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ordini@buponline.it

Editor-in-chief
Flaviano Celaschi
Alma Mater Studiorum
— Università di Bologna

Deputy Editor-in-chief
and Managing Editor
Elena Formia
Alma Mater Studiorum
— Università di Bologna

Guest Editor diid No. 76
Paolo Cardini
Rhode Island School
of Design

Founded by
Tonino Paris

Associate Editors
Viktor Malakuczi
Sapienza — Università
di Roma

Lorela Mehmeti
Alma Mater Studiorum
— Università di Bologna

Elena Vai
Alma Mater Studiorum
— Università di Bologna

Art Director
Davide Giorgetta

Editing Assistant
Olga Barmine

Publisher
Fondazione
Bologna University Press
Via Saragozza 10
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Tel. (+39) 051 232 882
Fax (+39) 051 221 019
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info@buponline.com

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Contents

Editorial

6
Editorial
Flaviano Celaschi, Tonino Paris, Elena Formia, Elena Vai

Open Debate

16
Endogenesis
Paolo Cardini

22
A School for Vernacular Algorithms: Knowledge Transfer as a System and Aesthetic Algorithmic Encounter
Tegan Bristow

32
Discussing Emerging Topics in the DIY Design of Healthcare Devices
Massimo Menichinelli, Jose Gomez-Marquez

44
Critical Jugaad Ontologies
Deepa Butoliya

58
Mixed Media on City: Endogenous Design in Istanbul
Avşar Gürpınar, Nur Horsanalı

70
Walls: Participatory Design Activism
Nikki Juen, Basma Hamdy

82
By Choice and by Necessity: Endogenous Design in the Time of Pandemic
Constantin Boym

Stories

90
Design in Conversation
José de la O, Renata Fenton

Designrama

102
Materials for SDGs: A Synergy Towards Sustainable Development
Romina Santi, Lia Sossini, Mattia Italia, Silvia D'Ambrosio, Francesco Zurlo, Barbara Del Curto

114
The Delphi Method as a Morphological Catalyst for Foresight-Oriented Design Research
Noha Essam Khamis

126
From Open-Source 3D Printing to Industrial Manufacturing
Matteo Zallio, Claudia Porfirione, Francesco Burlando

138
A Framework Towards Understanding the Performativity of Products
Gizem Çelebi, Çiğdem Kaya

146
Seniors and the Use of Digital Media in the Post-Pandemic
Giulia Panadisi

156
Design as a Driver for Multidisciplinary Teams: An Applied Research Case in El Quisco, Chile
Rodrigo Culagovski Rubio, Cala Del Río Alemparte

168
An Open Toolkit for Small-Scale Data Visualizations
Andrea Pronzati, Michele Mauri

178
Digital Architectural Design Inspired by and Created with Nature
Valentina Perricone, Silvano Arcamone, Francesco Monti

Forum and Reviews

Over the Mainstream

190
Research, Design, Action: The Story of a City's Identity
Dolly Daou

Cultural and Creative Industries

200
Pixels Are Like Fruit Jelly Sweets
Giulietta Fara

Editorial

We celebrate the twentieth anniversary of *diid* Journal founded in 2002.

Twenty years after the publication of the first issue of *diid,* the founder of the journal, Tonino Paris (Professor Emeritus at Università La Sapienza di Roma) and the neo-director Flaviano Celaschi (Full Professor at the Università di Bologna) dialogue about the journal's history and the prospects of scientific writing on design in the contemporary age. Their words depict a time of great contradictions and new challenges, for the discipline of industrial design as well.

Elena Vai Tonino, could you describe the context that led to the idea of founding *diid* in 2002?

Tonino Paris It was a very simple operation. At the time I was teaching architectural technology and the possibility of opening design programmes in architecture schools was of little interest to me. One day I received a call from Mario Docci, Dean of the School of Architecture at the Università La Sapienza in Rome, and he asked me to start a degree programme in industrial design. After considering the question for some time I decided I could still teach technology, a discipline that would in any case be included in the curriculum. At the same time, however, I understood that I had little knowledge of international work in the field of design: I knew Italian design, but not what was happening abroad, or the experience of the most renowned schools. I gathered my collaborators and suggested founding a journal: this would be a way to gather knowledge, to study and thus begin to master the teachings of this discipline. Little by little we ourselves became scholars in the field. As a small community, we opened up this experience to investigate design in the direction that was most consistent with our interests. My background is in technology, it's obvious that I am interested in the theme of industrial design and how projects in the design field are finalized towards the innovation of industry. The term *industrial design* chosen for the title, in my opinion, was the clearest. I was very disappointed when the Italian scientific community chose a path forward that would prevent any cross-fertilisation with architecture; to me that seemed to orient design towards the ephemeral and towards everything that was more volatile and short-lived. This was the idea at the origin of the journal and the reason why, with great generosity and a desire to keep up to date, the management passed into the hands of teams that I trust.

EV What were the phases of evolution in the editorial plan?

TP In its first sixty issues, the journal addressed, in monographic form, sixty themes of the contemporary design culture in its various manifestations, themes that represented the wider debate around the phenomenology of the product system and its technical and cultural extensions. Various positions were expressed dialectically in a continuous and fertile debate. The narrative in each issue focused on the interpretation of design as a project of the artificial, as a representation of material culture, as an interpretation of man's needs, to transform them into products made to improve his life and social relations.

Under the second management, I imagined that the focus of the observation would be different, no longer concentrating on specific themes, but on the contexts and scenarios that frame the design culture, such as new methodologies and new design practices in relation to the innovation of industrial production processes; its influence on the construction of the artificial environment, in the transformation of the scientific, social, economic and cultural contexts; the culture of design and the evolution of languages, from a historic and historiographic perspective as well. I presented this vision as the programme for phase two of *diid,* but it was not fully accepted: the doors were opened to interesting contributions, but they were completely foreign to this objective. In my opinion, it remains a fundamental principle to not disorient the reader of a journal, and I do not believe that this contradicts an approach centred on the themes of innovation within the system of production and management. Take *Domus* for example, which recently handed over the management for one year to personalities from the design world. When Jean Nouvel was appointed, he outlined a programme of activities that were scheduled to take place and conclude over the span of a year, without changing monthly.
In this new phase I imagine that, on the one hand, there is a need to engage with the international as well as the national scientific community, but also with the context of scientific journals. Naturally, given the first three issues that have been published, I give great credit to this approach, which I consider to be an alternative.
In a general climate of deep uncertainty, when the earth is brittle, the lines part, impulses fritter away and prospects waver, I like to quote Umberto Eco: "Everything dissolves into a sort of liquidity and the only solution for an individual with no points of reference is to appear at all costs, appearing as a value, in a sort of bulimia with no purpose other than to discard the old to participate in this orgy". What could replace this liquefaction? We don't know yet and this interregnum will last a long time, says Eco. Given this premise, I would like to express my thoughts on the design discipline, to give you my view of how it is tied to post-modern culture. All the work done in recent years to extend the domain and meaning has made this term a universal brand name the reason and origin of which have been forgotten. I believe it is a fatal misunderstanding to place the burden of understanding the theory of modernity in contemporary design on this word, with no exception. Modernity as a whole, just like the deterioration of the word and its partial short-circuit, have been caused, in my opinion, by one crucial reason, its post-modern inclination. If industrial design has coincided with the principle of modernity, which was the case starting with its terminological genesis, as well as the limits imposed by its historically accredited mandate, its subsequent development as design, demonstrating its freedom and inclusivity, appeared as an exhaustive metaphor of postmodernism.
Fortunately, the journal does not use the term "design" and I would programmatically avoid using it not only here, but in the educational context as well.

EV Flaviano, what was the role of journals in your education?

Flaviano Celaschi When I began to study this discipline, in light of the awareness I have today, I would say there were three main typologies of journals on the scene. The architecture magazines, which dealt primarily with architectural products; the art magazines, which prevalently covered the authors of the products; the scientific journals, which focused on experimentation and the state of the art, constituting what is known as the literature. There was another trend rising at that time, what we now call design magazines. I was particularly fond of *Modo* – which seemed bolder to me than others, though occasionally flighty – as well as *Abitare* and *Domus*. The design magazines, in my opinion, brought with them a commingling between the investigation of the manufacturer, the brand and the evolution of the culture, production and processes. That accompanied the rise of an emphasis on the culture of the interpreter, e.g. the design critic or literato, the shareholder or situationist who speaks, writes and deals with things involving the culture of design. Magazines from the United States, England, France, Spain and Germany began to circulate. I was a fanatic of airport newsstands because they offered a selection that was far richer than what you could find even in our university libraries. These magazines consisted of two parts: one of advertising and one of content. I was more fascinated by the advertisements than the content pages, because of the quality and perfection with which they were created. In light of today's experiences, I might say that they all contained a lie: the lie of the isolated creative act, of the demiurge who shapes and obtains a result. None of them, neither the art and architecture magazines nor the scientific journals or the design magazines, told the truth. The truth was that those products were the result of very complex production chains, consisting of generally anonymous actors, with a complexity of material and process-related issues. Today I know that this was the symptom of distress; the distress of which Tonino also spoke, at seeing how the birth of educational programmes in design led to the interruption of the relation between the different scales of the design project. The phenomenon was a mutual one: the design programmes ceased to talk about architecture and the architecture programmes banished any discourse addressing industrial design; there was an ostracism that can still read scientifically in today's multiscale Ph.D programmes, where city planners don't talk to the architects who don't talk to the designers. This was a decision and a choice that I deem to be shameful. We will pay for this error in the decades to come: it has led to a loss of quality which had been guaranteed until then by the simple fact that the doors were left open. This snub of the product irritates me today. As I look back to my past with magazines, I must admit that I gradually grew tired of architecture and art magazines (I still leaf through them with pleasure, but they are no longer useful to me, because I recognize now that they lie). I know that three-quarters of the content is venal, from the advertising pages or the nod towards products by certain brands that the editor must acknowledge, to the celebration of certain starchi-

tects, or the pleasure of standing with a series of actors who are in the mainstream, and thereby qualify the design firms, which have grown to become multinational businesses, and as such design industries themselves. So this irritation curbs my enjoyment and I merely leaf through them for the aesthetic pleasure.

EV Tonino, what role did the journal play in consolidating themes you were interested in and still believe are necessary?

TP My commitment to education was more important to me than my work for the journal. Therefore the outcomes of the virtues of certain educational methodologies in design were those that made their way into the journal. I have always been involved in education within the school in Rome, except perhaps most recently, and many of the "deformations" with respect to the basic idea of design were tolerated. Why? Because I have always sought to give priority to the students' interest in finding their place in the job market. This was the only school, at the time that I directed it, that offered a one-year internship with manufacturing companies, not professional firms. The approach that was produced as a response to the design experiences in the school, while not directly impacting the journal, influenced it in some way in terms of its outside references, its most advanced experiences. This is a fact, and the reason why the same group produced not only the journal, but monographs as well, dedicated to the latest generation of schools abroad, in which one could grasp the distance between educational systems, for example the English system compared to the French. Not to speak of our own, which has slipped into decadence.
In the industrial design schools I know in Italy, the confrontation against architecture is prevalent. I have always enjoyed exploring the profile of a designer to understand his ideas and his vision of the world, when they are not expressed explicitly. That is why I have always liked and still like Philippe Starck a great deal, not just for his formal and aesthetic solutions to the products he developed, but for his capacity to give meaning to every product. A chair is not just a chair, it is the result of an exploration of the chair typology in relation to the manufacturers' production capabilities and capacity for innovation. Design is design, independently of the scale. Our brain stores memories in quantities greater than the giga we think we can keep in store.
What does this mean for the design process? As you search for solutions, you move in apparently random fashion among things the things you see, and your brain stimulates its memory. That is creativity. If you have no information in your memory, you cannot design a product.

EV Flaviano, since you have been the director of *diid*, the journal has become open access. What role do you believe that distributed knowledge can play? Does accessibility produce new shared knowledge?

FC This question brings me right back to the present, as if I were dipping my foot in a lake in which there are rocks that emerge above the surface which I step across to get to the other side. I would start with the reductive viewpoint of western literature

as it observes itself: “western design” is a kind of design that is embedded in the market, in which products are designed and communicated, and the designer is an important part of the communicative value of the product. This is what we fundamentally talk about, and have talked about almost exclusively for many years, completely ignoring much of the past, present and certainly future of the Far East, the Middle East, Africa, Latin America, India and Indonesia. This is the first problem.
The second problem is the English language: you cannot share globalized open access unless it is in a language that can be understood. We recognize this and are adapting to be available in open access through the language of commutation that the world has decided to choose for itself at this time.
Another stone is the speed of research, of the production and consumption of knowledge, which also occurs through indexing. We no longer search for concepts, but for key words that are merchandise and therefore need to be consumed, found, exchanged at very high speed, otherwise the machines themselves can’t know them.
And finally, we come to the open access system, which significantly disrupts the product we are talking about, the journal, because the journal possesses within itself the fact that it itself is a “product”. When we put it online with no paid advertisement, free of charge and totally dematerialised, that content is released from a series of characterising constraints. That is also what happened to design objects when they were forced to deal with dematerialisation. Today the product is no longer n analogic, but something else we do not entirely know how to handle yet.
I therefore believe that we have entered a system of global sharing based on the English language, indexing and research engines. Rapid research has led us to a system that quickly consumes the state of the art, but does not investigate it in depth. The enormous distress in the present time of a sixty-year old such as me, is the almost total disappearance of in-depth study, notwithstanding the other products that transmit, produce and channel knowledge, but are not journals.
This, as Tonino said, requires becoming part of this system in the present time and conducting real experimentation, seeing what happens if we improve certain steps and seeking to understand the reactions this provokes. It’s as if the journal we are handling was a Living Lab, a context in which to conduct experiments to perceive their effects as rapidly as possible.
The question is: are we still talking about producing design? Are we still talking about production? Does the industrial design we inherited as a journal deal with the production of design or the authorship of design, that is with creativity? Is its focus the designing human being or design as an industrial product, which is bought and sold, that has an economic value and a brand and exists within a system of communication? Maybe one is contained in the other, but these are two phenomena which require different skills and systems of elaboration.
One final note: we do not produce the journal, we collect content that is produced by others, and sometimes we take it

upon ourselves to comment on it, use it, open it. A word that I encounter with great joy in this work, which actually entails great effort, is 'orchestration', or better yet the illusion of orchestrating a choral endeavour composed of many minds, many intelligences, many actors, who are the ones truly responsible for the development of the product. Because I wouldn't want the role of the director to be exasperated. Or better yet, by law it is my responsibility, but the value lies in the authors: this is a dogma that everyone in this profession should accept.

TP These words prompt me to advise Flaviano to accept a profound responsibility. Schools have never been extraneous to prevailing movements; without a doubt, we are influenced by the principle of the present. As I have been saying for some time, ideologies have gone into crisis under the weight of post-modernism and the many "isms" of the late twentieth century and the present – from weak thought to relativism, to deconstructivism, to positivism. I believe that this world, the one we see on television every day, is a product of the crisis of ideologies. Pure communication, truth or lie, we don't know. Nevertheless, the principles, methods and goals of modernity have never ceased to express themselves with continuity, and the intent to improve human life with the design of things and of architectural and urban space. Sometimes driven by a utopian impulse. And so we react with the project for a journal that reinterprets the modernity that we have lived through and little by little postmodernism in decline, to give us a compass with which we can orient ourselves. Aware that we must seek help by reading the most advanced outcomes we observe daily in every field.
I titled my editorial in issue number 64 of the journal *The Time is Out of Joint: or Cursed Spite. That I was Ever Born to Set it Right!* (Shakespeare, Hamlet, Act 1, Scene V).
We are certainly not alone in this adventure: we are assisted by the texts of the classics or by recent exhibitions and relative catalogues in some of the most important museums in the world.
The journal can play this role, it can weaken the dignity of isolated intervention and provide dignity to an intervention that is the result of a collaborative effort and a way of thinking that opposes fashion and trends.

Elena Formia I would like to submit a provocation to Flaviano, about a possible vision of the future for the journal, and for publications in general, starting with the identity of the very concept of industrial design. Does it exist and will it still exist? How will we build a system of narration around research into contemporary design?

FC I cannot make any long-term assessments. But I do have a certain appreciation for the problems we must deal with and for which we must find a "courageous" solution, a term I borrow from the hope expressed by Tonino.
The journal deals with research into the design of products. The product has changed, is changing, will change. The design process has changed, is changing, will change. The

way we conduct research into design has changed, is changing, will change. Therefore the first observation is that we are walking headlong into a triple challenge, trying to correlate these three lines of reasoning, as they are changing. So I will approach it with courage, perhaps recklessness, for the challenge is considerable.
The second discourse is about multiple channels: we are still digesting, with some difficulty, our loss of the printed analogic version. Let's say it's for the good of the Planet, though it remains uncertain whether the digital consumes more energy than the paper we once relied on. Multiple channels are the challenge. We will talk about research into product design with a written form of narration, following the criteria we are dealing with today to address the rules of international ranking and science. The potential of multiple channels make it clear that there are more effective channels which engage all the senses or many of the senses and that are probably indispensable. But we don't have the answer yet.
The third challenge is quantity: when *diid* was founded, there were ten, maybe fifteen magazines that I monitored to feel the pulse of what was occurring in criticism and research into product design, today it would be impossible given the evolution of the computer which systematically analyses key words. The quantity of information, knowledge and studies is overwhelming. In this quantity of knowledge capsules launched into the global system I get lost, I get lost as a researcher and as a lighthouse in a sea in which, given the task I have been entrusted with, I must do more than just float. How do I filter? How do I cut? How do I reduce? It takes an inordinate effort to subtract compared to the past. The choral effort of production I referred to earlier is far more complex than the idea of orchestration alone. Think of the challenge of a research study fixed in time t at zero and circulated, on which from that moment onwards, others can intervene to correct, increase, enrich and develop the content, leaving a trace of the earlier versions, transforming the product itself to such a degree that soon after, no one will know who the author is.
The last challenge I wish to speak of is the challenge of the discipline. The discipline could cease to exist. I have the good or ill fortune to have seen what happened to mechatronics: my graduate thesis was about the impact of mechatronics on the relationship between individual and space in the mid-1980s. In the span of thirty years, that discipline, which overtook and transformed the world, is disappearing because it has been superseded by the digital. Our discipline as it came into being, could disappear. The challenge is therefore to address the evolution of the discipline itself, which could implode because it may not have the capacity to deal with contemporary transformation, and therefore be reabsorbed and downsized. It could entail a possibly painful future, following a moment of invasive explosion and the capacity to contaminate everything and everyone.
I have a strong sense of these challenges, we are trying to investigate them and address them day after day.

Designrama

The Designrama section is open to international debate and is not characterized by any specific theme. It is conceived as a space for the scientific community to give evidence of where research is heading worldwide.

102
Materials for SDGs: A Synergy Towards Sustainable Development
Romina Santi, Lia Sossini, Mattia Italia, Silvia D'Ambrosio, Francesco Zurlo, Barbara Del Curto

114
The Delphi Method as a Morphological Catalyst for Foresight-Oriented Design Research
Noha Essam Khamis

126
From Open-Source 3D Printing to Industrial Manufacturing
Matteo Zallio, Claudia Porfirione, Francesco Burlando

138
A Framework Towards Understanding the Performativity of Products
Gizem Çelebi, Çiğdem Kaya

146
Seniors and the Use of Digital Media in the Post-Pandemic
Giulia Panadisi

156
Design as a Driver for Multidisciplinary Teams: An Applied Research Case in El Quisco, Chile
Rodrigo Culagovski Rubio, Cala Del Río Alemparte

168
An Open Toolkit for Small-Scale Data Visualizations
Andrea Pronzati, Michele Mauri

178
Digital Architectural Design Inspired by and Created with Nature
Valentina Perricone, Silvano Arcamone, Francesco Monti

Materials for SDGs: A Synergy Towards Sustainable Development

Romina Santi
Politecnico di Milano
romina.santi@polimi.it
ORCID 0000-0003-2012-517X

Lia Sossini
Politecnico di Milano
lia.sossini@polimi.it
ORCID 0000-0002-0101-5461

Mattia Italia
Politecnico di Milano
mattia.italia@polimi.it
ORCID 0000-0001-6313-563X

Silvia D'Ambrosio
Politecnico di Milano
silvia.dambrosio@polimi.it
ORCID 0000-0002-7931-1148

Francesco Zurlo
Politecnico di Milano
francesco.zurlo@polimi.it
ORCID 0000-0002-7095-0699

Barbara Del Curto
Politecnico di Milano
National Interuniversity Consortium
of Materials Science and Technology (INSTM)
barbara.delcurto@polimi.it
ORCID 0000-0002-0125-0226

Abstract
The 17 Sustainable Development Goals (SDGs) represent a tangible and holistic vision of sustainable development, embodying a systemic vision that integrates environmental, social, and economic aspects. By adopting such a systemic vision, designers can drastically reduce the negative impact of their products. Materials represent a design element capable of influencing the entire life cycle of a product. Indeed, in the last decade there has been a frenetic race towards greener materials, focusing mostly on the environmental aspects of sustainability and neglecting economic and social dimensions. This paper aims to investigate a new thread of thought regarding sustainability within the design process, analysing the connections between SDGs and materials. The result is a taxonomy of materials that meet the SDGs and enhance their relationships by offering designers a new approach to sustainable material selection and development.

Keywords
Materials4SDGs
Sustainable development
Sustainability
Systemic approach
Taxonomy

An Inclusive View of Sustainable Materials

The term sustainability has acquired a primarily green meaning in the last century. The English verb from which it derives, "to sustain", has an apparently banal meaning: to maintain a condition, to preserve a state. Like the sustain pedal on the piano, which, once pressed, sustains the notes, making them play for longer even when released. Similarly, sustainability in modern society aims to preserve, maintain, and improve the ecosystem and the species within it. The most widely used definition was formulated by the Brundtland Commission defining sustainable development as a "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). This opened the dialogue around the preservation of the ecosystem and the improvement of the human condition (Vezzoli, 2018).

These concepts have subsequently influenced the agendas of associations and governments worldwide, and have become goals to be achieved. Over time, they have been interpreted and evolved until they were formalised and translated into tangible objectives by the United Nations in the 2030 Agenda for Sustainable Development (UN, 2015). The Agenda proposes 17 Sustainable Development Goals (SDGs) with a systemic vision of sustainability that integrates environmental sustainability with economic and social issues (Barbier & Burgess, 2017). SDGs aim to "stimulate action over the next 15 years (only 8 left) in areas of critical importance for humanity and the planet" (UN, 2015).

Though simplified and pragmatised, the 17 objectives can only be achieved if there is a widespread effort and a radical change in everyone's behaviour, in the way society organises and relates to itself and the environment, in the way we produce and even in the objects we use and how we use them. The latter in particular, which are part of the world that we experience every day, have triggered a virtuous cycle that actively involves both consumers and designers (Sanders, 2006). Thanks to digitalisation and globalisation, there is a growing awareness in society, which is now constantly searching for products that meet the new needs of sustainability (Manzini & Menichinelli, 2021). The designer is therefore called upon to respond to these new challenges (van der Bijl-Brouwer & Malcolm, 2020). The greatest possibility of reducing the environmental impact of a product is through its design, giving the designer increased responsibility and greater impact on the product's entire lifecycle (Bevilacqua et al., 2012; Ceschin & Gaziulusoy, 2016; Vezzoli, 2018).

Materials play a fundamental role in this context, as an element that can condition the entire life cycle of the product, and consequently the various systemic impacts. Many companies and practitioners have realised the primary importance of materials, and search for increasingly sustainable choices. Over the past decade, this necessity has led to a frantic race for green materials, linked to terms such as bio-based, biodegradable, compostable, recycled, and recyclable, sometimes generating confusion and some superficiality among young designers and consumers. As a result, the general thinking with regards to sustainable materials focuses on the environmental aspects of sustainability, neglecting the social and economic aspects. There is an urgent need for increased awareness and

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research to realign the selection and development of materials with a holistic, systemic, and strategic perspective on SDGs.

The aim of this paper is to investigate new threads of thinking regarding the topic of sustainability in the design process, offering an open-minded overview of the meanings and implications of "sustain-ability". This has been done by analysing the interconnection between the deep concepts of SDGs and materials. The core of the research proposes a taxonomy of materials that meet the SDGs, highlighting insightful connections from their collision. This synergy can provide designers with new approaches to the selection and development of sustainable materials. Finally, an extensive analysis of case studies may serve to open new horizons for further debates that focus on developing materials-based approaches to achieving SDGs.

Materials That Meet SDGs

There is no hierarchical classification of the SDGs consistent with the principles contained therein, but to deal with them within thematic areas, we will apply the diversification published by Johan Rockström and Pavan Sukhdev in 2016 (EAT, 2016). Their systematisation of Sustainable Development Goals is based on the tripartite model of the economic, social, and environmental implications of sustainability. Taking this reference, the SDGs and materials cases will be clustered within three main thematic areas: Biosphere, Society, Economy.

Biosphere

The preservation of the biosphere is a necessary condition for the survival of animal and plant species. The focus of this discussion will therefore be on materials that support the biosphere, operate cohesively with it, without hindering it.

- SDG 6 aims to ensure the availability and sustainable management of water and sanitation for all. Water-filtering materials can support this goal. *Indus,* a project by The Bio-Integrated Design Lab at the Bartlett School of Architecture is a modular system of bioinspired tiles that, thanks to algae and an algae-based hydrogel, allows small rural communities to obtain clean water. A second example is *Acquaporin,* which purifies the water through its *Drinking water membranes* project. It relies on a semi-permeable TFC biomimetic membrane that exploits the operating principle of the aquaporin proteins inside it.
- SDG 13 calls for urgent action to fight climate change and its impacts. Materials that support this goal are carbon neutral or carbon negative. One such material is *Made of Air*: a carbon-negative bioplastic made from a binder with biochar, a carbon-rich material produced by burning biomass without oxygen, which prevents carbon from escaping as CO2. Another example is olivine: an abundant mineral that can absorb its own mass of carbon dioxide when finely pulver-

ised. Another way in which climate action can be taken is to raise community awareness: the smart fabric *Aerochromics* by Nikolas Bentel operates by reactivating and transforming its patterns as the levels of harmful particles in the air increases.

- SDG 14 aims to preserve the oceans, seas, and marine resources and ensure they are used sustainably. In this sense, *ECOncrete®* is a bioinspired material on a micro and macro level, that fosters the growth of marine life on under-water concrete infrastructure. Other projects share the same goal, such as the *3D-printed Coral Carbonate* by Danielle Dixson and Emily Ruhl, designed to constitute natural coral skeletons to be inserted into the marine environment. In addition, numerous projects aim at de-plastifying the seas, hence the collaborative project between Parley® and adidas® for the design of a shoe made of reclaimed marine plastic waste: the *Ultra Boost prototype* shown in Fig. 1.

Fig. 1
Parley and Adidas collaboration for the *Ultra Boost prototype* shoe. © Filipe Alves on Unsplash.

- SDG 15 aims to protect, restore, and promote the sustainable use of terrestrial ecosystems. In this perspective, materials with FSC and PEFC certifications, international standards in the field of wood and its derivatives, are developed with the aim of spreading the principles of good forest management in civil and industrial society. An international group of researchers has been working on a biomimetic material to combat desertification through a micro and meso structure that facilitates condensation, drawing inspiration from cacti and beetles (Park et al., 2016).

Society

The social dimension of sustainability determines if a product promotes people's welfare, health, and safety (Ljungberg, 2007). In literature, it is challenging to find correspondences with socially

diid No. 76 — 2022
Doi: 10.30682/diid7622i

sustainable materials. One of the possible approaches is to shorten the supply networks of raw materials and facilitate local small and medium businesses as a measurable parameter that can be referred to the procurement of natural resources, renewable and non-renewable energies (Allione et al., 2012). This research, however, explored other approaches to determine materials that are sustainable in a social sense, following the SDGs.

- SDG 1 aims to end poverty, in all its forms and everywhere. This goal dialogues perfectly with green building materials applied in disadvantaged communities: materials of natural and local origin, such as wood, mud, coconut palm leaves and above all bamboo, are used by local labour for the construction of buildings for social purposes. On the opposite side of the coin, the plastic materials that invade communities without structured recycling networks can be seen as a precious resource for them. In Kenya, *FlipFlopi*, a *dhow*, the small traditional East African boat, was made entirely of recycled plastic from materials recovered by collecting flip-flops, since they are made of flexible expanded lightweight plastics.
- SDG 2 aims to end hunger, achieve food security, better nutrition, and promote sustainable agriculture. Not only materials, but technologies as well can be used at this juncture. The Food and Agriculture Organization (FAO) has offered open-source 3D designs of innovative equipment for post-harvest handling and food processing that can be downloaded and used freely. Reducing food loss and waste could be an approach in support of Zero-hunger materials. *Apeel* is a protective extra peel that seals moisture in and keeps oxygen out, based on substances that exist in the peels, seeds, and pulp of all fruits and vegetables.
- SDG 3 aims at ensuring healthy lives and promoting well-being for all people of any age. Latex, a widespread and not particularly new material, has nevertheless enabled the introduction of disease prevention and protection products. More innovative materials were also used to fight for the cause such as, for example, antibacterial coatings based on silver dioxide, which during the Covid-19 pandemic were applied by Industrie Grafiche Pacini on paper products (books, magazines, menus), as well as packaging and children's toys. Another example is *d3o*, a company that develops a series of polymer blends formulated to achieve specific properties for protective or shock-absorbing products for sports, motorbikes, and industrial safety.
- SDG 4 aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. Innovation was pursued towards this end in educational support materials. The first example is the *ETHERGRAF*® pen: its metallic tip microscopically "scratches" the paper, oxidising it without tip wear or waste, making it a "forever pen". Paper is another critical focus and, thus, Favini's *Crush* paper line is made from by-products of agro-industrial processing. These innovations do not represent an inclusive and equitable educational phenomenon to date, but they hold great potential for products that can provide lasting tools and raw materials

supply for education to disadvantaged communities.

- SDG 5 aims at gender equality, eliminating disparities and ensuring equal opportunities. The material that first provided great inspiration was an equal-opportunities fabric: jeans denim. A fabric which has fostered equal opportunity for women giving them the freedom to dress in defiance of stereotypes since the 1960s, in parallel with the feminist movement. Starting from the concept of gender neutrality, the trend in "gender-neutral design" works on the CMF (Colour, Material, Finishes) aspects of materials. A groundbreaking example is in the sector of children's toys: in 2012, *Harrods* unveiled the first gender-neutral toys department to prevent the formation of gender stereotypes from an early age.
- SDG 7 aims at ensuring access to affordable, reliable, and sustainable energy for all. In this context, high-performance composite materials for wind turbine blades carry with them a major problem regarding their disposal, but the *FiberEUse* project envisages new circular economy solutions for the reuse of end-of-life fibre-reinforced composites Fig. 2. In the category of materials that support clean energy, there is an impressive project developed by dyaqua: *Invisible Solar* is a new photovoltaic material that can take the appearance of terracotta, stone, cement, or wood, to integrate and maintain the aesthetic continuity of buildings and landscapes.
- SDG 11 makes cities and human settlements inclusive, safe,

Fig. 2
***FiberEUse* project displayed at FuoriSalone 2021, a close-up of the recycled composites on a chair prototype. Ph. by the Author.**

resilient, and sustainable. The *i.active BIODYNAMIC* cement by Italcementi featured in the Italian pavilion at Expo 2015, when irradiated by sunlight, "captures" certain pollutants in the air, transforming them into inert salts and thus helping to rid the atmosphere of smog. A similar example is *theBreath*® by Anemotech S.r.l., a fabric with multi-capacity applications,

diid No. 76 — 2022
Doi: 10.30682/diid7622i

that, through the natural flow of air, coupled with perforated metal panels or expanded metal sheets, absorbs and purifies the air without the use of additional energy sources.

- SDG 16 focuses on promoting peaceful and inclusive societies for sustainable development. This theme is inevitably connected to SDG 8, but now it will be looking at two realities that produce material in collaboration with the local communities. The first is *karuun®,* which produces rattan with Indonesian communities innovating the traditional way of processing this kind of material. The second is Ananas Anam, the maker of *Pinãtex*. *Pinãtex* is a leather-like material that comes from the harvesting of pineapples, a by-product of existing agriculture. Through the recovery of this material, it has been possible to create an additional income stream for farming communities, helping the circular economy and the economic development of the Philippines.

Economy

Profit is a necessary condition of sustainability (Elkington, 1994). SDGs for sustainable economic development concentrate on ensuring a better future in terms of profit and work conditions in general.

- SDG 8 promotes inclusive, and sustainable economic growth. The most representative material is a protest against the working condition of child workers in Congo to extract cobalt and coltan. The material becomes a rich asset that exceeds the value of human life. *Fairphone 2* has set out to fight for this issue: the materials used are obtained from Congolese mines managed by non-governmental organisations outside the military conflicts in the area. Another case is the Italian company *OltreCafé,* which gives new life to coffee grounds, creating pellets for stoves and reusing a precious resource that would otherwise end up in landfills.
- SDG 9 focuses on building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation. The design of *Plyskin,* a thesis project at the Royal Academy of Art in The Hague, Netherlands, was based on the structure of a polar bearskin, and consists in generating a three-layered module to insulate a building efficiently (Cafsia, 2017). Another case study is a collaboration between the Italian companies *Mapei* and *Iren*. They signed an agreement to use thermoplastic polymers deriving from innovative recycling processes to create durable and sustainable road surfaces.
- SDG 10 seeks to reduce inequality within and among countries. Many projects deal with minority communities: one of them is the *Quid* project. The material involved is recycled fabrics that are transformed into ethical fashion garments, offering job opportunities to vulnerable people. Broadening the concept of inequalities, in the *IMK architects* project for a *hospital façade* , the bricks were made out of earth and subsequently dried on site, uplifting the country's development and providing jobs for the people in the local

community. But looking at the SDG from another perspective, a very innovative case to ensure equal opportunities for blind people is the *Braille E-Book*, which instantly generates a slight roughness on the screen using EAP (Electroactive Polymers) technology.

- SDG 12 aims at sustainable consumption and production patterns. In this SDG, relevant companies have a more comprehensive vision of the entire concept of sustainability: the B-Corp Patagonia developed *Infinna*, a regenerated textile fibre from cotton-rich textile waste with the natural look and feel of cotton. The Italian B-Corp Davines developed a solid shampoo: a real example of responsible consumption, because it drastically reduces the packaging and the resources needed to obtain the same function. The last example is a material from GoodHout's, *a* coconut husk panel manufactured by upcycling existing agricultural by-products and waste streams, caring for customers' health by avoiding the use of toxic chemical additives, and supporting local communities.
- Most importantly, there is SDG 17, which strengthens the means of implementation and revitalises the global partnership for sustainable development. With regard to this SDG, the chosen materials are those that focus the attention on the networks and the relations between the different parties involved. The first material is *MOSO® Bamboo,* an example of a partnership between Europe (the Netherlands) and China: it establishes a production plant totally dedicated to the production of bamboo veneer. The other example of a network is *Precious Plastics*, Fig. 3 an open-source community that promotes knowledge about recycling plastics, thanks to a digital platform, with the goal of creating an alternative global recycling system.

Fig. 3
***Precious Plastics*, the community was hosted in the Ro Plastic Prize 2020 finalists' exhibition. Ph. by the Author.**

diid No. 76 — 2022
Doi: 10.30682/diid7622i

The case studies delineated in the paragraph above were the result of a collection effort, supported by a profound reasoning on the intrinsic objectives of each SDG. At the initial connection between SDG and material, however, it became clear that, while basing their concept mainly on one, they also nurtured other objectives. Above them all however is the purpose of collaboration and generation of a network to achieve the objectives (SDG 17). Fig. 4 shows how the cases intertwine objectives and form bridges for joint objectives.

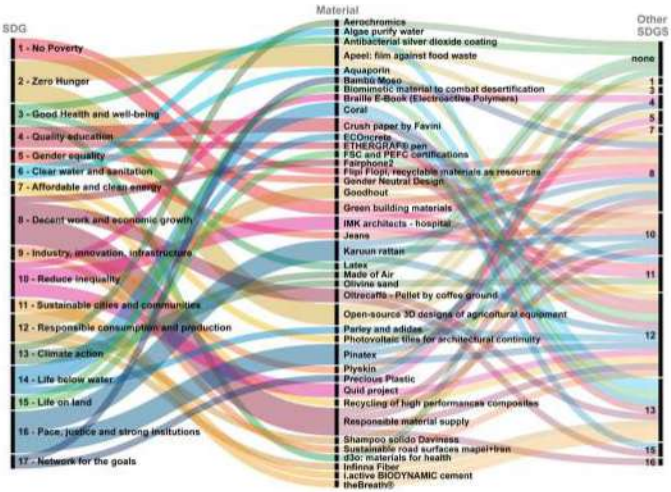

Fig. 4
Case studies analysis as a bridge between SDGs, a data visualisation obtained through https://rawgraphs.io/, by the Author.

The cases selected to represent the material side of SDGs were also classified according to material categories and application sector Fig. 5. The result is that most of the cases presented refer to natural materials, though they also cover the other families. In fact, sustainable innovation can also be achieved through more traditional materials, reaching diversified sectors of application to foster sustainable development. What changes is the systemic vision within which the material is embedded, which may or may not make it sustainable.

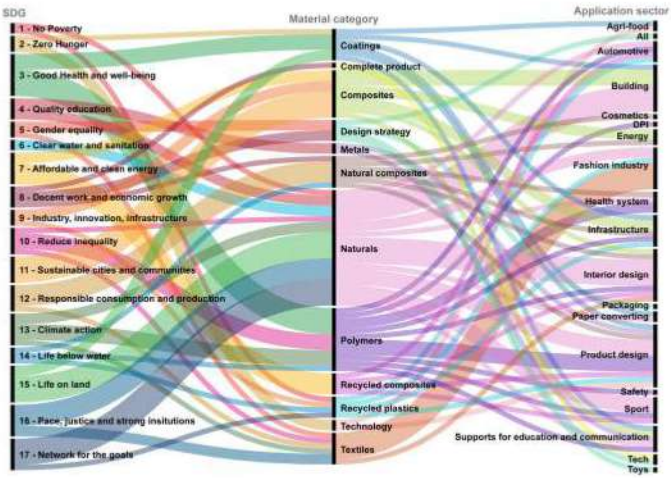

Fig. 5
Case studies analysis clustered by materials categories and application sector; a data visualisation obtained through https://rawgraphs.io/, by the Author.

From the research it was possible to draw up roadmaps for the selection and development of materials aimed at achieving SDGs. These indications, elaborated in Fig. 6, emerge from this study and from the research into case studies, but the research remains open to debate and integration. However, we wanted to emphasise how the approach we adopted made it possible to consider lines of development and a selection of materials for sustainable development that consistently integrate social and economic aspects, that are innovative, open-minded, and think out of the box. These assumptions do not claim that all the above mentioned are "sustainable materials", but rather materials for sustainable development, which integrate a systemic vision, aiming at a holistic vision of sustainability.

Fig. 6
Material-based roadmaps toward sustainable development based on the case studies analysis, by the Author.

diid No. 76 — 2022
Doi: 10.30682/diid7622i

Conclusions

According to the new design paradigm based on the insightful interconnections among the materials and the SDGs, a new role has been identified for the designer, who is increasingly viewed as a multidisciplinary bridge merging different disciplines and practices, such as, for instance, the design field itself, chemistry and engineering. This new design approach is a crescendo that is occurring in response to an ongoing, changing and emerging scenario related to the benefits of the planet, of society and of the economy. Inevitably, this new role implies new research and design skills that merge various methodologies and tools, to mention just a few: the ability to approach the selection of the suitable material as "a project within the project", the ability of the designer to manage and activate complexity as virtuous synergies among different actors and stakeholders while constantly considering materials not as a limit but as an opportunity.
The paper intends to open the debate on identifying material selection and development criteria in terms of social and economic sustainability in addition to the more generally considered environmental sustainability, in line with the millennial goals (SDGs), a highly unexplored field to date. The goal of this work is to look at materials from different perspectives, giving designers broadened material-based roadmaps towards sustainable development, and applying a dash of creativity, criticism of stereotypical sustainability concepts, and lateral thinking to guide their activity.

A reflection upon some limits is required. The methodology for materials selection that designers may apply as a result of this work is a selection by inspiration that relies heavily on the designer's experience and his ability to activate logical connections based on experience. For the future, a more systemic methodology could be integrated following the development in the literature of units of measure and impact assessment methods for the economic and social aspects of sustainability.

Romina Santi
She recently earned a Ph.D. in Design at the Politecnico di Milano and is now a research fellow there. She is interested in the consequences of materials design on consumer behaviour with a focus on sustainable materials and practices.

Lia Sossini
She graduated in Design&Engineering from the Politecnico di Milano, and is now a research fellow. Her research focuses on the perception of sustainable materials combining elements of CMF design and sustainability.

Mattia Italia
He is a Ph.D. candidate in the Design Department of the Politecnico di Milano. His research focuses on the translation of sustainable company strategies within the product, through the selection of sustainable materials and suppliers. Other research topics are footwear sustainability, strategic design and CCI.

Silvia D'Ambrosio
She is a Ph.D. student in Design at Politecnico di Milano. She collaborates and co-designs with institutions and cultural and creative companies at national and international levels by applying and testing systemic design approaches and design thinking methodologies.

Francesco Zurlo
Ph.D., Full Professor, Deputy Dean of the School of Design of the Politecnico di Milano, Chairman of POLI.design. His research interests concentrate on strategic, systematic and creative research-through-design, focusing on the ecological impact of business innovations and human flourishing.

Barbara Del Curto
Graduated in Design and Ph.D. in Materials Engineering. She is a Full Professor in Design at the Politecnico di Milano. Her research activity focuses on the design of materials and surfaces, with particular attention to innovative and functional materials, nanotechnologies, and functional surface treatments.

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diid No. 76 — 2022
Doi: 10.30682/diid7622i

76

There is a different tradition in design that we have learned to know through the application of ethnography, anthropology, natural studies, climate studies and the study of complex social relations. This tradition flows like a river underground and occasionally rises to the surface carrying with it profound results that help us to understand design reality. What we are studying in issue number 76 of *diid* is a subterranean river that requires scrupulous and attentive researchers with uncommon delicacy and sensitivity to discover, understand and scientifically convey the phenomena that derive from it.

We are quite far from a quantitative and experimental performance analysis, from historical research in the archives, the phenomenology of the user's analysis and the use of the sophisticated technologies that enable the contemporary designer. Here the discussion is about how form, function, value and meaning retreat from market logic yet transform the behaviour and structure of society or individuals in a global and contemporary manner through the cultures of design and its practices.

Paolo Cardini has orchestrated this observation by highlighting a community of researchers who are studying and applying these themes at the intercontinental level, and with the awe-struck curiosity of children we remain drawn to and pensive before the array of images that illustrate this issue.

Flaviano Celaschi

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