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INTRODUCTION

11 Environmental Design
Mario Bisson
Politecnico di Milano, Italy

SUSTAINABLE DEVELOPMENT

15 RAISE ecosystem: urban design for accessible and inclusive Smart Cities
Francesco Burlando[1], Federica Maria Lorusso[2], Claudia Porfirione[1]
[1]University of Genoa, Italy
[2]University of Campania Luigi Vanvitelli, Italy

27 Culture, meaning, value and sustainability: A terminological analysis
Piera Losciale
Politecnico di Bari, Italy

37 Bio-inspired design: A systemic and interdisciplinary design approach to increase the sustainability of processes and products
Lucia Pietroni[1], Mariangela Francesca Balsamo[1], Giuliana Flavia Cangelosi[2]
[1]University of Camerino, Italy
[2]Università degli Studi della Campania "Luigi Vanvitelli", Italy

49 Eco-sea design. Transdisciplinary products and services for sustainability in seaside contexts
Ivo Caruso[1], Vincenzo Cristallo[2]
[1]Università degli Studi di Napoli Federico II, Italy
[2]Politecnico di Bari, Italy

Fashioning a Sustainable Future: Navigating Zero-Waste Practices in Textile Chain
Maria Antonia Salomè
Università degli Studi di Firenze, Italy

75 The black hole of the fashion system: The contribution of design to the sustainable transition of the fashion system
Elena Pucci
Università degli Studi di Firenze, Italy

87 Digital art direction and sustainable communication for fashion in Italy: A literature review
Filippo Maria Disperati[1], Elisabetta Cianfanelli[2]
[1]Università degli Studi della Campania "Luigi Vanvitelli", Italy
[2]Università degli Studi di Firenze, Italy

97 Fast Fashion. Sustainability and the negative psychological and social impacts for consumers
Giovanni Maria Conti
Politecnico di Milano, Italy

105 Mixed reality for addressing boredom at work: grounds and perspectives for PhD
Francesco Musolino, Dario Gentile, Michele Fiorentino
Politecnico di Bari, Italy

113 Design as a Catalyst for Sustainability Bridging Disciplines in the Anthropocene
Dario Russo
Università degli Studi di Palermo, Italy

125 The environmental labels for sustainable communication design
Francesca Scalisi, Dario Russo
Università degli Studi di Palermo, Italy

SOCIAL INNOVATION

141 Urban lifestyle in twenty years.
Forecasts from a Young Generation of Interior Designers
Luca Guerrini
Politecnico di Milano, Italy

159 Design as a catalyst for rural regeneration:
Insights from a Research through Design study
Alessandro Ianniello[1], Riccardo Palomba[2]
[1]TU Delft, The Netherlands
[2]IUAV, Italy

175 The role of the communication design for the Mediterranean enhancement and development. The representative case studies map
Chiara Tuttolani
Politecnico di Bari, Italy

179 From concepts to open products:
The experience of a design hackathon for inclusive open-souse products
Federica Caruso, Venanzio Arquilla
Politecnico di Milano, Italy

191 ReMade Community Lab, Design explorations in a Proximity System
Susanna Parlato
Università degli Studi di Napoli Federico II, Italy

203 Utensilia© to design. On the "process by which people go about producing things"
Rossana Carullo
Politecnico di Bari, Italy

215 Color loci placemaking: Color and processes of place appropriation
Cristina Boeri
Politecnico di Milano, Italy

225 Editorial Design and the Influence of Racism on Black Representation in Brazilian Magazines and Newspapers: The Panorama Before and after George Floyd and João Alberto Silveira Freitas
Gustavo Orlando Fudaba Curcio, João Vitor Pereira Moura
Universidade de São Paulo, Brasil

241 Playing as a cultural dissemination strategy. Eco-bab:
Designing collaborative, playful and educational experiences
Nicolò Ceccarelli, Nađa Beretić
University of Sassari, Italy

253 Functionality and significance in the design of tourist and community interaction structures in Laguna de Colta
Sandra Núñez[1], Claudia Balseca[1] and Eliska Fuentes[2]
[1]Universidad Indoamérica, Ecuador
[2]Universidad Técnica de Ambato, Ecuador

261 A journey into social innovation through the tombolo of Mirabella Imbaccari, from history to project perspective and the first workshop of the community Fondation of Messina via the Tombolo Academy
Luca Fois, Camilla Guerci
Politecnico di Milano, Italy

273 Urban interiors. The domestic space and the city/the street as a living room
Tiziano Agieri Rinella
IUAV, Italy

TECHNOLOGY APPLICATIONS

293 The 'New Morphologies':
When Technology Becomes Gender-Neutral
Matteo O. Ingaramo, Martina Labarta
Politecnico di Milano, Italy

305 UX Design in The Context of Navigation Aid Equipment Maintenance.
A new approach to Monitoring and Control System Design
Elie Barakat[1], Venanzio Arquilla[2], Maximilian James Arpaio[1]
[1]Thales Italia Spa, Italy
[2]Politecnico di Milano, Italy

317 Enhancing User Experience in Autonomous Driving Levels 4 and Above:
A Novel Seat Concept for Motion Sickness Mitigation.
Venanzio Arquilla, Shangyi Bai
Politecnico di Milano, Italy

333 Digital Manufacturing of Tactile Maps to Improve Accessibility at Archaeological Sites
Alfonso Morone, Edoardo Amoroso
Università degli Studi di Napoli Federico II, Italy

347 TREELOGY: Preserving Urban Forests through IoT Monitoring Data of Greenery
Alfonso Morone, Mariarita Gagliardi, Silvana Donatiello
Università degli Studi di Napoli Federico II, Italy

361 Research into the exterior walls of residential buildings in the context of
sustainable construction based on bio-based materials and waste
Alberto Reaes Pinto, Marlene Canudo Urbano, Carlos Oliveira Augusto
CITAD / Universidade Lusíada, Portugal

377 Design, cultural heritage and technologies:
New forms of dialogue between the user and museum spaces.
Giusi Castaldo, Mario Buono, Elena Laudante
Università degli Studi della Campania "Luigi Vanvitelli", Italy

389 Environmental Impact of Wood, Steel, and Concrete in Residential Buildings
Sonsoles Vela, Ruben Garcia Rubio
Tulane University, USA

409 A sustainable territorial development
Luca Bullaro
Universidad Nacional de Colombia, Colombia

HEALTHCARE AND WELLNESS

419 Textures design for Augmentative and Alternative Communication (AAC)
for people with deaf- blindness and multi-sensory impairment
Denise Dantas[1], Lia Sossini[1], Barbara Del Curto[2]
[1]Universidade de São Paulo, Brazil
[2]Politecnico di Milano, Italy

431 Design against cancer. Topics and projects for a new culture of prevention.
Erminia Attaianese, Ivo Caruso, Carla Langella
Università degli Studi di Napoli Federico II, Italy

443 Thriving children's perceptual learning through educational environments
color and material design
Elisa Longoni[1], Michele Zini[2], Barbara Camocini[1]
[1]Politecnico di Milano, Italy
[2]ZPZ Partners, Italy

455 Enhancing Healthcare Systems: Redefining Strategies and Stakeholder Engagement for Community Care Service Evolution
Federico De Luca, Daniela Sangiorgi
Politecnico di Milano, Italy

POLICY AND GOVERNANCE

467 The Project of ethical visions for new enterprises in the South
Rosa Pagliarulo
Politecnico di Bari, Italy

475 REMANUFACTURING ITALY. The role of design in the manufacturing chains of the southern contexts, for the development of territorial cultural heritage, between local archetypes and global connections.
Domenico Colabella
Politecnico di Bari, Italy

479 Re-Made in … Locally. The empowerment of regional practice
Lisa Hockemeyer[1,2], Anna Santi[2]
[1]Kingston University, UK
[2]Politecnico di Milano, Italy

493 Green design for resilient urban pathways
Davide Bruno[1], Felice D'Alessandro[2]
[1]Politecnico di Milano, Italy
[2]Università degli Studi di Milano, Italy

ALTERNATIVE FUTURES

507 Design and Literature for Education: Academic and Pedagogical Transdisciplinary Integrated Lab as Innovative Project for Graduate Programmes
Michaella Pivetti[1], Diana Navas[2]
[1]Universidade de São Paulo (USP), Brasil
[2]Pontifícia Universidade Católica de São Paulo (PUC-SP), Brasil

521 What if interactive artifacts would disrupt human relations?
Andrea Di Salvo
Politecnico di Torino, Italy

533 The (Un)Sustainable Future - Design and Resignification of Materials and Processes
Maria João Barbosa, Benedita Camacho, Diogo Frias Riobom, Bernardino Gomes
CITAD / Universidade Lusíada, Portugal

549 Shaping the future of automotive design: The automotive experience design lab
Venanzio Arquilla, Giorgia Ballabio
Politecnico di Milano, Italy

561 Defining garment quality for user experience design in metaverse: The outerwear case study
Dario Gentile, Francesco Musolino, Annalisa Di Roma, Alessandra Scarcelli, Michele Fiorentino
Politecnico di Bari, Italy

571 Research through Design in Multisensory Narrative Dimensions
Clice de Toledo Sanjar Mazzilli
University of São Paulo, Brazil

585 Anthropogenic Narratives. Imagination and Anti-Disciplinarity for the Communication of Non-Human Perspectives
Francesco E. Guida, Martina Esposito, Enrico Isidori
Politecnico di Milano, Italy

MADE IN...

601 Design storytelling e microstorie del Made in Italy:
Nuovi modelli di sostenibilità e innovazione nel distretto produttivo murgiano
Vincenzo Paolo Bagnato, Antonio Labalestra
Politecnico di Bari, Italy

609 Values, Identity, Stereotypes
Daniela Anna Calabi, Francesco Ricciardi
Politecnico di Milano, Italy

622 From territories to communities. A new perspective for Made in Italy.
Iole Sarno
Università degli Studi di Napoli Federico II, Italy

627 MADE IN AItaly.
The Identities of Fashion Design in the Era of Artificial Intelligence.
Andrea Quartu
Università degli Studi della Campania "Luigi Vanvitelli", Italy

633 Food, Design, and Territory:
The Valorization of Manna in the Madonie area.
Benedetto Inzerillo, Samuele Morvillo
Università degli studi di Palermo, Italy

641 Made in Italy. Values, Identity, and Relationships
Mario Bisson, Daniela Anna Calabi, Stefania Palmieri
Politecnico di Milano, Italy

From concepts to open products: The experience of a design hackathon for inclusive open-source products

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Abstract

This paper explores the role of a Hackathon within the Open Cometa project, an initiative stemming from the rich experience of Cometa Lab. Originally conceived within educational settings, Open Cometa has evolved into a digital platform promoting open-source collaboration within the autism community. Through strategic partnerships with local FabLabs and other autism associations, the platform facilitates the exchange of resources and fosters information sharing. It enables the development of accessible solutions for autistic individuals. The transition towards an open-source approach addresses the increasing demand for customised products, addressing a significant market gap. The hackathon engaged 30 students from diverse backgrounds and played a role in refining and aligning projects with platform requirements. The event aimed to bridge the gap between education and professional practice through multidisciplinary collaboration, enhancing participants' soft skills and technical competencies. The hackathon fosters innovation and inclusivity within the autism community by transforming student projects from concept to tangible, open products with real-world impact.

Introduction

Hackathons are short events where participants work together in small groups to generate ideas, develop solutions, and present them (Flus & Hurst, 2021). According to Flores et al. (2018), they have been used in various settings and for multiple purposes, such as networking, education, and accelerating creativity. Organisations can manage them internally or as public open events (Briscoe & Mulligan, 2014).

Hackathons also differ widely in length; they can last as short as weeks or as long as months or even years, although they usually last 24 to 36 hours without interruption. The term "hackathon" combines the words "hack" and "marathon" (Briscoe & Mulligan, 2014), where "marathon" implies a race-like event. In contrast, the term "hack" relates to the term used in cybercrime; in this context, it refers to exploratory programming, as these events are typically associated with digital innovation and software development.

The hackathon was first conceptualised as an "event where developers, programmers, designers, and computer amateurs meet and work intensively to create software projects" (Flus & Hurst, 2021). From 1999 onwards, since the name "hackathon" was coined to describe this kind of event, hackathons have gained global recognition and traction (Briscoe & Mulligan 2014; Richterich 2019), making this kind of work popular outside the software industries. To that end, hackathons have become platforms to facilitate rapid innovation. They are also known in other areas by other names, such as game jams, design jams, hacking festivals, hack days, sprints of designs, and code fests. The most crucial factor in encouraging individuals with similar interests to participate is the hackathon's aim and the challenge of achieving it, even if many also offer a prize or a work placement. The opportunity to collaborate, co-create with others, and try out new designs are additional motivators for participation.

To help characterise the Hackathon's goal, Briscoe et al. (2014) have helpfully offered a classification system that ranges from a tech-centric to a focus-centric approach (Page et al., 2016). While focus-centric hackathons mainly address social or business concerns or positively impact a societal issue, tech-centric hackathons typically focus on developing a particular technology or application (Page et al., 2016). What is clear from the definition of the hackathon is that this type of event can foster collaboration and drive participants to achieve complex problems by working together.

The hackathon discussed in this paper falls under the category of focus-centric hackathons, as it was organised primarily to address innovation in a social context rather than solely focusing on technical issues, despite participants being tasked with utilising specific technological tools and scenarios. Due to its hybrid nature, this event could enhance technical and soft skills among participants.

The emergence of hackathons in the 1990s and their subsequent rise in popularity in the 2000s (Briscoe & Mulligan, 2014; Richterich, 2019) coincides with the development of change design. This evolution has seen several "waves", including a period of formalising the link between design and innovation, known as the third wave, and a subsequent era, the fourth wave, characterised by the acceptance of design beyond its traditional disciplinary boundaries (Flus & Hurst, 2020). The event described in this paper aligns with these overarching trends in change design by aiming to establish new boundaries and foster collaboration across fields. The event's organisation is covered in depth in the following paragraphs.

Context and Problem Statement

The hackathon discussed in this paper is an integral component of the Open Cometa project, which originated from the decade-long experience of Cometa Lab, a bachelor's degree program in Product Design. Initially conceived within the classroom setting, Open Cometa has since evolved into a digital platform that is currently being launched. Open Cometa (to see the work-in-progress website, visit https://www.designhub.it/opencometa/) is an open-source platform hosting autism-related projects, thereby expanding the realm of Design-Autism.

The platform's primary objectives encompass sharing resources within the autism community, facilitating information exchange, employing rapid prototyping techniques, providing essential materials, and extending support through a network of FabLabs and partners. This framework simplifies the implementation of accessible and reproducible solutions for interested users. Leveraging the extensive expertise of COmeta Lab, over ten concepts emerge annually, offering diverse perspectives on autism, proposing solutions, and engaging in meaningful discourse on the subject. Traditionally, these projects have been archived on a blog for educational purposes, garnering interest from parents and caregivers seeking to procure the highlighted solutions.

This growing interest underscored both a project opportunity and a noticeable gap in the market for products addressing the needs of the autism community, prompting the involvement of the COmeta team in the platform's design and development.

Responding to the rising user demand, a strategic shift was initiated towards an alternative approach to supply and demand. This transition aimed to foster collaborations with partners while providing the autism community with a more accessible means to access products. As a result, the focus shifted towards an open-source dimension, emphasising inclusion and accessibility.

The concept of "open design" emerged in the late 1990s, denoting the unrestricted sharing, modification, and evolution of designs (Van Abel et al., 2012). This collaborative approach is particularly relevant in autism, where individualised requirements present challenges for mass production. Open design allows for broad participation in the design process, which is crucial when addressing the nuances of autism. Moreover, it streamlines the design and manufacturing phases, traditionally separate and outsourced, by leveraging local production facilities like Fab Labs and maker spaces (Boisseau et al., 2018). These facilities enable the production of individual prototypes or limited series of artefacts, reducing cost barriers and skill requirements.

The hackathon activity was organised to facilitate data entry into the platform. This extracurricular initiative engaged 30 design, engineering and architecture students in enhancing the quality of selected projects and ensuring their alignment with platform requirements. Hackathons are renowned for fostering collaboration among diverse experts, enabling teams to leverage varied subject matter expertise (Frey & Luks, 2016). In this context, the multidisciplinary nature of the hackathon experience enabled young designers to assume the role of facilitators, guiding diverse stakeholders toward shared ideas and solutions. The Open Cometa project has provided a fertile ground for experimentation, bridging education and professional practice. By exposing students to different contexts, such as digital fabrication and web design skills, the Open Cometa experience aimed to reinforce both soft skills and technical competencies. In an increasingly hybridised landscape, where product designers require skills beyond their core expertise, the emphasis on cross-disciplinary collaboration and teamwork instilled valuable lessons essential for future professional success (Dorst, 2018). The overarching goal of the Hackathon is to facilitate the implementation and adaptation of projects from the COmeta Lab to fit within an open-design framework, thereby contributing to the expansion and enrichment of the Open Cometa platform. This event followed the methodology proposed by Kollwitz and Dinter (2019).

Methodology

Kollwitz and Dinter (2019) formulated a taxonomy of hackathons to elucidate their nature, underlying characteristics, and understanding within organisational innovation processes. This taxonomy delineates two key aspects: operational design decisions, which mainly direct the workflow and procedures during a hackathon, and strategic design decisions, which are more abstract and stem from overarching aims. The event discussed in this paper follows this framework, specifically focusing on strategic design decisions such as defining the context and problem statement, identifying the solution space, and articulating the value proposition. Regarding operational design decisions, factors considered include the duration, venue, incentives, target audience, and level of elaboration.

Hackathon structure

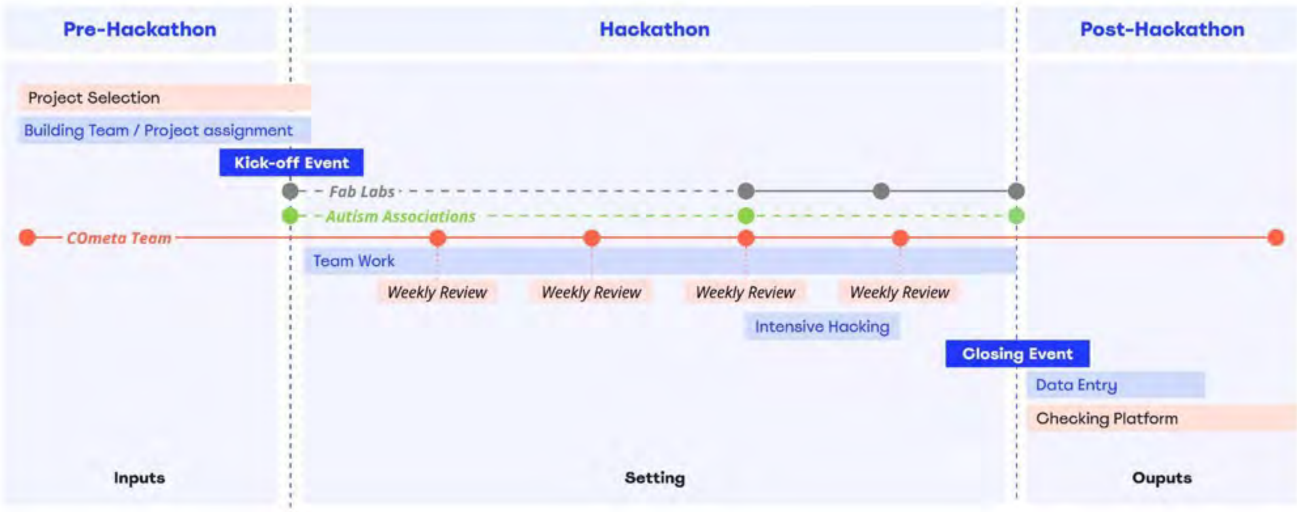
This paragraph outlines the structure of the hackathon, delineating its phases and identifying the stakeholders engaged in the event. Subsequent paragraphs will delve into strategic decision-making and operational design aspects.

The Open Cometa hackathon comprises three phases: pre-event, event, and post-event, corresponding to input, setting, and output components (see Figure 1).

During the pre-event phase, participants engage in both a preparatory stage and a kick-off event, where they receive fundamental information about the activity, available resources, and the hackathon's format. Moreover, the involvement of hackathon partners during the kick-off event helps participants become acquainted with the COmeta team and other relevant stakeholders.

During the hackathon phase, participants are immersed in the primary activities and setting where they actively pursue the set goals, guided by the partners and the Cometa team. Participants engage in hackathon activities in teams to achieve the defined objectives.

Figure 1. Summary of Hackathon Path is divided into Pre, during and post and with the involvement of the human resources, you had different roles based on the hackathon phase



In the post-event phase, emphasis is placed on reviewing outputs and disseminating results. This includes a closing event where participants present their work to partners and receive final feedback. Subsequently, participants collaborate with the COmeta team to upload their projects onto the Open Cometa platform, aligning with testing and refining the platform under development.

The hackathon fosters collaboration between autism association partners of the COmeta Lab, leveraging their expertise to assist participants in redesigning projects focusing on the end user's needs. Additionally, two Fab Labs in the Lombardia region actively support participants throughout the event. They provide access to cutting-edge technologies to experiment with digital fabrication and offer a wealth of professional experience to draw on.

Participants benefit from regular interactions with teaching staff and tutors, who provide guidance and mentorship throughout the event. These moments of discussion serve as opportunities for participants to seek advice, share insights, and refine their project ideas. The COmeta team's involvement was constant, but participants also received support from other partners.

Intensive Hacking is a moment organised after the third week of the hackathon in which all the students are asked to complete their prototype directly in a Fab Lab with the help of an expert.

Additionally, the hackathon incorporates mid-week revisions, strategically scheduled during extracurricular hours, allowing participants to receive timely feedback and iterate on their designs in real-time.

Before the kick-off event, the COmeta team undertook thorough preparation and planning activities. This encompassed delineating the objectives and scope of the hackathon, along with selecting concepts from the pool of student projects available on the former COmeta blog. Selection criteria included: 1) projects generating significant interest from associations, partners, and potential users; 2) feasibility and adaptability of projects for available digital fabrication resources; and 3) innovation within project proposals.

Fifteen projects were chosen and categorised into two main groups (Figure 2):

- *"Born to be Open Concepts"* encompasses concepts in various stages of readiness for digital fabrication.
- *"Products to be Rethought in Open Logic"* focusing on technological and analogue products requiring substantial rethinking to align with digital fabrication. This differentiation aimed to highlight varying skill requirements, aiding participants in selecting projects based on their expertise or desired challenge, particularly for technological products, which demand specialised knowledge for development.

This selection was presented during the kick-off event, with all partners invited to participate. Hackathon participants could then choose a project to work on from the selection, forming teams led by the COmeta team.

Figure 2. Selection of the COmeta project proposed to the hackathon participants

The strategic design decisions

Challenge Design

A fundamental aspect common to all hackathons is their association with addressing a specific task or resolving a problem (Briscoe & Mulligan, 2014). This dimension encapsulates the central focus of the hackathon's objective or challenge (Vanauer et al., 2015). Open Cometa's challenge aligns seamlessly with the platform's overarching mission, presenting a distinctive project opportunity. Participants were thus tasked with re-designing select concepts from the COmeta Lab to align them with open-source principles. This involved revisiting the project's concept and fundamental value based on the user research carried out earlier. Teams were tasked with restructuring elements, specifying materials, and determining the digital fabrication technologies essential for realising the product. Operating within a realistic context, teams navigated material sourcing and technology experimentation to craft viable solutions that meet user needs. The ultimate goal was to produce functional prototypes rooted in the original design concepts.

Therefore, the hackathon aimed to translate students' design concepts into tangible, shareable products in line with open-source principles. To this end, participants were required to develop instructional materials, including video tutorials, assembly guides, material lists, and practical tips, to empower users to create the product independently.

Solution Space

This aspect pertains to the parameters set for the execution of the hackathon. Kollwitz and Dinter (2019) categorise solution spaces into open, semi-structured, and structured. Open spaces feature broad challenges, allowing diverse interpretations and individual ideas and minimising requirements and restrictions that could block creativity. Conversely, structured spaces impose strict guidelines on both the process and outcomes, significantly constraining the solution space.

In Open Cometa, the solution space is typically semi-structured. While certain specifications, like digital fabrication constraints, provide boundaries, there is also room for individual creativity. Participants were encouraged to collaborate and devise innovative solutions to their chosen challenges. They were free to adapt the initial products to suit user needs better.

Value Proposition

This dimension recognises that hackathons are organised with clear objectives rather than isolated events (Nickerson et al., 2013). In the case of the Open Cometa hackathon, the primary goal is to generate data entry for the platform. Furthermore, the aim is to refine students' concepts and preliminary ideas based on well-structured user research but still need to be market-ready, into products ready to be shared and fabricated using open-source methods. Additionally, participants benefit from the opportunity to share their projects on the Open Cometa platform and contribute to the autism community.

The operational design decisions

The operational design decisions inherent in the Open Comet Hackathon, outlined in Figure 3, are categorised into six dimensions, as described below.

Figure 3. Hackathon organisation in terms of Target audience, communication means, material resources and Human resources.

Duration

The Open Cometa Hackathon spans four weeks, incorporating various events such as a kick-off and closing ceremony. Unlike continuous hackathons, this setup incorporates breaks, enabling intermittent development periods (Rosell et al., 2014). Teams operate autonomously during the weeks but also convene for scheduled feedback sessions. Moreover, intensive work sessions are scheduled after the third week to refine prototypes before the closing event. The engagement of autism associations, alongside the COmeta team, is crucial, boosted by the active involvement of local FabLab experts. Leveraging their expertise in autism and digital fabrication, these experts offer valuable on-demand feedback and guidance to the projects.

Venue

The kick-off and closing events occurred at the university's FabLab, providing a collaborative space for participants to begin and conclude the hackathon. Weekly reviews occurred in university lecture halls, offering structured feedback sessions. Additionally, on-demand online meetings were arranged with the COmeta team to provide support beyond the scheduled reviews. A Telegram group chat was also established to facilitate asynchronous communication between participants and the COmeta team. During the intensive hackathon session, teams were hosted at another partner, FabLab, facilitating hands-on prototyping and refinement of solutions developed in the preceding weeks.

Target Audience

The hackathon is part of a program called "Passion in Action", a catalogue of open-participation teaching activities that the university offers to students to support the development of transversal, soft and social skills and to encourage/facilitate students in enriching their personal, cultural and professional experience. Students may choose from various subjects depending on their interests and aptitudes. For this reason, the Open Cometa Hackathon welcomed participation from designers, engineers, and architects interested in contributing to projects that promote inclusivity. Ideal candidates were those passionate about inclusive design and proficiency in rapid prototyping systems. Experience in 3D modelling was preferred, and familiarity with FabLab and maker environments, including rapid prototyping tools like 3D printing, laser cutting, and CNC, was beneficial. While the call was open to all university students, there was a focus on attracting individuals from various faculties, predominantly engineering, architecture, and design. Participation in the hackathon was considered an extracurricular activity alongside regular university commitments.

Recruitment Process

Out of more than 80 applicants, 30 participants were selected to form 6 groups of 5 members each. Prospective participants were required to submit a brief 280-character description outlining their motivation and the skills they could contribute. This initial step evaluated personal and professional motivations for joining the hackathon. The recruitment process aimed for diversity in skills, although most applicants were from design backgrounds, given the nature of the event. Consideration was given to participants' academic backgrounds, ensuring representation from disciplines such as product design and interaction design. Experience levels were also considered, with priority given to students beyond their first year of undergraduate studies to ensure a certain level of skill readiness. As a result, the participant composition reflected a diverse mix of academic backgrounds and years of study (Table 1).

Table 1. The list of the participants composition with a diverse mix of academic backgrounds and years of study

Degree	Participant Number	Course of study	Year of Study
Engineering	**1**	Biomedical Engineering	2° Bachelor's Degree
Engineering	**3**	Biomedical Engineering	2° Master's Degree
Engineering	**1**	Materials Engineering and Nanotechnology	1° Master's Degree
Design	**7**	Product Design	2° Bachelor's Degree
Design	**6**	Product Design	3° Bachelor's Degree
Design	**2**	Digital and Interaction Design	1° Master's Degree
Design	**5**	Integrated Product Design	1° Master's Degree
Architecture	**2**	Space & Interior	1° Master's Degree
Design	**3**	Design & Engineering	2° Master's Degree

Incentives

Typically, hackathons are team-oriented events where the composition and size of teams may vary, whether formed beforehand or during the event (Brenner et al., 2014, Rosell et al., 2014). While collaboration is often encouraged, some hackathons adopt a competitive format with prizes at stake. However, the Open COmeta Hackathon takes a different approach, prioritising cooperation over competition.

Unlike many hackathons, the Open COmeta event did not incorporate a competitive aspect, nor were cash prizes offered, aligning with its educational purpose. Instead, participants received a participation badge and earned five extra-curricular training credits, which benefited their academic evaluation. The primary motivation lies in fostering collaboration with diverse entities and the opportunity to explore skills beyond one's academic discipline.

Resources

The resources provided can range from hardware, software, or datasets to existing ideas, concepts, or prototypes that require further development. Additionally, human resources in the form of mentors or industry experts can offer valuable guidance to participants.

Students in the Open Cometa hackathon were provided with comprehensive research and materials gathered during the COmeta Lab phase to aid in developing their products. This included user research data, 3D model technical drawings, concept specifications, and detailed information.

Furthermore, students were allocated a monetary fund to buy materials essential for prototyping. Collaboration with FabLabs allowed participants access to state-of-the-art machinery for material processing, including 3D printers and laser cutters. Mentorship was provided by autism associations, offering project evaluations, and by FabLab experts, who conducted personalised reviews. Additionally, when faced with specific challenges, support was enlisted from the university's network of professors and professionals to address issues, for instance, those related to Arduino programming or technological aspects of software and hardware.

Participants were given a Google form at the kick-off event to vote for project concepts based on their interests and skills. Each participant could express three preferences, ranking them from 1 to 3. Using these preferences, the COmeta team organised the groups. If specific projects received fewer or more votes, redistribution occurred to ensure that each concept had at least four students working on it.

Results and Discussion

Six projects were transformed from conceptual ideas into fully redesigned products ready to be shared on the open-source platform. The realised projects are (Figure 4):

Go tag

The kitchen organisation kit is designed to rationalise and differentiate kitchen utensils effectively. It includes holders for pots and pans and labels for ladles and knives. Each label indicates the food or the name of the utensil, facilitating recognition and use.

The open-source version offers the flexibility to create silicone components that can be applied to existing kitchen utensils. In addition to complete instructions, users receive 3D mould models for making the components and an instruction booklet complete with integrated cooking recipes.

StarDreams

A star-shaped puppet with a pass-through hole allows children to insert their hands inside and hug the puppet. Positioned within the opening are two buttons that activate the StarDreams inflation system, creating a calming sensation reminiscent of breathing to aid relaxation. The open-source iteration of this puppet entails modifying it by partially removing its stuffing and inserting a bag containing an Arduino connected to a small lever inside. This lever moves rhythmically and cyclically, simulating a breathing effect that induces relaxation when hugged. Accompanying the instructions are details for the Arduino code and electrical circuit.

Figure 4. Products exhibited during the final events

Mowhee

The project initially arose as a tool to assist Andrea, an 18-year-old passionate about cinema but facing challenges in communication and sharing emotions with those around him. The game consists of a cover containing three different discs, whose random rotation allows for the creation of various combinations that stimulate the user's behaviour. The manual interaction with Mowhee creates an anti-stress system, as its dimensions are ergonomically designed to fit comfortably in the palm. This toy can engage individuals through individual training and facilitate group activities, enhancing communication and sharing. The open-source version is 3D printed, and the content of the internal discs is customisable using a provided mock-up of the discs.

Rabble

It is a daily bag conceived for those who need to travel without fear of stress; it aims to assist users through sensory and insulating features, minimising stress from external stimuli. The bag boasts dual compartments capable of accommodating an 11″ MacBook, a sensory lower pocket for tactile relaxation, and a shoulder strap equipped with a hood to reduce external noise. Its waterproof and sturdy material ensures reliable transport of personal items such as computers, books, and wallets. Additionally, the secure closures provide theft-proof functionality.

The open-source version adopts a design rooted in a modular fashion. This technique eliminates the need for stitching as the fabric takes shape through strategically positioned interlocks and cuts. This approach facilitates the bag's creation without requiring sewing skills or a sewing machine, which would have imparted a more artisanal feel to the product. Instead, with this method, one can laser-cut a 3mm felt sheet and then attach other components using glue. Furthermore, incorporating sound-absorbing fabric reduces noise during use in public transportation.

Rulant

Rulant is a game designed to enhance fine motor skills and coordination. The objective is to guide a ball out of a box by moving the sticks upwards. Rulant engages users by emphasising auditory and tactile sensory experiences. Crafted from wood and laser-cut materials, it offers options for personalised graphics. Additionally, the team designed a cardboard version that provides a more accessible alternative, allowing for quick and easy assembly with minimal resources at home, using printed cutting templates. The instructional materials include detailed guides and explanatory videos to introduce users to the gameplay and various challenge levels Rulant offers. This enables users to understand the game's difficulty levels and select the mode that best fits their needs.

Snake fun

A flexible and sensory anti-stress tool designed for those who require constant tactile input to calm down or tend to move their hands frenetically in uncomfortable situations. Its flexibility provides mental entertainment, encouraging users to experiment with and memorise new shapes. The open-source version is made of silicone, with the team focusing on designing the flexible joints that connect the anti-stress pieces and 3D-printed moulds used for casting the silicone. The silicone material was chosen to be food-grade compliant, ensuring safety if the user puts it in their mouth, thus avoiding toxicity issues.

Overall, the hackathon fostered innovation and creativity and highlighted the potential of open-source collaboration in addressing diverse needs and promoting inclusive design solutions. Each project showcases the power of collaboration and open-source principles in creating impactful solutions for various user groups.

Conclusion

The strength of the outcomes lies in the inherent potential for continual refinement and testing through an open-source framework. While the products are not finalised, they embody solutions open to improvement and iteration. The OpenCometa Hackathon underscores the significance of experiential learning fostered through active engagement within social and cultural environments. Encouraging students to participate directly in FabLabs serves to extend learning beyond the confines of conventional university classrooms. This hands-on involvement empowers students to apply their skills in real-world settings, enriching their educational experience (Herrington et al. 2014). Student satisfaction was evident, with post-activity feedback highlighting three key outcomes:

Technical Skill Enhancement

Students gained valuable insights into digital fabrication, honing their prototyping and product creation abilities. Collaborative coding exercises broadened perspectives on teamwork and technical proficiency.

Collaboration Development

Exploring diverse perspectives and collaborating with peers from various backgrounds fostered an inclusive and dynamic learning environment. Skills and knowledge exchanges across groups enhanced the overall experience.

Empowerment and Perspective

Engaging with open-source concepts empowered students to prioritise simplicity in design, ensuring accessibility and user-centricity. Realising the feasibility of delivering user-ready products instilled a sense of empowerment.

In conclusion, the OpenCometa Hackathon demonstrates the potential of collaborative, experiential learning initiatives to empower students, foster interdisciplinary collaboration, and drive social impact. Through hands-on engagement and partnerships, students acquired technical skills, developed collaboration abilities, and gained insights into design and social change. This holistic approach prepares students to tackle real-world challenges creatively and empathetically.

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