a sense of nostalgia. The findings regarding sentiments in souvenirs show that souvenirs act as receptacles for historical and ethnographic narratives.

A limitation of this research is the so-far small number of participants who have joined this study. In the third stage of the research, this aspect will be addressed by increasing the number of participants and promoting participant diversity. Future studies could expand on the case study to explore CH sites to improve their souvenirs through authenticity and sentiment.

Author Keywords

Souvenir, Sentiments, Emotional Design, Memories, Participatory Design

Introduction

This research argues that the protection of Cultural Heritage (CH) through souvenirs appeals to sentimental values. Souvenirs work as sentimental ties to trigger memories and strengthen local identity (Hunter, 2012). Souvenirs, however, are often kitsch, which has detrimental effects (Swanson & Timothy, 2012) such as the emergence of authenticity anxiety for both tourists and locals (Setiyati & Indrayanto, 2011). In contrast, authentic souvenirs can help build connections between local artisans and tourists, as well as between tourists and travel sites (MacCannell, 1984). When exploring authenticity, it is crucial to note the importance of subjective authenticity (Wang, 1999); sentiment is one of the aspects of subjective authenticity for tourists. The sentimentality of a souvenir refers to the long-term appreciation of an item related to CH.

Considering the above, this research explores key elements of souvenirs that are related to CH, which are authenticity and sentimentality. The aim of this study is to explore the role of souvenirs as a tool to support the preservation of CH.

To further explore the authenticity and sentimentality of souvenirs, this research starts with a literature review and discusses authenticity and sentiment in terms of souvenirs. Then makes use of semi-structured interviews, a focus group and participatory workshops with designers, residents near Taylor's Bellfoundry. In the end, the research concludes their findings from the study above.

Literature Review

Many souvenirs have homogenised characteristics or can be classified as 'tourist kitsch' (Cohen, 1988). Increases in kitsch production may not meet tourists' diverse needs for souvenirs in the long term. It is worth considering that souvenirs are good cultural carriers since they increase the diverse approaches to presenting local culture to tourists. The originality of culture has been regarded as authenticity in this research. Current souvenir production has an obvious feeling of 'staged authenticity', with products selected by elites (Littrell et al., 1993), lacking the presence of cultural diversity (Markwick, 2001).

Authenticity

This research explores authenticity through groups of tourists, makers and residents.

Authenticity Perception According to Tourists

For tourists, authenticity brings new feelings (Potts, 2018, pp.81-82). Authenticity can be conveyed via an emotional mediation object such as a souvenir that can extend the users' identity and memories (Elomba & Yun, 2018). Souvenirs must be presented in a way that inspires tourists to see them as authentic objects that incorporate sentimental ties related to the individuals' expectations of the CH.

Authenticity Perception According to Makers and Locals

Understanding authenticity from the makers' and locals' perspectives has the benefit of improving regional identity and self-identity, which contributes to the diversity of regional information.

Figure 1 provides a summary of the literature review on authenticity (Carroll, 2015; Bergadaà, 2008; Littrell et al., 1993). It contributes to establish an authenticity perception framework, which needs to be refined in the data collection process. Firstly, 'history and ethnography' refers to tourists being able to acknowledge past objects, techniques, cultures and other relevant concepts.

Secondly, 'uniqueness' refers to using local materials (Bergadaà, 2008) and local manufacturing.

Thirdly, 'workmanship' includes craft knowledge and artisanship. Newman and Bloom (2012) also emphasise the importance of artefacts having any form of connection with the creator.

Fourthly, 'aesthetics' highlights the visible, semiotic power and artisanal appreciation (Littrell et al., 1993).

Lastly, 'utility' is an element of souvenirs, but it is rarely researched.

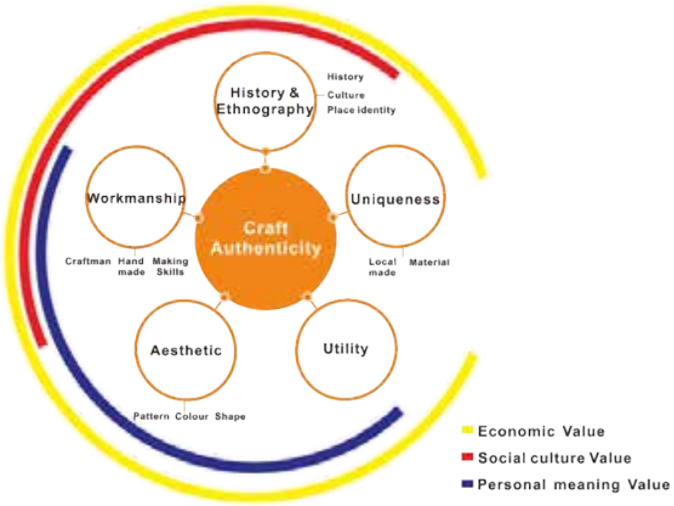

Figure 1. Souvenir authenticity perception regarding craft knowledge (created by the author, 2022).

Sentiment vs Emotion in Souvenirs

Sentiments are a complex experience of consciousness, bodily sensations and behaviours that reflect the personal significance of a thing, an event or a state of affairs (The Britannica Dictionary, 2022). Emotion, for comparison, places more emphasis on motion while sentiment places more emphasis on the feelings and memories.

Compared with 'emotional design', sentiments may be less designed for short-term desires, focusing more on long-term emotion and arousing memory. In this context, this study chooses to explore sentimental souvenirs, referring to souvenirs that can be a long-term collection and that evoke memories of tourist sites.

Methodology

This research has started with a literature review. Since there is much research regarding authenticity in souvenir design, this research aims to prove and refine the models of Figure 1 using inductive reasoning. Furthermore, literature reviews featuring sentiment research are rare in the design discipline, meaning the research uses deductive reasoning to generate themes from interviews and creative participation workshops. To achieve the aim of understating authenticity and sentiment in souvenirs, this research has made use of semi-structured interviews, focus groups and creative partic-

Table 1. Research Method for Authenticity and Sentiments

Title	Research theme authenticity or sentiments	Sampling methods	Participant identity and numbers
Expert interviews	Authenticity and sentiments	Purposive sampling	Experts (4)
Creative participatory workshop	Sentiments	Purposive sampling	Experts (3)
Bellfoundry focus group	Authenticity and sentiments	Snowball sampling and convenience sampling (Bellfoundry social media)	Residents (3) and museum staff (2)
Bellfoundry interviews	Authenticity and sentiments	Snowball sampling	Tour guides (3)

ipatory workshops (see Table 1). The interviews, focus groups and workshops have been audio recorded and transcribed for thematic analysis. The text-based data has been hand-coded with NVivo software.

Authenticity Perception

This research aims to prove and refine the models in Figure 1. To investigate authenticity in souvenirs, four university experts in crafts and design were interviewed. The aim of these interviews has been to get an understanding of authenticity according to experts' cognition. This research has chosen to interview design and craft experts to understand, first, the importance of authenticity in souvenir design according to experts' understanding, second, how to recognise authentic feeling and, third, what the criteria of authenticity are according to these interviewees.

Regarding the focus group and interviews, five people participated in the focus group. Two of the participants were Taylor's Bellfoundry museum staff. Another three participants were residents who had lived near the Bellfoundry for more than 15 years and had knowledge about Bellfoundry. These participants were recruited as they were ideal when considering the research emphasis on both historical and ethnographic factors in authenticity.

Sentimental Souvenirs

The research method adopted to explore sentimental souvenirs started with conducting interviews and creative participatory workshops with design and artisan experts. In the workshop, designers and artisans were invited to bring an emotionally charged souvenir before sharing a story regarding the souvenir, using Figure 2 from the Premo emotional response tool (Laurans & Desmet, 2017) as a probe to describe sentiments before designing badges or key rings. During this process, participants interpreted the emotions figures according to their own understanding.

Findings

In this section, the preliminary results from the first part of the study are presented.

Perception of Authenticity in Souvenirs

The findings regarding authenticity perception support the model of variables that affect souvenir authenticity perception, as generated from the literature review. Due to the perception of souvenirs being influenced by the experience of travelling, authenticity perception in souvenirs and travelling are considered in these results.

Most of the participants linked their authenticity perception with history and ethnography and workmanship. The participants expressed a willingness to buy an authentic souvenir because they knew the artisan or had some type of connection with the souvenir makers. For example, participant Online 1B says: 'I meet them (the artist) ... if I like the work, I buy a piece (of it). ... I admire the artist a lot and I'm very happy that I got it.'

Figure 2. The Premo emotional response tool (Laurans & Desmet, 2017).

Authenticity can bring a sense of nostalgia, as was mentioned throughout the Bellfoundry workshop. For an explanation of the nostalgia regarding the bellfoundry, Bell 1C states: 'I've seen a lot of forges and heavy industrial equipment being used. To me, this was just pure nostalgia, absolutely fantastic. I like old buildings, steam trains, anything sort of around the Victorian era.' The making process of casting also triggers the feeling of nostalgia.

This study raises awareness of authenticity being attached to memories of visiting or working with CH. These authenticity-related memories could be triggered by different senses like sight, smell and hearing. Surprisingly, in the Taylor's Bellfoundry focus group, smell was mentioned constantly as especially triggering a direct link with the Bellfoundry. Participant Bell 2S said: 'The first time I came was for the smells ...(the)metalworking and then you've got woodworking and they will smell slightly different'.

Sentiments in Souvenirs

The Premo emotional response tool is not always suitable for describing sentiments in research. Participants found the pictures presented to them could not fully express their sentiments, which are more complicated than those of the figures in the pictures. Therefore, the researcher had to instigate conversations to complement the sentiments depicted in the images. Sentiments regarding the souvenirs have the potential to change with time, going from positive emotions to neutral or negative emotions and vice versa. The memories embedded in a souvenir may also change or build up with time. To be more specific, the memory could start with a tourist site and then transfer to scenes and memories of using the artefact with friends and families. The sentiments also may not change through time.

Conclusion

The aim of this study has been to explore authenticity perception and sentiments in souvenirs. This research explores souvenirs about authenticity and sentimental. To achieve this study goal, this research has used interviews, a focus group and participatory workshops, asking participants to share narratives regarding authenticity and/or sentiment perceptions. This research finds that emphasising sentiment in design may be different from traditional emotional design, with sentiment possibly being a choice that includes potential longer emotional attachment.

Based on the findings above, the uniqueness this research contributes is both theoretical and practical with regard to the development of souvenirs for the protection of CH. This research has also conducted a case study into Taylor's Bellfoundry in Loughborough, which is a CH that is rarely researched. This not only helps residents to express their narrative but may also encourage further potential academic study.

Only a small number of participants, however, took part in this study and participant types have been limited. This will be addressed in the next step of the research. Future studies could expand the case study to CHs that need to improve their souvenirs by providing authenticity and sentimental attractiveness.

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How does design intervention promote sustainable rural transition – an analytical framework based on the multi-level perspective model

Dan Zang

Abstract

Rural socio-technical system has become an emerging area for design to expand its field of practice, and a large number of localised design interventions in rural areas have emerged in China. Although numerous literatures on design research for rural transition, seldom has answer the question how it happens form theoretical aspect, rather than merely from case descriptions. In order to analyse the processes and pathways of design intervention for rural transition, an analytical framework based on multi-Level perspective theory has been implemented, in which nested layers of landscape, regime and niche illustrate how does design Intervention promote sustainable rural transition from a dynamic and multi-layer perspective. According to the framework, localized design practices for sustainable rural transition in China accelerate niche innovation by three internal processes and one external process, with the internal process consisting of taking rural values as the core, promoting multi-actor collaboration, and two-way learning process between designers and local people, and the external process being the urban-rural factor flow. With niche innovation as the cornerstone, there are two pathways to design intervention promote sustainable rural transition: *top-down landscape influence* and *bottom-up grassroots breakthrough*. For the pathway of *top-down landscape influence*, development of macro-landscape accounts for sustainable rural transition by affecting grassroots design practices and the regimes for design practices, while for the pathway of bottom-up grassroots breakthrough, the dominant model of design intervention for sustainable rural transition acts as leverage points in rural socio-technical system, which is formed and merged by the interactions of multiple elements in various design interventions, and eventually brings about the upward momentum for rural transition.

Author keywords

design intervention; multi-level perspective model; sustainable rural transition.

Introduction

Rural areas as organic systems, besides ecological conservation function, their diverse economic activities, a unique social life and a rich cultural heritage contribute to diversity of functions (Akgün, Baycan, and Nijkamp 2015), which require the joint efforts of multiple shareholders to push rural systems to sustainable transition. Sustainable rural transition is a wicked problem and also a systemic process, implying comprehensive weighing of issues such as top-level design and grassroots innovation, as well as comprehensive consideration of the systemic relationships among industry, talents, organisation, ecology and culture. The practicality, openness and flexibility of design make it a meaningful constructor to deal with the complexity. In China, environmental landscape design, packaging and branding design, cultural and creative product design, service and experience design have empowered the countryside in different ways.

The explosion of design interventions in rural areas has also given rise to relevant academic research on design practices from a micro perspective. However, there is still a gap in terms of comparing and analysing the various practice patterns of different design interventions in rural areas, condensing common features, exploring how design influences the social regimes and macro strategies of sustainable rural development from the micro realm. This paper draws on the analytical framework provided by the Multi-Level Perspective model (Geels, Frank W., 2002) to build a comprehensive perspective on design interventions for sustainable rural transition in China. It analyses the common features of different models of design interventions in sustainable rural transition and explore the pathways of design interventions.

A MLP analytical framework of design interventions for rural transition

Multi-Level Perspective theory provides an analytical and heuristic framework for analysing the sustainability transition of socio-technical systems (Geels, 2002). It divides the transition process into three levels: (1) niche innovation at the micro level, (2) socio-technical regime at the meso level, and (3) socio-technical landscape at the macro level. The macro landscape is influenced by exogenous environmental factors, the meso regime is nested within the macro landscape and explains the stability and trajectory of change, and the micro niche is nested within the meso regime and represents a protected space that provides the seeds for change and determines the occurrence and incubation of new things (Geels, 2008). Transition is achieved through a non-linear process of interaction and synergistic evolution between the three layers, where niche innovation establishes the internal dynamics of change, the environmental landscape create pressure for institutional change, and institutional instability creates windows of opportunity for niche innovation (Geels and Schot, 2007). A successful transition depends on coherent development of three levels, with different patterns of interaction and development leading to two different paths of change: Technological substitution and Wider transformation (Kemp

et al., 2001; Geels, 2005). However, layers of macro-landscape and meso-regime, respectively, are more exogenous and have a stronger lock-in effect, designers usually act on the niche level, providing leverage and triggering innovation to bring about systemic change.

Based on the knowledge from MLP model, a framework of design interventions for rural transition has been constructed in Figure 1:

Firstly, the government has issued policy to actively promote the rural transition to sustainability, and the main strategy on which various rural policy based in China, Rural Revitalisation strategy, becomes the landscape for design intervention in rural areas.

Secondly, Under the appeal of the Rural Revitalization strategy, multiple actors such as new villagers, social enterprises, the grassroots government, public institutions, and especially, the First Secretary in the village, gather in rural areas with their own interests and values. The social structure formed between these multiple actors and elements is the regime layer of the rural field, which provides guidance and coordination for the practices of the relevant groups of actors institutionally, organizationally, economically and culturally.

Finally, various localised design practices for rural transition, such as architecture acupuncture, art interventions and community empowerment, are niche innovations by taking design as an effective means. Niche provides a protected space for design intervention with internal processes including the articulation of expectations and visions, the building of social networks, and learning processes at multiple dimensions (Pereno and Barbero, 2020), while the external processes include linking to wider rural-urban integration strategies.

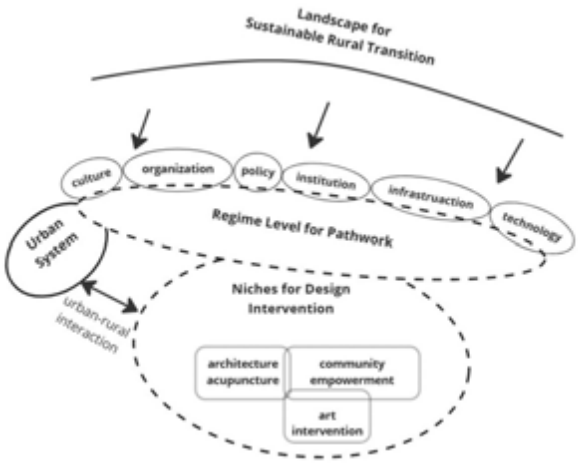

Figure 1. MLP analytical framework of design interventions for rural transition.

Localised practices of design intervention in niche level

According to design practices for rural transition in China, there are three main patterns of design intervention: architecture acupuncture, art interventions and community empowerment, which have the common processes in niche level (See table 1).

Architecture acupuncture means to intervene in sustainable rural transition by environmental landscape design. There are two main implementation paths for the localisation practices of architectural acupuncture: firstly, to protect traditional villages and enhance their overall appearance through environmental and landscape planning; secondly, to renovate public space in rural community through architectural design. These two main paths are mostly based on sorting out the historical and cultural resources of the villages, and some projects will give the villages some new businesses to boost the village economy on this basis.

Art interventions are a series of actions, such as artistic performance, art exhibition, aesthetic practice, art education, carried out by contemporary artists and aim to promoting the emotional communication between people and people, people and gods, people and artefacts in rural network. These actions focus on the cultural dimension of rural society and the emotional demands of local people, and affirm the cultural values of the countryside to make it relevant to the times.

Design practices of community empowerment for sustainable rural transition focus on "making things happen" (Manzini, 2015) by empowering people and objects in rural communities and using design to establish an endogenous mechanism for rural development, thus activating, sustaining and guiding rural communities in a sustainable direction, mainly through the integration of design.

Pathways of design intervention for rural transition

According to the MLP framework of design interventions for rural transition, design interventions not only have internal and external processes at the niche level, but also have certain pathways by interactions within three levels. There are two pathways of design intervention for rural transition: top-down strategic influence and bottom-up grassroots breakthrough, to influence the meso-regime and macro-landscape.

Table 1. common processes of design intervention in niche level

MLP framework	Architecture acupuncture	Art interventions	community empowerment	Common processes
articulation of expectations and visions	Respecting the rural fabric to rebuild public space	Reinventing rural communities based on cultural traditions	Establishing endogenous mechanism for rural transition	*taking rural values as the core*
building of social networks	Multi-actor building	Multi-actor linkage	Multi-actor participation	*promoting multi-actor collaboration*
learning processes at multiple dimensions	A two-way education for villagers and architects	Artist's artistic action in locality	Co-creation of values for villagers and designers	*two-way learning process between designers and local people*
Urban-rural integration	Attracting urban people to form a mutual benefit between urban and rural areas	Building complementary urban-rural communities	Urban-rural value swap	*urban-rural factor flow*

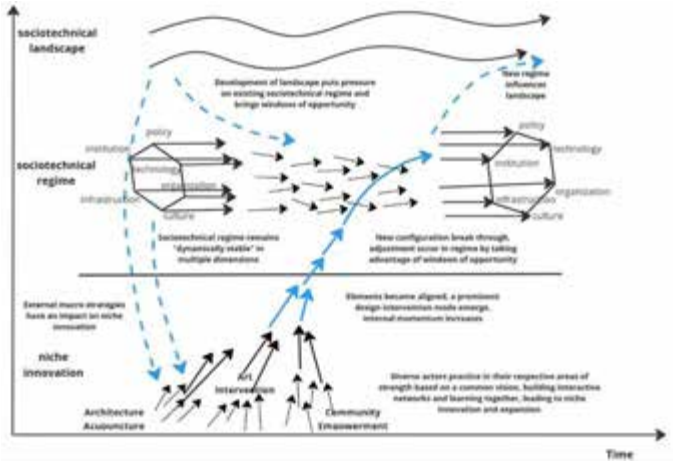

Figure 2. Design intervention pathways for rural transition.
(Adapted from Geels, 2002)

1 Top-down landscape influence (See blue dotted line in following Figure 2)

On the one hand, the development of macro-landscape for sustainable rural transition affects grassroots design practice within existing social regimes. On the other hand, the development of macro-landscape for sustainable rural transition brings pressure and windows of opportunity to existing layers of regimes, and gives rise to a series of adjustments in social regimes that help sustainable rural transition.

2 Bottom-up grassroots breakthrough (See the solid blue line in following Figure 2)

First of all, multiple actors gather at the rural grassroots to carry out practical exploration in their respective areas of strength based on the common vision. Then, multiple types of localised design practices interact, merge and develop together into a dominant model of design intervention in rural areas, and an internal impulse is created. Finally, the internal impulse breaks through the existing social regimes upwards, taking advantage of the window of opportunity, and the meso-regimes level changes accordingly and eventually indirectly influences the macro-landscape level.

Conclusion and Further Studies

Design interventions for rural transition in China have illustrated vividly the processes in niche level and two pathways on which they influence regimes and landscape for sustainability transition. Design practices can bring about a series of internal and external processes at the niche level, thereby progressively influencing the mechanistic and landscape levels of rural transition. However, could the framework apply into other rural context, where rural conditions of economic, environmental, cultural, and social, are thoroughly different from China. In order to answer this question, further studies may be as follows:

First, do further research on design practices for sustainable rural transition around the world for further development and optimization of the framework.

Second, based on the framework, the strategic portfolios embedded in design practices are still under the black box. Thus, in-depth exploring should be paid on design portfolios by comparative case studies of sustainable rural development.

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Designing future hybrid creative spaces using digital tools in educational institutions and organizations

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Abstract

The existing models/frameworks that serve as reference for the design of hybrid creative space in educational institutions and organizations, have shown some limitations. On one hand, current spatial design theories concerned with hybrid spaces and digital technologies are limited; on the other hand, the analysis of digital technologies' influence on spaces conducted in Information System and Computer Science research fields rarely uses a spatial theory as a foundation. The aim of this on-going PhD research project is to develop an analytical framework that integrates creative space types and a blended space model in support of the design of future hybrid creative spaces (FHCS). The pattern language approach is applied to bring together design guidance and tools from different disciplines, in a form that can be understood and shared across disciplines. Through a pattern mining process, 323 patterns are derived from four selected disciplines. The expected outcome of this PhD project is to offer designers a useful design model (FHCS framework) and a set of design tools (design patterns) in support of the design of FHCS.

Author keywords

Design patterns; creative spaces; hybrid working; hybrid learning; blended space; spatial design.

Introduction

Conventionally, space for creative activities in educational and workplace contexts is often defined as a built formal physical environment; and these environments can also be informal spatial clusters that encourage exchanges and social networks based on in-person interactions. Users perceive and evaluate learning and working spaces through their architectural properties and physical settings (e.g., spatial layout and furnishing, lighting, colors, smells, sounds and technology, status, and image). Nevertheless, in recent years we have seen a significant shift to a more hybrid form for learning and working since the beginning of Covid-19 pandemic in 2020, and many higher educational institutions and organizations are likely to embrace "hybridity" beyond the pandemic. At the same time, "extended reality" has an emerging presence in our everyday life, and with the future of the internet and metaverse, the combination of augmented, virtual, and mixed realities will become an essential medium for social, business, learning and working engagements. Nowadays, the term hybrid space (or blended space) is widely used as an interplay of physical and digital spaces. An urgent call is raised for designers to rethink the current design practice to accommodate future challenges when designing creative spaces in transition to hybrid forms of learning and working. Therefore, this PhD project is guided by two main research questions:

1. How future hybrid spaces for creative learning and working need to be designed to support collective creativity and innovation?
2. What technologies and digital tools can be utilized for new opportunities to aid design and enable future hybrid creative spaces?

Background

"Creative space" consists of two parts - "creative" and "space". The term "creative" associates with activities related to design and innovation process. "Space" conventionally refers to the built environment in various scales, from urban context, architectural space, interior layout, to small single elements such as a furniture. The existing models/frameworks that serve as reference for the design of creative space in educational institutions and organizations, have shown some limitations. For example, most of the studies in the field of creative spaces are limited to the built environment and have not given enough attention to contemporary issues such as hybrid working and learning and emerging technologies (e.g. Wycoff and Snead, 1999; Dillon and Loi, 2006; Moultrie et al., 2007; Ceylan, Dul and Aytac, 2008; Luz, 2008; Van Meel et al., 2010; Bustamante et al., 2016; Paoli, Sauer, and Ropo, 2019; Thoring et al., 2019; Mäkelä and Leinonen, 2021; Mov-Avi, 2022). Whereas some frameworks developed design principles for creative spaces but failed to acknowledge the importance of the connections of design components in a form of network. Therefore, it is difficult for designers and users to understand upcoming design issues and set the priorities in the design process (e.g., Luz, 2008; Van Meel et al., 2010; Thoring et al., 2019). On one hand, current spatial design theories concerned with hybrid spaces and digital technologies are limited; and on the other hand, the analysis of digital technologies' influence on spaces conducted in Information System and Computer Science research fields rarely uses a spatial theory as a foundation (Mütterlein and Fuchs, 2019).

Creative Space Types	Physical Space summerized by Thoring et al. (2018)	Digital Space summerized by author
Personal space	allows for concentrated 'heads-down' work (thinking, reading, writing), deep work, and reflection; requires reduced stimulation to avoid distraction	access to single-user digital space, storage and resources; applications to support; allow control of personal territories; easy transitions between personal devices and shared devices.
Collaboration space	is used for group work, workshops, face-to-face discussions, client meetings, or student– teacher consultations.	access to multi-user space and digital storage; share and display knowledge; provide a clear structure for access to collaborative functionality and media content; provide alert to indicate changes; application support synchronization across digital spaces; provide meeting area
Presentation space	is used to share, present, and consume knowledge, ideas, and work results in a one-directional way (presentations or exhibitions)	provide a platform for display of work and social interaction; knowledge transfer; highlight presenter or work; encourage feedback; Provide software to support multi-user interaction; control interfaces and activities; easy transitions between personal devices and shared devices.
Making space	is used for model making and building; allows experimentation, play, noise, and dirt.	Access to user space, storage and resources; provide simulation of physical tools and training; provide software to support multi-user interaction and shared digital areas; access to software and training materials; application support synchronization across digital spaces
Intermission space	connects other space types; is used for breaks, recreation, and transfers; includes hallways, stairs, cafeterias, and outdoor areas	provide reflection and relax space; disengage and play; simulation of nature or outdoor space; navigation portals; facilitate knowledge transfer; facilitate casual exchanges; enable collective breaks; provide recreation and gaming zone; provide overview of the space for easy navigation between digital spaces

Figure 1. Key design issues suggested for both physical and digital spaces.

Theoretical framework

In a built environment, Thoring et al. (2018) identify five space types associated with creative processes in the literature and empirical evidence. They are personal space, collaborative space, making space, presentation space, and intermission space. For designers to develop hybrid space, Figure 1 *presents key issues that are suggested in digital spaces as well as physical ones*. Moreover, to adopt existing spatial design knowledge and theory in the context of hybrid spaces, architects and interior designers need a new model bridging the physical and digital environments, as well new useful design tools derived from other disciplines.

An analytical framework for future hybrid creative spaces: FHCS framework

Following Lefebvre's theory (1992) and Milgram and Kishino's Virtuality Continuum (1994), a hybrid creative space brings together at least two distinct modes to create a new spatial typology, where a physical space flowing within a digital space and vice versa seamlessly becomes possible with technologies. Built on Blended Space model (Benyon & Mival, 2015), the author develops an analytical framework for designing future hybrid creative spaces. Figure 2. *illustrates the relations between four space domains in FHCS framework*. For the physical space, the author only focuses on five types of creative spaces mentioned in Figure 1. The digital space consists of more diverse forms, such as applications, data, actions and events. In the generic space where characteristics are shared by both physical and digital spaces, four attributes (ontology, topology, volatility, and agency) (Benyon, 2012) should be considered. In the hybrid/blended space, five hybrid design themes (territoriality, awareness, control, interaction and transitions) seem to be a relevant starting point for the development of a new spatial typology of FHCS. The author also intends to indicate that hybrid creative spaces can be designed with a new collection of design tools potentially derived from both physical and digital domains. Figure 3. *presents a new spatial typology defined by two sets parameters, creative space types and hybrid design themes*.

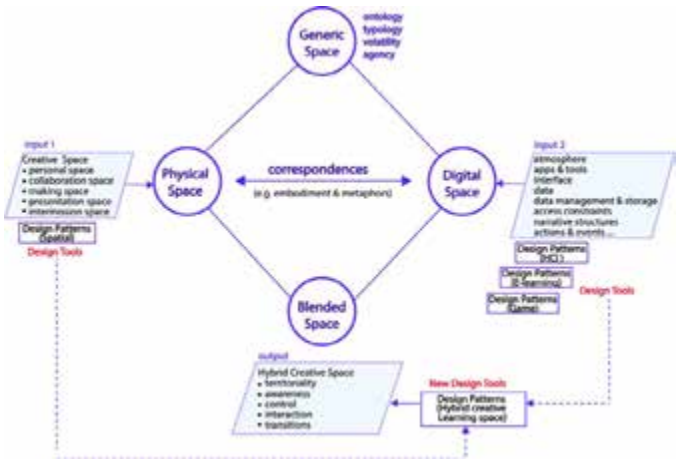

Figure 2. FHCS Framework, adopted from Benyon & Mival's Blended space model (2015) (Drawn by author).

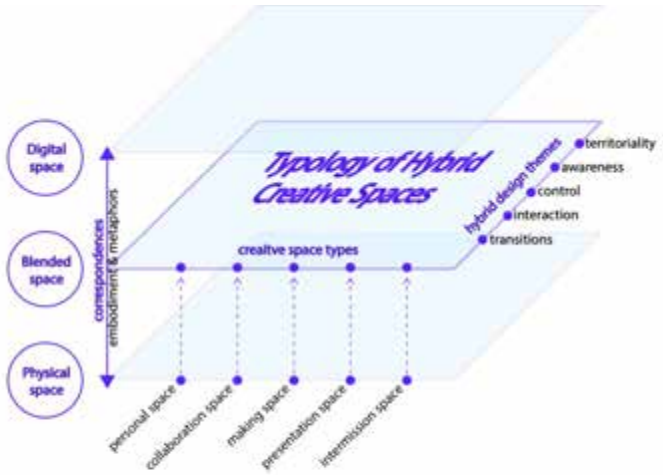

Figure 3. FHCS Typology is defined by two sets parameters, creative space types and hybrid design themes (Drawn by author).

Research approach and method

The aim of the present research is to develop an analytical framework that integrates creative space types and blended space models (FHCS framework), in support of the design of FHCS. The review of the literature has shown that many different social-spatial design solutions exist for both physical and digital spaces, and they have been systematically organized in a form of pattern language. Identified pattern candidates are from various specific application domain, and they

Table 2. Overview of 17 design requirements for FHCS (Drawn by author).

ID #	Design requirement
R1	Space as a platform or network for ideas
R2	Social interaction, micro multination
R3	Human-centric, culture, and identity
R4	Biophilic design
R5	Playful experimental atmosphere
R6	Software and hardware support
R7	Flexible space, changeability
R8	Ownership of space
R9	Multi-sensory stimuli (visual, tactile, olfactory and acoustic)
R10	Accessibility
R11	Integrating technology &Infrastructure
R12	Space and information management
R13	Reduced stimulation, back to analogue
R14	Bodily awareness and movement
R15	Techiture
R16	Making spaces
R17	Creative labelling

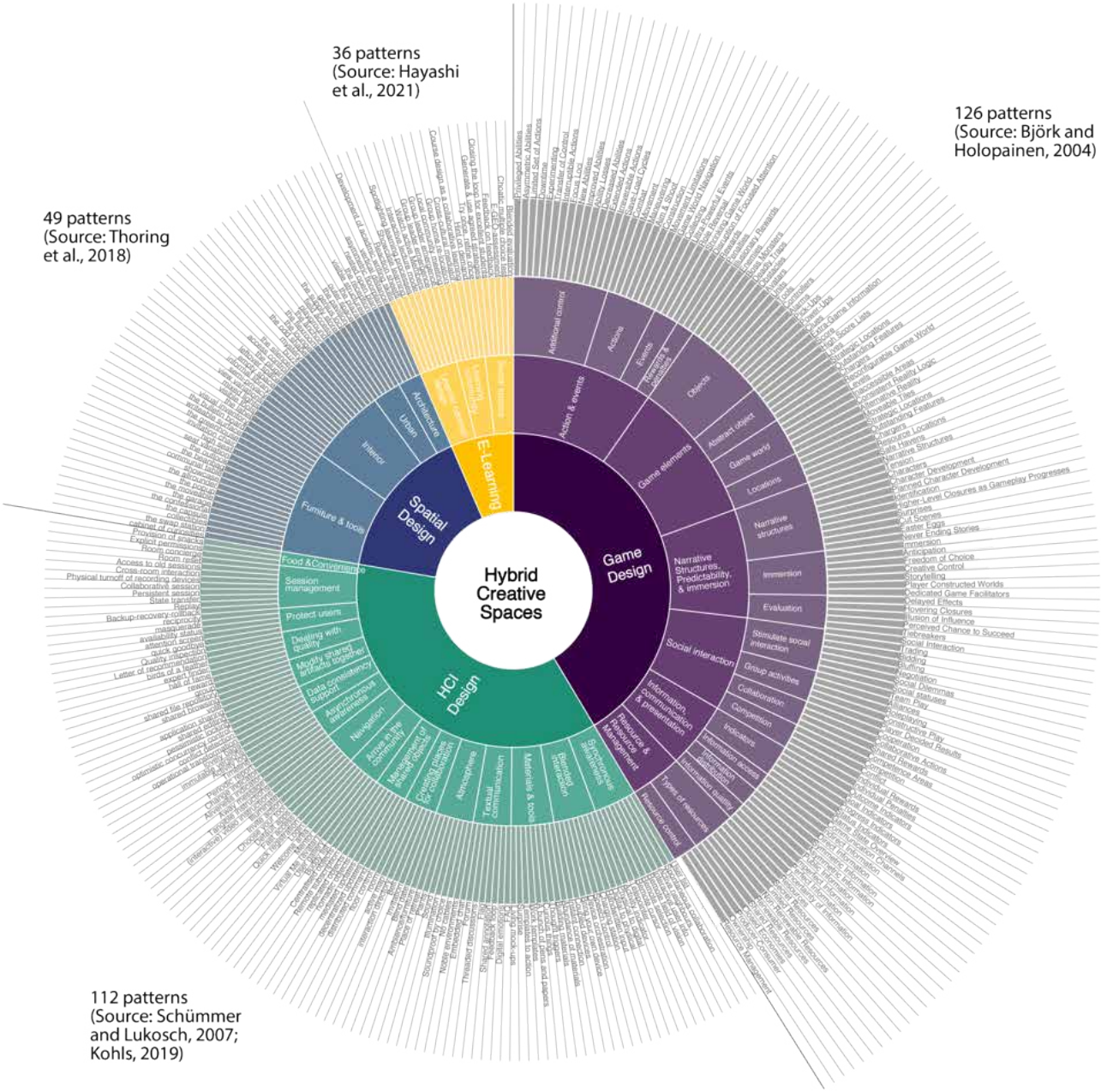

Figure 4. 323 pattern candidates from four disciplines (Drawn by author).

capture and represent design knowledge of the experts. Therefore, the pattern language from Christopher Alexander et al. (1977) seems an appropriate approach to bring together design guidance and tools from different disciplines, in a form that can be understood and shared across disciplines. Moreover, it can offer a connected network of design patterns that continues to grow and evolve through the knowledge and experience input from the experts. This research is conducted in three main steps:

1. Pattern mining. A mix of methods is used to derive pattern candidates from existing pattern frameworks of various disciplines, organizations' reports, case examples and expert interviews.
2. Pattern analysis. Collected pattern candidates are verified by a multi-case study and focus groups. Network analysis is subsequently employed to identify the network structure of patterns visually and statistically.
3. Pattern writing. This process involves proper naming and writing of patterns in a standard template with detailed description. This is realized through a workshop with pattern experts.

Design requirements for future hybrid creative spaces

To better understand how to create successful hybrid creative environments, the author investigates the potential challenges and opportunities of using and designing hybrid spaces, especially related to creative process. Insights are gathered from recent literature, organization reports, expert interviews, and real-world cases. Table 1 *summarizes important design requirements for FHCS*.

Results and discussion

Through the pattern mining process, various pattern frameworks and many pattern candidates have emerged from the analysis. Given their relative importance and time restrictions, the author puts an emphasis on the patterns that fit the following criteria: (1) Relevant to hybrid social-spatial de-

sign; (2) Addressing to the design requirements of FHCS; (3) Supported by empirical evidence; (4) Completeness of the pattern language, including pattern descriptions, hierarchies of the patterns, and indication of the internal links among patterns.

As a result, *323 patterns are derived from four disciplines, Spatial Design (49 patterns), HCI design (112 patterns), E-learning (36 patterns), and Game Design (126 patterns), and they are organized in their original clusters and sub-clusters* (Figure 4). After further analysis of these patterns' possible application, *13 generic pattern clusters have evolved, which are mapped in relation to hybrid design themes* (Figure 5).

Conclusion and future work

This PhD research project addresses the design issues from both physical and digital spaces in support of the design of FHCS, as well as to use a pattern language approach to bring together useful design guidance and tools from different disciplines. Moreover, this project will also offer a systemic network that continues to extend and evolve with the input of knowledge and experiences from experts. Based on current findings, the pattern candidates (or proto patterns) collected from four disciplines have proven validity in their original contexts, and together they offer a huge potential for solving problems that might not so easily be solvable alone, as interdisciplinary work with patterns is endorsed by many architects and pattern language theorists (Alexander, 2002-2005; Salingaros, 2005; Leitner, 2007; Neis, 2015). However, the proto patterns have to be transformed or updated for hybrid creative spaces, based on the FHCS framework. Future work will include the evaluation and validation of the patterns, plus analysis of their connections. The following actions are currently planned:

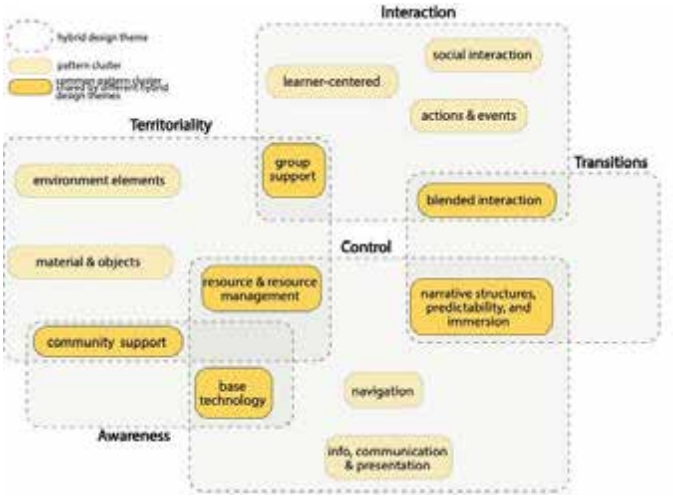

Figure 5. Five hybrid design themes and how they are addressed by 13 generic pattern clusters proposed in this study (Drawn by author).

- Development of a spatial typology for hybrid creative environments and its implementation into the blended space framework.
- Multi-case study in three design institutions (UK and Belgium), including interviews and observations of their creative learning spaces.
- Network analysis on proto patterns to identify their new links, and evaluation of the links with focus group.
- Pattern writing workshop (focus group workshop) with experts.

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C3

DRAFT PROCEEDINGS

This book contains academic papers and posters of the Cumulus Antwerp conference, held in Antwerp on 12-15 April 2023. The Cumulus community, designers, artists, and educators were invited to submit contributions on how culture and creative industry can offer resilience, consolation, and innovation models on human scale, in line with the conference theme 'Connectivity and Creativity in times of Conflict'.

The contributions were double blind reviewed in the tracks

1) Nature positive/Design for transformation,
2) Digital futures/Hybrid reality,
3) Handle with care/Inclusivity, and
4) PhD network.

Editors: Kristof Vaes & Jouke Verlinden

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