Design has been recognized as a discipline of doing. Its practical dimension has always exceeded the theoretical one, and the second has always placed the first at the centre. If this assumed a connotation of certainty in the context of the 20th century, today, in the contemporary world, is the Design dimension of
doing still valid? How the applied dimension of this knowledge has to be expressed? Can the "profession" of the designer specialized in product categories still valid? What space will it occupy between the professions of the future? What should be its relationship with production and consumption systems?
The issue 72 of **diid** opens up to those applied experiments where Design, within the laboratories and in the places of production, is outlining a different nature and prefigures a new role in and for society.

Loredana Di Lucchio, Lorenzo Imbesi, Sabrina Lucibello

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Design 2030: Practice

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Editorial

Design 2030: feasible practices for the next future

Tonino Paris

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Design, born as a discipline of "doing", has enhanced its theoretical dimension, passing through its disruptive practical dimension.
In this issue, the aim is to investigate and verify whether this assumption is still valid or whether the theoretical dimension has gone beyond the experimental one.
What skills will be required to the Designers of the next future? What should be the relationship within Design and the systems of production and consumption? And, above all, could we still call the operators of Design "designers"?
These are just some of the questions that the proposed papers attempt to answer.

The contribution of Bassi opens the session "Think", inviting to shift the point of view from the "possibilities of doing" in search of the "meaning of doing" and, even more, moving from the logic of "being able to do" to the logic of "knowing how to do". This paper promotes a" pro-adaptive" or "pro-active" design, that can act "in relation to the changing and transitive conditions of products, systems and services", and that can elaborate not a "solution" but "multiple solutions".
In the other papers, the protagonists of design open a critical reflection with those involved in research and training.
In the first paper two design teams, Forma Fantasma and Joe Velluto, tell about their slow and resilient design, that is able to rethink the nowadays life with "ideas as objects"
Then, Giovanni Iannella and Chiara Scarpitti tell about their "active" to marge research and design, convinced that is the only possible way for the next future, but finding within this relationship 5 different paradoxes.
Maurizio Montalti of Officina Corpuscoli, proposes new paradigms of collaboration in between Design and Science, where the innovation drawings inspiration from the Natural Systems, but in any case, where the Design attitude of "make" is fundamental in comparison with the other disciplines.
Finally, with the work of Gillian Crampton Smith and Alessandro Masserdotti, a reflection on the presents and future of the Interaction Design is opened within the contemporary scenario increasingly dominated by technologies and digital devices.

In the section "Make", the papers open towards experiences where the authors recognize the seeds of an updated vision of the Design practices.
In the paper of Conti and Motta, a zoom on the new adaptive design practices is offered, demonstrating their effectiveness within the knitwear industry; at the same way, Raj Kumar and Malakuczi describe how Generative Design, within the evolutionary path of CAD, outlining new directions such as topological optimization, morphogenesis and biomimicry", requires not only new technical knowledge, but also more flexible approaches.
Also the paper of Stando, Casciani and Bolzan proposes "a projective reading of the contribution of Design as a holistic discipline in the redefinition of materialization and production processes" between Digital Fabrication and Growing Materials, as interstitial practices, but at the same time central to design; while the paper of Mincolelli, Marchi, Imbesi and Giacobone underline how "the complexity triggered by the development of increasingly interoperable and intelligent objects is determining new dynamics of use and interaction between man and artefact" actually requires a rethinking of prototyping methodologies and practices.
Finally, the paper of De Chirico offers a reflection on "design as training, research and work" and theorizes about new practices and new places where the nature of designer is defined in relation to the relationships between universities, research and small businesses.

In the last of the three sections, "Focus", thanks to a more critical reportage of some research experience, a highlight on some key concepts about the Design for the next future is offered.
In the paper of Ferraro and Stepanovic AI is considered one of the most relevant topics, not only for the Computer Science, but also within the Design community, starting from the Interaction Design. In the paper of Ronchi, Ciancia and Piredda, the reflection moves towards on the "role of design in the evolution of processes that can become human-driven, starting from experiences and good practices of collaboration with companies and the integration of disciplines such as Design and Mangement in the development of a digital and cultural and design-oriented transformation ".
The "pollinator designer" is the "prototype" of a contemporary designer described in the paper of Papile, Coccia and Del Curto, in the experience made on the subject of the material selector, that is a facilitator with the ability to return information, receptor and, at the same time, promoter of changes at the systemic level.
The section is concluded with the paper of Sbordone and Pontillo that offers a reflection on the nature of the design innovation described as "the ability to integrate humanistic knowledge into technology "introducing to the phenomenon of collaborative industry".

Think

Think gallery > p.50/p.67

A sense of time for design

In order to try to think about the contemporary condition of design, it may be useful to appropriately reposition the sense-value attributable *latu sensu* to the project, freeing it – among other things – from the ideological incrustations of authorship or mercantile sussiego, from a self-referentiality devoted to irrelevance.
Therefore, many elements have emerged that are capable of configuring new opportunities to elaborate and practice different paradigms. It is then a question of moving design even further upstream, of strongly reconnecting the necessary and specific design action also to an intellectual and "humanistic" dimension, which in truth has always characterized it and fuelled its diversity compared to other modes of design.
If understood in this way, and unlike other linear, closed, high-definition and performance approaches, design may be able to interpret the contemporary transition and to use the appropriate tools to develop a strategy resilient to the random and unexpected conditions that characterise, with extreme evidence today more than in the past, our economic, social, technical and cultural system, and its environmental and natural modifications.
Perhaps we can begin to talk about adaptive design. Or rather, pro-adaptive or pro-active. Which means, among other things, the ability to design in relation to the changing and transitive conditions of products, systems and services. Not elaborating "the" solution but "the" multiple solutions (including those not yet imaginable) in relation to the unpredictable dynamics that characterise the phenomena of reality. A project with low definition but high complexity.

[design histories, plural design, s ense maker, hybrid age,
SLOC (Slow Local Open Connected), adaptive design, generative design]

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Distancing yourself: design and history of material culture

In order to try to think about the contemporary condition of design, it may be useful to appropriately reposition the sense-value attributable *latu sensu* to the project, freeing it – among other things – from the ideological incrustations of authorship or mercantile sussiego, from a self-referentiality devoted to irrelevance.
Assuming a historical-critical methodology and an appropriate temporal distance helps to go beyond the dimension of "instantaneousness", the substantial and not neutral renunciation of the dimension of time and therefore of history and criticism that irreparably marks our present. This feeds misunderstandings – such as, just to give an example, the confusion between chronicle and history and/or criticism, between novelty and innovation –, capable of harming a proper evaluation of design and of the ways of the obligatory placement within socio-economic, technological and cultural dynamics, in relation to the needs, desires, aspirations, ideals of human beings.

For the historian there are no trivial things [Siegfried Giedion, historian and architecture critic, said] he cannot afford to see objects with the eyes of those who use them every day, but must use those of the inventor, as if they were seeing them for the first time. He must have the new eyes of the contemporary, to whom the objects look wonderful or terrifying. At the same time, he must specify their mutual position in time and thus their meaning. (Giedion, 1967)

In this direction, the anthropologist George Kubler has elaborated a convincing model for the investigation of the multiple "forms of time", including material culture and design: a "history of things" that includes "all materials worked by the hand of man under the guidance of ideas linked and developed in time sequence" (Kubler, 1976). Inside it there are sequences of works of art and/or artefacts, understood as solutions linked to a problem that move from the first innovative object into a series; the fracture generated by the first object within the series, such as to determine the beginning of the sequence, is linked to innovation.
The history and the present day relevance of design are therefore inserted within the wider sphere of material culture, in other words the manifestations of human action, in which a technical and empirical aspect is combined with an artistic-creative-design aspect. Where the fabric component, of the concrete doing, is linked to the intellectual one, which provides meaning and value latu sensu to the artifacts. Giorgio De Michelis specifies: «The word artefact means made with art, artfully crafted", where art means "human activity regulated by technical expedients and based on study and experience" and only later "activity from which cultural products are born that are the object of value judgements, reactions of taste or similar» (1998).
Man has always produced tools or utensils. They serve to solve practical and concrete problems; over time they have consolidated in their form and functionality. At the same time he has also made objects to which further and more articulated meanings and values were attributed, such as an item of clothing, a jewel, a sacred vestment, a

weapon in the case of warrior civilizations, as well as that particular type of artifacts that are the scriptures. The boundary between tool, object of use, up to the work of art is of a qualitative nature, in relation first of all to the intellectual conscience of one's own role as author-creator; the distinction is then linked to the materials, to the manner of manufacture, to the conception and configuration of the form and its decoration.
Design represents the peculiar form of artifacts linked to the system of design, production, communication, distribution, consumption and management of the life cycle of the industrial age; in a conscious way, more or less convinced or polemical, it evolves and coexists with the transformations of the late industrial, post-industrial, neo-industrial era.
Within this temporal perspective, of contextual-value collocation and meaning, it makes specific sense to reason around the recent conditions and "plural" phenomenology of design (Bassi, 2018).

Hybrid age, techno-nihilist capitalism and the condition of design

The contemporary condition highlights a crisis in the role and figure of the designer. At least that traditionally understood. Looking at the current phenomenology of artifacts-systems-services we find a marginalization within known spaces and the emergence of other "fields of action" with respect to which designers need to focus appropriate instruments of intervention.
Design traditionally operates along two directions. On the one hand, with the ability to find the correct goods-methods manufacturing relationship, creating a complex of innovative activities that are difficult to detect and measure with the "classic" methods of analysis; on the other hand, with the acceleration/facilitation of interdisciplinary relations and with the arrival at a formal-functional synthesis, also through a systemic approach that links the territorial and entrepreneurial vocation of the product with the obligatory processes linked, for example, to identity, communication, distribution and life cycle management. It therefore provides a fundamental contribution aimed at giving unity to the company's operations and defining an integrated strategy around (mostly) incremental innovation for the product.
The design system is currently facing some unprecedented conditions: from the crisis of the model of infinite growth and consumption to the "long tail" and the new niche markets; from the obligatory need for recognizable strategies and identities (for quality and responsibility) for companies and products to the renewed methods of consumption, experiential, personalized and knowledgeable; from the horizons outlined by the new technologies of communication, design, distribution and production linked to digital and computer networks, to the pressing demands towards the culture of design, which is also asked to "take care" (both in a cultural and concrete sense through a social, ethical and conscious design) of people, things and the planet.
The central theme has become how to design, produce and consume within the "post-growth society" and make these activities compatible with a "limit economy" (Bassi, 2017).

The sociologist Mauro Magatti argued critically about the demagogic-imaginary freedom of techno-nihilist capitalism (Magatti, 2009). That is to say that the events linked to project-production, understood in a broad sense (from the technical object to the automotive, up to living), have particularly privileged the possibilities and tools of the so-called techno-sciences, active within performative-exhibition logics and ways of "doing to do", in substance organic and functional to the capitalistic-consumerist system. Priority has been given to consumption, possession, performance and speed, also as privileged forms of self-realization through "acting and/or appearing to exist".
Also in relation to this, Ayesha and Parag Khanna argue that we have entered a hybrid age (Khanna & Khanna, 2013), a new sociotechnical age that emerges as technologies combine with each other and human beings with them. Information technology, computerisation and robotics are bringing with them an increasing number of processes that once required the hand of man: automation is replacing human labour in logistics, production and distribution.
On the other hand, companies and societies are today characterized by knowledge organization, based on awareness, culture, imagination and creativity. Alongside the capital-labour binomial – which for a long time identified a traditional mode of production of value –, processes with an immaterial and symbolic dimension, such as communication, distribution, marketing and, indeed, design, have assumed maximum importance.
The potential linked to the digital revolution in a human design-driven key, the possibilities of holding a "lateral power" determined, for example, by renewable energies, knowledge systems and "widespread" technologies (Rifkin, 2011; Rifkin, 2015), as well as the government of big data, artificial intelligence, machine and deep learning, have also transformed the terms of the common lexicon with the bursting of words like commons, open, sharing or crowd, charged with subversive potential towards an apparently consolidated system.
Work and project, in part or in full, freed from the constraints of the technical-executive-material factory dimension, are in the unprecedented condition of focusing on sense making, human driven innovation, artifacts, systems and services for real people in a world where they want to live and try to pursue personal realisation and happiness.

Global, local, SLOC paradigm and responsible enterprise

Between the end of the 20th century and the beginning of the new millennium, economic, social and market models were redefined, with the obligatory need to act within a unitary world system and at the same time, particularly in our country, to reconcile the global and local spheres, so as not to lose the identity linked to the genius loci. This applies to companies – which physically produce artefacts or act in the dematerialised, yet concrete, dimension of service or net-society –, to designers, educational institutions and universities.
The economic model Think local/Act global - complementary and/or alternative to the historical Think global/Act local - is now spoken of in its own right, in other

words, as a local rootedness as an identifying and winning tool with respect to the homologated global dimension, the idea of infinite expansion, often without quality and attention to "limits".
"From local to global" is to be considered the basis of the recognizability and affirmation of our country's economy, territory, culture, lifestyles and products; in essence it is the formula of Made in Italy, design and fashion (Bassi, 2018). The entrepreneurial reality that expresses them is characterised by small and medium sized companies, frequently located and developed within clusters, including subsequent developments such as meta-cluster, networks or aggregations based not only on the territory and so on (Amatori & Colli, 1999; Becattini, 2000; Colli, 2002). These are local systems, driven by individuals and family groups, accustomed to the medium-long term construction and "internal" transmission of government and corporate culture, where the results in terms of efficiency and flexibility are often based on extra-economic factors of a social and historical nature, on contextual knowledge and relations between individuals, on the "speciality network", in other words the complex and articulated system of skills and "know-how" generated by the explicit or tacit transmission of knowledge. An original profile that does not change even when robotics and numerical control are introduced into the workings. Initiated towards niche strategies, the companies are, therefore, marked more than by the introduction of new technologies, by the incremental management of "mature" product typologies, by intangible competences, in relation to the valorisation of the brand or the role of the project.
Also in relation to this Ezio Manzini has proposed a SLOC paradigm - small, local, open, connected - that tries to combine the local dimension and the digital revolution (Manzini, 2015).
The current advanced condition of research and project of mental and physical wellbeing – not only consumption but real needs, connected also to fears, natural disasters, social and cultural discomfort and so on – seems in fact to look at social quality, in the direction of a "relational society", which can go back to linking territory and local wellbeing, as well as feed the virtuous relationship between project culture and business.

From problem solver to sense maker

For a long time the figure of the designer coincided – particularly in specific economic and local contexts – with that of those who provided solutions to problems of different order and degree. In the beginning mainly technical-formal and then progressively linked to identity and business strategy, up to the needs of markets and sales. The search for possibilities to innovate, to be first mover and acquire unique competitive advantages, places him today in a different condition not only of problem solver (which remains a relevant component of his work), but also of the one who contributes to the construction of new meanings, able to provide practicability of meaning and existence for the artefact system.

Design as sense making (i.e. the search for meaning as a territory of specific action) means contributing to imagine products, systems and services that do not yet exist and finding new ideas around existing ones, more or less obsolete, but it should also be understood as openness towards new possibilities, beyond the conception of physical or immaterial "products", in search of other, high meanings and values. It can be a renewed typology to acquire a new meaning. In other cases the intervention has to do with social innovation linked, for example, to a more effective communication or organisation of a service (through sharing or participation) or to the construction of a focus on relevant issues such as, among others, the life cycle of products or design for all.
The everyday object and its duration, both physical and in the collective and market imagination, our familiarity with things and the ways in which this is achieved and satisfied, deserve renewed reflection around the "time factor".
We design and produce continuously because a certain model of economy and market requires continuous innovation; we cannot carry out substantial research and study on the overall system because the defined timeframe does not allow it; cultural-design hypotheses that discuss smart economy and indiscriminate development are marked by incompatibility with the needs of today. At the same time, operating with the logic of the short term struggles to reconcile with the needs of business construction and in the end with the same possibility of work for people.
Bruce Sterling states in a simple and powerful way: "thinking in terms of time is a moral vision of the world" (Sterling, 2006).
Two elements, among others, seem to be decisive in forcing us to think differently not only about tools and solutions (problem solving), but also about meanings (sense making): The first is the emergence of the open paradigm (source, knowledge, innovation, production, design); the second is the transition from an economy of possession to one of access and sharing (which is transforming us, often with little awareness, into many prosumers, producer-consumers, new "proletarians" or i-slaves in the generation of goods and services, from Ikea furniture to be assembled to social networks to be fed with our public-private sector). In short, an internet connection and a facebook, instagram or twitter profile are worth more today than having "many things".
At present in some sectors it has become difficult to distinguish between production and consumption: consumers have started to produce what they consume or consume experiences that are only possible by virtue of their fundamental role as co-protagonists, according to a top-down, top-down, peer to peer dynamic. In short, there is a growing mix between business and consumers, in which the company takes advantage to ask consumers to do a part of the work. This situation is evident in many forms of business-to-consumer "collaboration", enhanced by the network and digital communication, based on content production and interaction by users. In short, we can talk about productive consumption: I use and contribute to realize.
Another relevant condition is the physical dematerialization of objects, in a process of "evaporation of goods". At the same time, the economic value assumed

by services, contemporary new goods par excellence, is growing, especially those related to the digital and virtual dimension, where the modes of interaction and interface take on maximum importance.
The development of the system of services and the idea of using them without owning them involves a radical rethinking of the system of objects, with a consequent reduction of tangible things, but also of the commitment to move them, manage their logistics, place them in spaces for sale. It is enough to consider the ongoing reflection, even if only from the point of view of environmental impact, on "zero kilometre" products, made, managed and consumed in their places of origin instead of being moved around the entire planet.
From the point of view of the project, the possibility of using many services from personal multifunctional devices has made the physical component of the products and the aspects connected to it (external form, emotionality, playfulness) less relevant, while the way these activities interact with people has become decisive, in terms of visual, tactile and sound interaction as well as communication and information management.
Therefore, there are different ways of using things: some of them we still own, such as clothing or home furnishings, while others are available through "access", as happens with the web, sharing, the cloud.
As Vilém Flusser explained, linking the phenomenon to the transformation of bourgeois values based on production, accumulation and consumption of objects: "Owning things interests us less and less, while we are more and more interested in using information" (Flusser, 2003).
Moving the point of view from the "possibilities of doing" to the search for the "meaning of doing" and, even more so, moving from the logic of "being able to do" to that of "knowing how to do" appear to be difficult actions when we speak of the present-future or the future-next. The second option in particular is crucial for the culture of design, in a phase in which the technical-operative possibilities seem to compromise the forms of construction of meaning deriving from the specific instruments of the "discipline".
Clearly the misunderstanding consists in the substitution of thinking with doing, of the means with the end, while it is necessary to distinguish "doing as production" from "doing as research of quality and meaning". It is therefore decisive to distinguish the idea and/or the creative act from the project as a disciplinary operation.
The increased notoriety of design seems to have led to an equivocal substitution of tools with finalities combined with the erosion of theoretical-operational spaces, frequently absorbed by other forms of knowledge: drawing made to coincide with design; marketing made into design thinking; the "project to work" of the engineer confused with the "project to use" of the designer; up to the omnicomprehensive, exhausting and neutralizing melting pot of "everything is design" and we are all designers.

A contemporary phenomenology: new tools and "objects of love"

Common artifacts seem to have developed two modes of existence and relationship with users. On the one hand, new tools, physical or technological prostheses with which one interacts on the basis of accelerated and even knowledge-rich functions, but where the potential for innovation or simply the designer's identity intervention are mostly marginal or cosmetic. From devices and digital services of every kind and degree to homologated and anonymous transports, waiting for the transformations linked to self-driving modes and without yet a different, powerful and universal practicability of energy from renewable sources.
More generally, the "dictatorship" of the market, technologies, engineer design and computer science have reduced the designer's field of action, reserving it to the irrelevant extravagance of the star-system dinosaurs.
On the other hand, the "economy of the symbolic", that is the need for "other" enhancement beyond the form-function of goods, calls for the construction of socio-cultural and emotional imagery that in recent decades have ended up swinging, on the one hand, between the conservative and interested nostalgia of the past - the so-called design of memory, transitive design, retrodesign - which proposed the anachronistic redesign of old cars or bags of divas, on the other hand the decultured and anesthetized triumph of vintage. So: new tools and objects of affection (real or imaginary).
In short, the space for innovation appears to be very small, even the practicability of basic themes such as "real" sustainability, complete life cycle management (not the green-washing of corporate propaganda), extended usability (also opening up niches in the human design-driven market), the project in relation to old and new needs (not forgetting, among other things, the many Southerners of the world, rather than the duty of an inclusive design for all or to look at urgencies/calamity/insecurities), without forgetting desires (but perhaps not whims).

Towards adaptive-generative design

Therefore, many elements have emerged that are capable of configuring new opportunities to elaborate and practice different paradigms. It is then a question of moving design even further upstream, of strongly reconnecting the necessary and specific design action also to an intellectual and "humanistic" dimension, which in truth has always characterized it and fuelled its diversity compared to other modes of design.
If understood in this way, and unlike other linear, closed, high-definition and performance approaches, design may be able to interpret the contemporary transition and to use the appropriate tools to develop a strategy resilient to the random and unexpected conditions that characterise, with extreme evidence today more than in the past, our economic, social, technical and cultural system, and its environmental and natural modifications.
Perhaps we can begin to talk about adaptive design. Or rather, pro-adaptive or pro-active. Which means, among other things, the ability to design in relation to the changing and transitive conditions of products, systems and services. Not elaborating

"the" solution but "the" multiple solutions (including those not yet imaginable) in relation to the unpredictable dynamics that characterise the phenomena of reality. A project with low definition but high complexity.
Others similarly propose the concept of generativism, a dynamic modality of "non-finite", of programmed variation of the series, with which the culture of design has been dialoguing for a long time, which has recently expanded with the increase of computer knowledge and code writing skills. In fact, generative design is an approach, or rather, a working methodology, which places the procedure, i.e. the creation and regulation of processes that can generate "structures", at the centre of the activity, instead (and/or together) of visual, architectural, linguistic or whatever else.
Generativism that also connects with deep learning, one of the research fields of artificial intelligence, that is, the possibility that by indicating to the "machine" a wide range of variables and structures, it can acquire the experience associated with the different situations in which it combines and uses them and rework them (thus learning, generating knowledge). In the hybrid age, in fact, we are faced with ways of generating shared knowledge and knowledge that lead us to talk about collective intelligence and artificial intelligence, or rather to consider collective intelligence a form of artificial intelligence: what was once conceived as «man-technology co-existence has thus become human-technological co-evolution» (Khanna & Khanna, 2013).

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Resilient Professions.
When Design practices become responsible

If we have to ask ourselves what the practice of Design will be like in the near future, we certainly need to observe the present and understand what the signs of changes are and try to project them in a prediction logic.
The most evident sign that we cannot ignore is the ever more pressing acknowledgement of the inadequacy of the massive consumption system to which the contemporary society, at least that in countries with mature economies, had conformed and informed during the previous century.
Design, born and developed in that same system, today is demonstrating the need for a rethinking and a change of its paradigms.
At the level of critical theoretical reflection, this rethinking and change are by now a recognized fact, and possible evolutions have already been imagined.
What we are interested in knowing here is whether and what changes are also taking place in the design practical dimension with which the designers express themselves and give their contribution to the social, cultural, productive and economic system.
For this reason, the authors have opened an informal dialogue with two interesting Design realities that already in their nature seems to have the seed of change. Thanks to a reflective, critical, but equally germinative action, they have made their work and themselves "a field of experimentation" for the design of the near future.
An interesting picture emerges where the keyword is "resilience", understood here not in its political meaning of "resistance" but in the one closest to psychology that speaks of "positive reorganization", of "sensitive reconstruction" of "enhancement of identity ".
So here is a practice made up of ideas even more than forms, critical thoughts that as objects resiliently redesign the near future as if to answer the "levian" question of "if not now, when?"

[anthropocene, responsibility, design practices,
joe velluto, forma fantasma]

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Design as an attitude[1]

The Design has always been an attitude typical of the man who, relying on an innate predisposition for planning and solving problem, has tried to improve his condition by changing what nature did not make available or not had granted to him (Di Lucchio, 2018). It is an almost ancestral attitude that man also shares with other animal species: and not only with the primates close to us, but also with birds, able to arrange their elaborate nests, or with insects, able to build their sophisticated constructions, and also with the simpler life forms such as bacteria and viruses that chemically modify the habitat to make it hospitable for their residence.
However, if in the human being this propensity has been the driving force for the unstoppable technological progress that has brought us to the current condition, today a general picture emerges that returns countless and evident criticalities rather than benefits.
Especially in the last three centuries, the effects of the ingenuity and work of human beings on the global environment have intensified until reaching an epochal transition that has veered towards the Anthropocene[2]. It is a human-dominated geological era (Crutzen, 2006) in which human actions irreversibly impact on the terrestrial ecosystem, causing territorial, structural, and climatic changes. An era where the cracking of the links between man and habitat does not only concern natural resources and the environment, but also the spheres of ethics and politics.
It is unprecedented, but a specific, predictable condition, in which the exponential increase of artefacts places the issue of pollution at the center of the debate. In this condition, scientific and technological progress outline consumption scenarios where every waste becomes obsolescence. Moreover, the many social, economic and cultural differences continue to divide an already open society globally, and the reasons for production and consumption are often distant from the real needs of people's lives (Imbesi, 2010).
Examining and following the now irreversible anthropogenic traces, therefore, means identifying and understanding the factors, both natural and artificial, that determine the creation of these new conditions of imbalance. "Nature that discards everything that does not support the entire system, is radically discarding our species as well," said Elizabeth Kolbert (2014) in her book "The sixth extinction" and the sustainability of the entire ecosystem starts from the formation of new planning.
The analytical and scientific eye of Design can attempt to respond with practical solutions to macroscopic problems and imbalances between multiple systems (Thackara, 2006). Design can be able to profoundly reconsider the relationship between human beings and the habitat that hosts them: renew ing the processes of design-production-consumption of new artefacts; limiting their environmental impact; rethinking how human beings build relationships within the ecosystem in which they live.
Therefore, Design becomes fundamental to develop projects considering all the interconnections in-between product, service, system and the environment. An

environment that includes its ecological, social, cultural, and technological aspects (Marseglia, 2017) and imagining the system not as a simple sum of its multiple parts but as a complex of intricate interrelationships, where quality derives from the relationships between the components of the system itself (Capra, 2013).
The goal is to reach design outcomes characterized by a profound interest in humanity, in its habitat and its system of relationships, that are altruistic, extroverted, interested in both the natural and social environment, and capable of matching ethics with aesthetics (Antonelli in Croci, 2018). They are new, creative, and cross-disciplinary expressions, sensitive and research-oriented, ecologically responsible, and socially responsive, the result of a renewed sense of responsibility of the Design Discipline which thus becomes a radical, revolutionary, and resilient tool (Papanek, 1972).
In this constantly changing scenario, a profound cultural change emerges, already underway for some years, the result of the formation and dissemination of critical thought and a systemic vision that guides innovation on a social and ethical scale. Here Design acts or should act, as a meaningful and conscious planning tool for the rethinking of products and services that can take care of the world and man in an effective way.
Therefore, how is the profession of designer adapting today in an attempt to respond, through design practice, to the environmental, economic, and social challenges that the anthropogenic era requires us to face? Trying to answer this question, we have opened a dialogue with two interesting Design studios which, albeit with different approaches, are both addressing the topic set here through experimentation, research, and production.[3]
The dialogue dealt with the ethical responsibility of design and rethinking the traditional practices to reflect on the role that the Design Discipline has in the search for a new balance in the interrupted relationship between man and nature.

Joe Velluto: resilient actions[4]

The ethical dimension of Design is today facing a new season of environmental and social commitments to respond to the many emergencies/urgencies that the most recent anthropogenic mutations require.
Together with Joe Velluto studio, we questioned how much this new version of the human-made world is influencing the traditional design practice. We reflected if Design as a discipline can intercept new directions of change in a resilient perspective, adapting the practice changes to the real world through a meaningful sense of responsibility.
The ethical dimension of Design is today facing a new season of environmental and social commitments to respond to the many emergencies/urgencies that the most recent anthropogenic mutations require. The answer is obvious. Design is changing, and we must necessarily ask ourselves what it means to be a designer in the anthropocentric present we are living. We must reconsider the small part that we represent as living beings on this planet by reflecting on the interconnection that exists not only between human beings but also between all living beings on this Earth.

Design practices have always and continuously shaped themselves to respond to the various economic, social, and technological dynamics from its origin until today.
Especially in Italy, after a very early rationalist orientation, there was a response – around the 1960s – linked to a radical approach, or counter-design, which went beyond the rational setup, entering the most interesting and unknown territory of reflection.
It was a "Design with the thought" – linked to the great masters Sottsass, Munari, Mari, Castiglioni – related more to the meaning of the project and a little less to the shape.
Then there was an approach – around the 90s – oriented more to the morphological dimension of artefacts, where form, aesthetics, and the consumer industry were the masters. A "Shape Design" which, by making the reasons for technique and the market prevail over meaning, led Design towards a formalist drift (Mari, 2002). Then, over the years, there have been several other approaches related to marketing and design thinking that have transformed the Design into a service, emptying the discipline of its soul of research and experimentation to go towards safe roads in economic terms (especially after the 2008 crisis).
Today, the Design Discipline is discovering a new historical phase that goes beyond the dynamics of the previous and rise to a profession that is no longer the overlap of various disciplines, but a multiform metabolic cycle in which they feed on each other and transform each other.
By feeding and contaminating each other, they generate a new way of designing aimed at improving the human condition to produce progress. We are therefore passing from a form of organization as a set of independent skills, to a heterogeneous fusion of simultaneous subjects that reason and work on the bonds that unite men to the natural environment. Bonds that have been deeply compromised, or even destroyed, over the years.
As designers, we should go back to making hierarchical clarity between what matters and understanding that man and nature are not separate entities and, everything is connected. We should understand that real innovation does not mean designing the ultimate LED lamp with IoT technology, but designing with a new mentality, possibly taking into consideration the end of life of a product and its environmental, social, and economic sustainability. Anthropocentric design (son of the great Masters of the past) must de-anthropize itself, leaving room for the imagination to (quickly) explore new solutions useful for the community (Meschiari, 2019). Here, the role of the Designer is crucial and cannot fail to be responsible in this sense.
In the same way, Joe Velluto Studio, always focusing on the daily human gestures within the theatre of life, has amplified their design actions in an attempt to adapt, with coherence, effectiveness, and responsibility to the different global challenges that the planet calls us to face today.
In particular, they focused on the issue of the indiscriminate use of plastic, wondering if it makes sense to demonize it in such an extreme way, or if it is possible to identify an alternative to the problem that leads to a more conscious and responsible use of this precious raw material.

An example is the project "To re or not to re", an apparent reference to the famous phrase from Shakespeare's Hamlet, which is a collection of vases produced using a post-consumer "second life" plastic, that therefore derives directly from waste, 100% recycled and recyclable. Each container "wears" a mask that represents the "original containers" from which the vase itself comes, representing its past life. The colour range is always variable because it comes from what it is possible to find from time to time in landfills, which is plastic materials compatible with each other and divided by colour. Once transformed into granules, they can guarantee a product quality very similar to that of a product generated with virgin plastic.
This project is part of the RO Plastic Prize (an event curated by Rossana Orlandi during the Milan Design Week 2019).
Furthermore, it is evolving in collaboration with the partner company, Teraplast SpA, thanks to new design research on the theme of information linked to the conscious and responsible use of plastics.
With a completely different approach, but always concerning the theme of the product life cycle, the "One shot, one life" project has questioned critically and provocatively on how to reintroduce an iconic piece of Design, the Superleggera designed by Giò Ponti for Cassina in 1955, within the biological life-death-life chain. Thanks to micro-holes in the wood structure, obtained by shooting the legs of the chair, the entry of woodworms that will initiate the process of re-inserting, facilitating the connection of the chair into the biological chain of life.
As the previous one, also the project "One shot, one life" is part of the line of experiments related to the theme "Responsible vision for a responsible design" which underlines the crucial role of Design in facing today's ethical issues.
Within the capitalist system, we have focused on making the human being feel good, but, in reality, the ecosystem in which we live is not composed only of the human being, on the contrary, we are the minority compared to the multitude of other beings living. The designer, therefore, has the necessary task of offering responsible answers that avoid contaminating the planet with «poorly designed objects and structures» (Papanek, 1972).

Forma Fantasma: resilient reflections[5]

In a context in which events occur suddenly and uncontrollably and in which resources are increasingly limited, an idea of research-oriented Design emerges more than ever. Here Design is capable of operating according to complex and fragmented operational approaches that are not limited to observe what exists passively, but rather to determine virtuous mechanisms of plausible transformations.
Together with Forma Fantasma Studio, we have reasoned if it is possible today to detect a paradigm shift that pushes Design to critically questioning about overcoming traditional concepts, practices and processes. The aim is to give an adequate response to the environmental, social, economic and technological challenges that new global assets call us to face.

Precisely as a consequence of the various kinds of stresses that the current context imposes on us, from the beginning of their work, the focus of the design activities of Studio Forma Fantasma has never been to try to satisfy the needs of the Industry necessarily. Nevertheless, their research and experiments immediately have questioned the traditional "four-leaf clover structure" of design, production, sale, and consumption (De Fusco, 1985), now considered traditionalist if compared to the current scenario of instability.
Since 2009, with the project "Molding Tradition", the Studio has focused much more on the meaning of objects into a broader context as a response to a historical moment characterized by a profound economic and social crisis. The project "Molding Tradition" examined the influence of African culture during the medieval period in Sicily draw a parallel with the current migration crisis.
A large part of their works has concerned with research in the field of materials investigated from multiple points of view – from the traditional dimension to the perspective of the meaning that they preserve and carry with them.
In the case of "Botanica" project – that has been commissioned by the Plart Foundation in Naples – the focus was on the origin of plastic materials in the pre-industrial (or pre-Bakelite) period, namely before oil entered plastic production processes.
The investigation of these raw materials led to the discovery of unexpected textures, sensations, and technical possibilities offered by natural polymers extracted from plants or derived from animals.
Although it was born within theoretical research, the project evolved towards the production aspects, testing some of the materials identified in the research phase according to engineered and systematized dimension.
Another part of the design experiences has concerned the work done on the local dimension to understanding how the connection in between production, place and context, and to emphasize the social attention that the designer's action should have today.
With the "De Natura Fossilium" project, the Studio explored the lava material of Etna and Stromboli, questioning the link between tradition and local culture and the relationship between objects and the idea of cultural heritage.
The aim was to change the concept of place as a tourist attraction/show towards an idea of place as a source of raw material. With the help of the volcanology centre, some glass masters, and several other professionals, the Forma Fantasma conducted exploration on the possible applications of these ashes for the production of glass-based material and volcanic fibres for fabrics.
The result was a collection of glasses, tables, stools, watches, and textiles with a linear, almost brutalist narrative line, made of lava material with different degrees of definition, from the rocky one to the polished crystal.
Similarly, with "Botanica", the "De Natura Fossilium" project also had a further phase of development that led to experimenting with the material on a larger scale, seeing the use of volcanic ash used as a glaze for tiles. The most significant aspect of this type of application is that, unlike other chemicals and metals for glazing tiles,

which require an invasive and expensive extraction from the subsoil, volcanic ash is a non-extractable material able to significantly reduce the costs of the production process and the impact on the ecosystem.
Considering the reconfiguration of production processes, and the need of reduction of the design activity effects on the planet, we can no longer ignore that Design is effectively supporting a system that is leading us towards (probable) extinction.
For this reason, in many areas, we are learning to to "survive through design" (Papanek, 1972).
Through more critical and transformative design speculation, one of their most representative work regarding this paradigmatic shift is "Ore Stream".
A work commissioned by the Australian National Gallery of Viktoria in Melbourne and subsequently expanded for the Broken Nature exhibition curated by Paola Antonelli and inaugurated in 2019 at the Triennale in Milan.
Starting from an analysis of the economic sector in Australia, mainly based on the extraction of minerals, the project set the goal of investigating what does it mean to extract minerals, and how Design, through the creation of desirable objects, irreparably increases an "unconditional consumption", and as a consequence, the ecological disaster.
In particular, this project focused on the topic of electronic waste (which represent the largest and fastest-growing waste stream globally).
It analysed how much the optimization of products, the simple disposal, and the recovery of raw materials, can contribute to drastically reduce the extraction of precious metals from the subsoil (e.g. gold, silver, tantalum and so on).
Furthermore, the abatement of mining activities, in addition to producing an immediate economic effect (the reuse of minerals is less expensive than the procurement of new raw materials), would allow further advantages. It would guarantee to have, on the one hand, an impact in social terms, thanks to the reduction of possible armed conflicts in the countries where mining activities are involved. On the other hand, the abatement would guarantee more excellent protection in terms of air and soil healthiness, often jeopardized by incorrect storage of the extracted minerals.
To reply to these questions, through a shared platform of information and a collection of furniture made with recycled parts of the electronic devices,
The "Ore Stream" project intends to be a critical and political complaint to the electronic industry, and its overproduction, as well as, a denounce to that logic of obsolescence made be possible by reckless practices of Design.

[1] The paragraph 'Design as an attitude' is edited by Loredana di Lucchio. The paragraphs 'Joe Velluto: resilient actions' and 'Forma Fantasma: resilient reflections' are edited by Angela Giambattista.

[2] The term Anthropocene, to indicate the current geological era characterized by the intense conditioning by human activity on the natural ecosystem, dates back to 2000 by Crutzen and Stoermer (see http://www.igbp.net/download/18.316 f18321323470177580001401 / 1376383088452 / NL41.pdf). It is an evolution of a concept, previously expressed by the geologist Antonio Stoppani, in 1873, as anthropozoic era; by the Russian geochemist Vernadskij, in 1926, as noösphera; by Andrew Revkin, in 1992, as an anthrocene.

[3] The dialogues are the result of talks between the protagonists and the author, Angela Giambattista, during Joe Velluto's "Responsible Vision for Responsible Design" seminar on May 13, 2020, and the "Forma Fantasma. Open online lecture" by Forma Fantasma on April 23, 2020, organized as part of the Sapienza Design Webinars 2020 with the scientific coordination of prof. Lorenzo Imbesi.

[4] Studio Joe Velluto is a design studio born from the collaboration between Andrea Maragno and Sonia Tasca to generate a positive impact on society through a design approach aimed at research, experimentation, and debate, with an inclination towards meaning, awareness, and the common good.

[5] Forma Fantasma Studio, founded by the Italian designers duo Andrea Trimarchi and Simone Farresin, through experimental investigations on materials, explores themes such as the relationship between tradition and local culture, the critical approach to sustainability, and the meaning of objects as a cultural channel. Recognizing the designer's role as a bridge between craft, industry, object, and user, the Studio aims to create links between research-based practices and the broader industry.

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Beyond Human.
New Paradigms of Active Collaboration in Design

The current period in history calls for a radical shift of the reigning paradigm, to allow us reconnecting with the rhythms and the complex functioning of the ecosystem in a broader sense. As it was the case in the post-war years, it is today the task and responsibility of designers to take up this ever-important challenge, first by returning to the act of "making", as their distinctive register of operation, and also by working both to recover the methods and tools of their own craft and to expand the scope of their knowledge into other disciplines, so as to be able to work in increasing synergy with other spheres of knowledge and application.
Only by restoring their utopian enthusiasm and starting over from experimental activities, in addition to closely observing and analysing the processes they have set in motion, can designers construct new visions and theories, first imagining possible scenarios for a truly sustainable world and then giving these visions tangible form, in order to provide effective benefit to the global public.

[design thinking, design doing, finished aesthetics,
living materials, growing materials]

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Starting from such premise, the present article explores one of the possible paths leading to effective forms of innovation inspired by Natural Systems. Nature, that in this context is deemed to be the model, the measure and the "mentor" from which designers can learn through a fully informed, responsible study of its biological and biomechanical processes, with the ultimate objective of improving human activities and technology to allow full resonance with Nature itself.
But drawing on the apparent simplicity of the mechanisms and dynamics that underlie natural systems in order to imagine "experiential", "intelligent", "high-performance" and "self-sufficient" materials calls for the use, in what would appear to be an inversion of the expected procedure, of increasingly elaborate techniques that require specific capabilities which designers have not necessarily mastered in an ultra-deterministic, independent manner. The path to be taken is one that obliges us to "get our hands dirty", leaving our comfort zone and doing what it takes to understand and respect the complexity of the related biological processes and cycles, in order to make use of the outcomes (i.e. materials, products etc.) for what they actually are, and not for what we wish they could be.
The experimentation currently underway, though much of it being still in the pre-industrial phase, has already produced some initial, intriguing results on which sequences of theoretical exploration are being constructed, calling designers upon experimenting with possibilities for new products conceived of and constructed in combination with living, collaborative materials.
However, important steps must still be taken before we can arrive at the actual industrialisation of these preliminary results, and such trajectory involves not only technology and design, but also implications of a purely sociocultural nature. For the fact is that society must succeed in reclaiming a concept of beauty far removed from the ideal of perfection, or exacerbated perfectibility, typical of a context such as the chemical industry (synthetic materials); on the contrary, the opportunity lies in learning to appreciate a concept of beauty capable of contemplating imperfection, variability and apparent incompleteness, as values rather than defects.

Design and industry: synthetic materials and the aesthetics of the finite

The discipline of design, which came into being following the industrial revolution, was initially developed by the Bauhaus movement in Germany, following which it increasingly asserted itself as an independent discipline. At first, its strength and its chief characteristic were summed up as "form-function", a slogan that embodies the capacity to transform simple merchandise into "products" which have both a "sense" and an "innovative language".
And so industrial aesthetics were born, an outlook that promoted "the humanistic aspect of design, within the mechanistic framework of production, pursuing the democratic objective of the largest quantity of beauty for the greatest number of people possible", fuelled by a common objective, and namely that of promoting the then fledgling sector of industrial design.

This revolution, facilitated by the new technological-production possibilities of the post-war period, as well as by the heightened aesthetic bent of newly invented synthetic materials, made possible a standardisation of products, fulfilling the social-democratic promise of making good-looking, functionally efficient and long-lasting industrial products available to everyone.
By reinforcing the aesthetics of the finished and the perfect, this revolution supplied products offering ever higher levels of performance and longer lifespans, though without violating the criteria of planned obsolescence, valid not only in functional terms, but also as regards performance and aesthetics, having been established by companies that unfailingly pursue the logic of profit within a global capitalist system.
All of this has led to what, today, is a highly saturated system, especially in terms of its dire impact on the environment. In full analogy with what occurred in the post-war period, the challenge to be faced today, especially by the design world, is to explore new processes that can be adopted by industry, in order to bring about a change for the better in the dynamic relations between ourselves and the surrounding environment, of which we, as well as a multitude of other forms of life, are an active component.

Design and bio-fabrication: living materials and the aesthetics of apparent incompletion

This necessary change in paradigm, which once again brings us face-to-face with the dualism of nature/*téchne*, should not be viewed as merely a romantic "return to naturalism", with the latter understood as an unchanging perfection[1], but rather as an outlook involving the ecosystem as a whole, throwing light on the very real need to mend the intrinsic bond between ourselves and nature, as well as that between matter and the processes from which it originates.
Materials play a key role in bringing the designer (a human being) back into contact with Nature, though, unlike what has occurred in the recent past, it is no longer a question of replacing "old" materials with others, but rather finding new functions that suit the new materials, not only in terms of their life (span), but also in regard to their birth and growth. Numerous efforts along these lines have been undertaken in experimental design-research, as for instance shown by pioneering studies on bio-materials, though years of development are needed before results could be reached triggering a concrete, practical impact.[2]
Today, the fully informed study of natural biological and biomechanical processes as a source of inspiration for improving human activities and technology, provides us with one of the most intriguing stimuli for investigating the potential of "living" materials, which can most certainly be considered extraordinary, in light of the opportunities afforded by their capacity to self-generate and self-repair, as well as the active, collaborative manner in which they respond to the actions of both the environment and the human.

In short, Nature serves as Model, Measure and Mentor for the design of technical artefacts, which includes studying the neurophysiological systems of living forms, with the objective of artificially reproducing them, in order to generate innovations in the fields of neuroscience, cybernetics, electronics, robotics and prosthetics (electronic retina, electronic cochlea, heart valves, orthopaedic prostheses etc.) or simply towards new materials and products. At the same time, by drawing on the dynamic equilibriums that Nature establishes between form, function and technical-aesthetic elements or between energy and matter, biomechanical, structural and functional models of use in the production of artefacts can be obtained.
But even if contemporary designers are expected to imagine, and ultimately to design, processes and products whose functions and physical consistency, as well as their form, are increasingly "natural", the aesthetic principle of the finished, or the idea of beauty that eschews *raw* surfaces or *naked* colours, appear to still persist. At the same time, materials are expected to be "experiential", "intelligent", "performance-oriented" and "self-sufficient", though they are also called upon, in what could be considered a reverse process, to imitate nature not only in terms of their form – becoming increasingly organic, thanks to ever more elaborate processes of production and computerisation capable of governing complex structures – but also in respect to their behaviour – appearing ever more naturally alive and capable of sustaining themselves – having reproduced Nature's seeming simplicity through highly sophisticated techniques (Lucibello &, La Rocca, 2014; 2015).
Creating a new platform for sustainable development calls for nothing less than being able to understand, know and manage such materials, while taking into consideration the numerous parameters that can have an effect on design, such as temperature, seasonality, geographical origin, category and species, or simply the type of nutrient that fuels the growth of the material. In case of spawned materials, the variables definitely increase, as there are many different substrates on which microorganisms can be grown, featuring a wide range of diverse consistencies, levels of quality and form. Even within a given set of fungal species, often classified under the same scientific name, there can be significant genetic differences among the individual species, a critically important factor that can contribute to different behavioural patterns during growth, while also being a factor that exerts a noteworthy influence on the outcome, both in terms of mechanics and from an experiential perspective. In short, not only each individual species, but every single microbial strain can be considered a universe on his own, calling for in-depth study before the ideal growth medium can be identified, together with the related environmental conditions, thus making it possible to foresee the outcome (the material/product) or its distinctive features in a relatively accurate manner, for the purpose of the subsequent application.
It is no question, therefore, that such processes also call for changes in the practice of the very discipline of design, in order to stimulate an experimental approach capable not only of amalgamating and integrating the various disciplines, but also

of generating tangible visions and possible perspectives, so as to derive innovations that could have a positive impact on society.

New design practices

The field of design has always shown a keen interest in science - mathematics, biology, physics, chemistry – drawing from it, in various hybrid combinations, methods, approaches and results, all with the goal of transforming advances in research into innovative products and visions (Carullo *et al*., 2017). And yet the opportunities for interaction between these two worlds are not always fruitful, at times due to different "languages" (Ashby, 2002) and in other instances on account of the speed at which scientific innovation and experimentation move forward, leaving the design field with too little time to absorb the advances and make them its own, to later derive products, while the swift pace of progress also makes it hard for users to understand and appreciate what has been accomplished.

A further complication is the lengthy timeframe needed for industrial development, which can create difficulties, especially when it comes to innovations involving new materials (Franklin & Till, 2017), in terms of applying such solutions to products that prove suitable and competitive, within the context of a market whose rhythms and demands are quite distant from the values expressed by the materials themselves.

Give this state of things, there is no question that design plays a significant role, seeing that, by its very nature, it can be viewed as a discipline which groups together a number of fields, enabling it to bring the cycle of innovation full circle, by imagining and adapting for practical use new design scenarios and concepts for future products, thus endowing «scientific and technological research with value and meaning» (Ferrara, 2015).

Activities of particular methodological significance, from this perspective, are those involving a 'contamination' of figures and capacities drawn from sectors that would seem quite distant from one another, as in the case of scientists and designers, so as to arrive at hybrid methods and procedures, an example being design workshops held in scientific laboratories, or vice versa. But this phase, characterised by considerable freedom of conceptual range and purpose, as well as a noteworthy utopian undercurrent, must necessarily be followed by a growing awareness, on the part of the designer, regarding how, in order to make the most of the challenge, he or she needs to learn to move one step at a time, accepting rhythms of development much slower than they are generally accustomed to, together with compromises that prove indispensable to rendering this change in paradigm acceptable, both in functional terms and with respect to aesthetics.

An apt example is the experience of the company Mogu, whose designers – compared to the freedom that came with working at Officina Corpuscoli, where the new paradigm was explored with fewer restraints, in order to unearth and bring to light all aspects of its potential – were deveoted to temper their expectations at times, focussing more closely on the practical need of succeeding to sell products suitable and acceptable for the market, with the ultimate goal of effectively triggering a renewed production cycle of growth (in the literal sense).

Working with living matters, designers establish a possible framework of meanings for innovation, allowing materials to take form as prototype products, but at the same time they learn that such processes are exceptionally dynamic, especially those involving biology. The relationship established with living elements must be one of collaboration, as in the case of micro-organisms, which cannot be "forced" to do things, but need to be "invited" and "coordinated", as co-workers, so that they can put their intelligence to use within the process, in an ongoing exchange with the designer.

Clearly, the role of the designer is no longer limited, as per the traditional approach, to the product, the graphics, the installation, or luxury and aesthetics, as his or her scope of action, and potential, have expanded significantly. Today's designers serve as liaisons between the different disciplines, and between the environment and DNA, between nature and *téchne*, proving increasingly capable - though without transforming themselves into something else (or, worse yet, pretending to possess skills and know-how that they have not necessarily acquired) - of interfacing with other apparently distant fields of knowledge, by making the different languages their own, so as to serve as "interdisciplinary interpreters" while engaging in forms of experimentation that, as was the custom in the past, are solidly grounded in making/doing.

In short, the designer's role is an active one, calling on practitioners to once again work on matter, and to understand it, subsequently elaborating and developing the accompanying theory.

From design thinking to design doing

Though the needs that must be addressed, and the tools available for the task, have expanded compared to the recent past, it is safe to say that the primary role of the designer today essentially corresponds to that of an earlier era, in terms of both methods and objectives.

For just as the secret to the success of Italian design in recent decades was its melding of a crafts approach with industrial production, with an attendant standardisation (the process that gave rise to the major Italian brands)[3], today's design field has once again been tasked with establishing new relations between theory and experimentation, as well as between matter (living and subject to transformation) and product, though, as always, this means keeping engaging in processes of active experimentation.

What is referred to today as "material tinkering" provides designers with yet another approach to placing their skills and know-how at the service of product innovation involving new materials, rather than in other fields, while it is only by "getting their hand dirty" that designers can expand their horizon to the point of understanding matter, together with the ways in which matters behaves and the opportunities it offers (Gerritzen & Lovink, 2019). By once again taking up the mantle of the "craftsman", designers also become "architects" of innovation, thanks to the trust that they can gain from the field of science.

It is only by understanding the recurring give-and-take between the processes of "design thinking" and "design doing", returning to the original methodology inherent in design, and namely that based on doing, that a theoretical vision capable of stimulating science can be constructed, making possible advances which once again demonstrate how design consists of a fully aware "line of thought" able to draw on unorthodox methods centred on "doing".[4]
Matter is the starting point from which design can recover its sensorial dimension (Lucibello, 2005; Karana *et al.*, 2013), once again making a serious, practical contribution to responsible innovation, all to the benefit of society and of the ecosystem that the designer (as human being) is an integral part of.

Conclusions

While it is true that industrial design is a discipline which has developed through a combination of scientific and humanistic approaches, having to engage with the sectors of both production and consumption, in part due to its underlying social vocation, there is also no denying that, in today's world, the term "industrial" has taken on a very nuanced meaning, opening the way to a more expansive vision of design: an approach whose visionary, utopian component is pursued through courageous, active initiatives based on "doing" (Lucibello & La Rocca, 2014; 2015), establishing a method able to lead to the creation of a fertile terrain for the planting and blossoming of new visions and theories, as well as the introduction of new paradigms of production that prove both practical and necessary, with positive repercussions for cultural, industrial, social and environmental contexts.
What is needed is a change in outlook, in order to hasten the development of the new, evolving paradigms, shifting attention from the traditional but obsolete anthropocentric conception, geared solely towards satisfying the apparent needs and desires of human beings, to an approach that once again focusses on Nature, viewed as a complex ecosystem teeming with multiple forms of life that all deserve respect, and are of fundamental importance, keeping in mind that, while technology can identify solutions, design is the practical tool that contributes to making them understandable, inclusive and equitable at all levels.

The original essay was written in Italian, therefore the English translation may not fully reflect the contents and meanings expressed in the original language

[1] Natural systems (and, therefore, the notion of nature) are not fixed, unmoving entities, nor should they be viewed from a mistakenly nostalgic, romantic or static perspective. In actual fact, they are dynamic systems subject to continuous change (in perpetual flux), a process through which "equilibriums" are constantly being balanced anew, based on the behaviour and actions of the multiple agents that give them life.

[2] An apt example is Lycra. An innovative, revolutionary material in the field of textiles and fashion (and elsewhere), it was created in the 50's by Dupont (the multinational chemical giant with enormous resources at its disposal). Totally synthetic in origin, it required ten years of research and development, plus an additional three years (along with millions of dollars in investments) to be positioned on the market, followed by 60 years of constant innovation.

[3] The designer has always served as a mediator of the process of introducing new materials (in the past, synthetics), first addressing questions of design and planning, and then those of production.

[4] There should be no underestimation of the power of design, as tool to communicate in a simple but effective manner, by drawing on both digital techniques and those of narrative description, the complex dynamics that often foreshadow possible futures, with this being true both in the field of research and for the design profession.

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* In 2010 Maurizio Montalti founded the trans-disciplinary design practice Officina Corpuscoli (NL), whose experimentation and experience led to the founding of the company MOGU (IT) in 2015.

The value of design practices in scientific research: 5 paradoxes

As a professional activity, as a research activity and as a cultural factor of our societies, design is a vast and not universally definable realm. Certainly, design has a project-oriented component, leading to the creation of objects and services for the benefit of a more or less broad range of users. Certainly, design is also an experimental tool to discover and reflect on the various aspects of our societies. Furthermore, design serves as an educational activity that allows us to learn ways of doing and thinking. With a good synthesis, we could identify these three cores that together cover the whole sphere of design: practice, critique, education (Munari, 2019). These three areas of design are not distinctly separated, but rather overlap, merge, and inform each other.
The authors of this article are two – relatively young – researchers and designers, working in the academic field as well as in the one of the practice. Like many other colleagues and peers, they have tried to integrate their professional activities with their commitment in universities. At a certain point, however, this dual role has become unsustainable. Not because of time or logistics, but because it is the very rules of the academy that impose that those who operate in academia cannot fully operate in the one of practice.
The questions that guide this article are essential to understand what the limits of academic commitment can be, and consequently their impact on the design practice. Basically, one wonders why being a researcher in Italy means giving up being an active design practitioner? Is it possible to build a career in design research without being able to consistently and directly engage with the world of practice? Why can't the presence in exhibitions and journals (recognised by an international scientific community) or consolidated design experiences be evaluated on a par with other academic achievements?
Through the use of paradox – adopted as a linguistic expedient to contrast opposing situations, identified in our experience as research-designers – this contribution tries to highlight the indispensable complementarity between theoretical and practical research, with the aim of a more effective integration between these two essential aspects of design.

[design practice, practice-based research, design philosophy, object design, academic research]

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Design as practice. The Maestros we study and who inspire us were designers and theorists. Why is this integrated model rarely pursued in the academic world?
The Maestros of design that we celebrate and by whom we are guided were often great designers and critics, experimenters and teachers, entrepreneurs and thinkers. This is especially true for Italian design, perhaps more than for any other national scene. The contamination and promiscuity of interests, intentions and skills is peculiar to Italian design. Thomas Maldonado was an intellectual and a designer, Alessandro Mendini a designer and an editor, Achille Castiglioni a professional and a teacher, Ettore Sottsass a designer and a theorist, Riccardo Dalisi a designer and an artist, Andrea Branzi a designer and an academic. Maldonado, Castiglioni, Branzi and Dalisi were strongly affiliated with the world of universities, respectively teaching in schools in Ulm, Turin, Milan and Naples.
Starting from the teaching of the Maestros and going back to the teaching methods practiced by the Bauhaus, it is interesting to observe how the teachers of these schools were first and foremost established practitioners: architects, painters, sculptors, graphic designers and great transdisciplinary experimenters. Referring to the Bauhaus experience, Tonino Paris observes:

Summarising, it can be said that the training was characterised by multidisciplinarity, [...] where experimentation in design was strengthened through Laboratories and Workshops. A model that is still praised today, but only rarely practiced, since a fragmentation of disciplines whose contributions are independent from experimentation is preferred". (Paris, 2019)

In metallurgy and carpentry workshops, for example, the creation of objects was theorized and simultaneously experimented through the manipulation of materials, tools and construction processes. The aim was to train competent designers, strongly oriented and capable in design.
However, methods that support the design practice in a similar fashion are hardly ever adopted in the Italian academic world. The reasons are multiple and overlapping. Among them, the lack of adequate laboratories and equipment, the scarce presence of professional designers within university faculty staff, the exclusion of design practice as a field of scientific research, the increasingly widespread dematerialization of the design discipline in favour of a prevalent design of services, processes, methodologies.
The contamination of experience and professional ubiquity has been one of the ingredients that has allowed Italian design to create an industry that transcends the main one of product design. It is thanks to the key figures mentioned above that editorial and educational platforms have been produced, of which Domus and its counterpart Domus Academy is the most striking example. So is the involvement of Achille Castiglioni in the Politecnico di Torino first, and Milan later – of which he became full professor in 1980. Castiglioni's commitment to industry transpires strongly in his institutional teaching activities.

This is therefore the issue that students should tackle first: verifying that industry is neither an abstraction, nor a definition, nor a way of producing only: industry is a social service that transforms social work into socially necessary products. (Bettinelli, 2014)

Castiglioni wrote in one of his notes to the course programmes. This clearly denoted a direct knowledge of production techniques, an awareness of the skills that industry required at that time and, even more significantly, what was missing in the industry, as well as what the industry should have required. Obviously, even those who devote themselves exclusively to design critique can exchange reflections on the design profession, but it is legitimate to think that those who deal with clients, producers, consumers, curators, gallery owners, on a regular basis, have a broader and deeper understanding of the design industry and profession.
Italian universities would perhaps have the opportunity, not so much to involve already trained professionals, but rather to train new designers within their own research centres and learn from their experiences outside the universities, in real time. To do this, it is necessary to allow – if not encourage – experimentation with the practice of their researchers outside the University. This has been the choice of some Dutch schools that have preferred young professionals – also Italians – to lead departments of the institutes. The reference is to Maurizio Montalti, entrepreneur in the field of sustainable materials and for years head of department at the Sandberg Institute in Amsterdam, and Simone Farresin and Andrea Trimarchi (alias FormaFantasma), successful designers and since a couple of years at the head of one of the departments of the Design Academy Eindhoven. When Gijs Bakker – designer and founder of Droog, among other activities – was responsible for the Design Academy Masters, in one of his speeches at the beginning of the academic year he argued that the work of the design teacher should not exist, but that instead there are designers who teach. Thus, emphasizing the need of being active within the design profession in order to be a better teacher.
Sharing the design process and everything you learn while doing so, is crucial in teaching design (Orlandi, 2010). The idea that we want to highlight here is that these three souls of design – designing, theoretical production and teaching activity – should coexist in a more integrated way within academic contexts, supporting each other in the mutual recognition of their essential contribution.

Teaching practice. If the University inhibits my activity as a designer, how can I teach design?
In the interviews *Maestri del Design*, responding to the recurring question *What is Design*, Mendini and Sottsass identify its dual nature, strained between theoretical and practical culture.

I don't like the word design, I try not to use it, I prefer the term applied art. The word design has a short history, it is one hundred years old, applied art is five thousand years old... and I try to follow that line, it gives me more satisfaction. (Mendini, 2005)

If, on the one hand, Mendini brings design closer to the applied arts, Ettore Sottsass, separates it from an exclusively commercial industry – and from the term industrial – defining himself, in answering the question, as «a theoretical designer, that is, one who thinks about design, what design is, what it means to design an object, to give it to someone, to place it on a table» (Sottsass, 2005).
One of the main problems encountered in the relationship between didactics and design is the lack of a real circularity between basic and applied research, of fundamental importance for the construction of methods and processes that can really perform beyond academic boundaries. In an attempt to analyse the relations between the outside and the inside of the academy, the *FRID 2019 Forum* set for itself the objective of providing a "double perspective of research in design" able to solicit:

a reflection both on how research relates to the academic context and on the possible encroachments that lead it to actively confront the outside world... in order to arrive at a bi-univocal, equal and virtuous relationship between the two contexts, academia and the outside world. (Riccini, 2019)

The frequent disconnection between these two worlds, due to different rules and contexts, could be overcome by a greater inclusion of professional designers within the academic world, and vice versa, and by a wider dialogue between the various actors of the system. The strengthening of design activities in the field of didactics, for example, would lead to a more immediate return of image which, once it has become part of a productive reality, both industrial and cultural, would give rise to practices with a high impact on the territory. Design, in short, besides being a research activity, would play a connecting function, allowing the comparison and exchange of knowledge between heterogeneous areas and contexts (Penati, 2001). The museum, the company, the University could all benefit greatly from a more assiduous and regular association and contamination.

The dimension of the practice. Design has an important material component, but the constructive-material dimension is rarely deepened within scientific research. How can we explore design aspects related to the physicality of objects if the academic system does not support those researchers who are inclined to do so?
On the relationship between materials and production, in the essay "*Dove vanno le istituzioni*", La Pietra reflects on the total separation put in place by institutional teaching in Italy in recent decades between the culture of making and the culture of the project. The absence of laboratories where it is possible to experiment with material practices or the lack of spaces where contemporary applied arts can be observed has rendered frequent
the not knowing how to distinguish glass from crystal, ceramics from porcelain,

marble from alabaster, [...]. This lack of knowledge consequently leads to a lack of interest in objects laden with values and meanings, and therefore there are no appreciators of materials, there is a lack of a market for art objects, there is a lack of interest for collecting, and the market fails in providing value and quotations [...]. (La Pietra, 2016)

Reflections like these bring out the existing problems within the current Italian design culture and underline how the laboratory spaces, together with a conscious material approach, can be strategic and necessary paths to pursue. In this perspective, which comes close to the theories of Northern European contemporary craft (Bull & Gali, 2018), matter is understood as an instrument for giving shape to thought, since it visualises it, assists it, until it is transformed. The ability to touch, feel, shape a material or the ability to experiment a technique, integrating the theoretical culture with the culture of doing, gives life to a design capable of deeply changing the way of conceiving and looking at objects. In this operative praxis, which substantially includes theoretical-speculative reflection, the place of production evolves from an unfamiliar location to a space that facilitates a symbiosis between matter, production and thought. Here, the ability to investigate also the aesthetic, constructive and material dimensions of the discipline opens to unexpected scenarios, through the study of the symbolic and technical qualities of objects, configuring the laboratory activity as an important expansion of the critical-scientific activity. Foreign universities, in particular those in the United Kingdom, precisely to compensate for the domination of theory over practice, have begun to contemplate what is called practice-based research. By practice-based research, we mean research that starts from practical experiments and includes the product of the project itself as an output of the research study (Collinson, 2006). The intention is to promote practice-based research into academic research and activities.

The impact of practice. Exhibitions and projects reach a large audience, scientific papers less so. Why when we talk about scientific impact do we refer mainly to the world of academic writing?

Writing has always played a fundamental role in articulating and legitimizing thinking in design. Writing is for many designers a necessary process to understand what you observe, what you think, what you do, and it is therefore really difficult to think of designers who has not produced books, articles, notes, in various periods of their career. Academic writing offers structure and rigour, as well as a proven system of reviews and contexts for dissemination and exchange. Even for researchers with a propensity towards designing, writing is not only useful, but necessary and constructive.

However, the world of design is complex and often difficult to articulate in a verbal way. For those involved in the project, it is natural and important to express themselves through the artifacts they produce. Designers are authors of objects, after all. The system of revising and reviewing artifacts is perhaps less structured when compared to that of academic articles. However, the whole apparatus of exhibitions and reviews in magazines includes more and less authoritative actors, more and less prestigious contexts. On this line of thought, hierarchies could be structured, built to codify and evaluate the legitimacy of projects and designers. In a way not very different from that of journals and academic conferences with their publishers and peers, the world of objects includes curators and critics, magazines, galleries and museums equally credible and not easy for designers to access. In the same way as with academic contributions, one could try to quantify the impact and credibility of this type of institutions, so as to evaluate the performance not only of theoretical academics, but also of those who are active in the practice.

The American academic world, for example, in the field of design and art, assimilates the performance of faculty members and researchers in exhibition contexts to academic performance. In other words, participation in exhibitions, and the citation of works in non-academic journals is evaluated in a similar way to academic publications and conference presentations. In the USA, the evaluation process that Assistant Professors – the equivalent of a *ricercatore confermato*, in Italy – have to undertake in order to obtain the title of Associate Professor, and which normally lasts between 4 and 7 years, must include a series of goals. In creative disciplines, such as art and design, a promotion can also be achieved with a *curriculum* of exhibitions, citations in magazines and publications both online and printed media, admissions in art residencies, awards and even the implementation of commercial projects, such as products or services. The College Art Association, which is the main reference for the Arts education and academia in the USA, in its guidelines states that: «Exhibitions, art commissions, design commissions, including commercial and/or client based work, and/or peer reviewed creative activities should be considered similar to publications in other sectors» (CAA, 2016). This evaluation system promotes the figure of the researcher as a professional. The benefit is not only to have active faculty members in the field within the University, but also to reach a wider audience.

A University composed of researchers and professors who have strong links with the world outside the Universities themselves would facilitate collaborations with external actors, be they public or private organizations. This would increase both the impact that the academy has on society and its visibility, useful in attracting new students and fundings.

Evaluate the practice. If I write about other people's projects, it matters. If others write about my project, it doesn't matter. My CV stands in "Other".

Entering the world of Italian academic research for a designer today means picking a side. It is difficult to have the time to dedicate to the compositional study of forms, materials, and the inventive paths of design – conducive of objects. You no longer have the space to think with your hands or through the verification of construction processes, in direct relations with companies for example. You move away from the knowledge of materials and techniques, derived from a first-hand experience; increasingly distant from the mastery of pigments, clays, powders, heterogeneous materials, tools, machineries, laboratories. Design researchers mainly write about other people's

projects, analyses scenarios and case studies, produce theoretical-methodological articles, study scientific literature and interpret it in a critical-historical key, since this is the kind of activity that can be evaluated as a result of their academic commitment.
However, the perspective of a researcher-designer could give a different contribution from that of a designer disjointed from the world of academic research. It would be a matter of operating between theory and practice in an integrated way, activating virtuous short-circuits between thinking and making, with the possibility of triggering innovations with a strong impact on the production system, if investigated with the due attention. On the contrary, the disappearance of these virtuous dynamics, relegates the researchers-designers to the role of spectators, leaving them mostly to citing and examining what others do, with the risk of finding themselves excluded from a vital system, too busy having to interpret it scientifically, protocol it and classify it.
As design academics, if one's own research activity also explores the modes of practice through the production of objects suitable for theoretical speculation – reviewed by magazines or exhibited in museums, foundations, recognized galleries – it does not count. Conversely, if a researcher reviews a project of others in a prestigious magazine, the article is counted in the performance of its author. Paradoxically, if a researcher is the author of a design project, reviewed by that same journal, that does not constitute value in the academic performance of the researcher.
It is in this perspective that this article would like to suggest parameters within the Italian academic evaluation system so to give prominence to those aspects concerning the side of practice – which is inextricably linked to the nature of the design discipline.
With reference to national criteria for the evaluation of research outputs, a proposal could be to give greater specific weight to those outputs, currently included under the heading “Other”, such as design projects, exhibitions, art prototypes that are characterised by "a high scientific-technological content" and that have been "published in journals or volumes with a critical text by another author" or "published in exhibition catalogues with a scientific committee" inclusive of a ISBN code (ANVUR, 2015).
It is of absolute importance to examine the academic research activity of design through the production of monographs and double-blind peer reviewed papers, in line with the international scientific community, but evaluating it exclusively through this lens would risk leading the discipline into a vicious circle that separates the area of thought from that of practice.
To give greater importance and scientific validity to the practice does not mean to standardize scientific research to an exclusively theoretical-methodological field, but to enrich it with a substantial exploratory possibility, intrinsic to the very nature of the discipline. Design by its very nature combines thought with practice, bringing together the imagination of ideas with the concreteness of artifacts (Arielli, 2003). The synergic conjugation of both these dimensions within academia would undoubtedly lead to a wider understanding of design, its critique and education, for the benefit of future generations of designers and theorists.

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The fifth dimension of interaction design: conversation with Gillian Crampton Smith and Alessandro Masserdotti

Through a comparison with Gillian Crampton Smith and Alessandro Masserdotti, this contribution offers a reflection on the present and future of Interaction Design. Based on curiosity and research interests connected to the teaching activity in the master's degree course in "Design for digital innovation" (University of Camerino), a dialogue was opened with these two figures who, in different times and ways, have contributed to the development of this discipline in Italy.
Their answers, in turn, open up a series of questions about the fate of the designer profession, in a landscape increasingly dominated by technologies and digital devices.
Within the complex map drawn by the professional practices of contemporary designers, interaction Design (IxD) has a crucial position. This term, coined by Bill Moggridge and Bill Verplank in the mid-eighties of the last century (Moggridge, 2007), maintains a strong relevance today. However, it coexists more and more often with other names such as User Experience (UX) or User Interface (UI) design. The evolution of digital technologies constantly reconfigures its disciplinary perimeter. The design of the interaction, precisely under this fluid and unstable condition, constitutes fertile ground for investigating the question raised by this issue of "DIID".

[interaction design, interactive spaces, digital technology, service design, coding]

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In the field of Interaction Design, the profession activity seems to be subjected to two opposed thrusts: one towards extreme internal specialization and the other towards contamination with practices, strategies and skills that are placed outside the sphere of action traditional design.
This vision emerges from the two conversations with Gillian Crampton Smith and Alessandro Masserdotti: two designers from different generations, who in different ways and times contributed to the development of the IxD in Italy.[1]
Despite their apparent differences, the two figures have an important aspect in common: a humanistic training (philosophy and history of art the first, philosophy of science the second) on which they have grafted solid technical skills.
The dialogue with them started with the theme of the humanization of technology and then went on to explore three central issues related to the present and future of design practices. The first issue concerns in need of common ground respecting the continuous overlapping and intertwining of knowledge, methods and languages that characterize the profession. Masserdotti defined this as a sort of basic grammar. The second issue is about the relation between the current condition of the design profession and its origins. From the first phase when the high tech industries displayed distrust of designers to the moment in the company incorporated design within its organization; or, from the emphasis on the spectacular possibilities offered by technology to the design of digital infrastructures with a logic closer to the design of services.
Finally, the third issue concerns the future of Interaction Design, even more, articulated in an archipelago of practices (from digital fabrication to storytelling), where the coding is becoming an almost "natural" component of the design activity.
This is in a scenario that is otherwise characterized by the dizzying development of artificial intelligence.
As Gillian Crampton Smith reminded us, the design of interaction has historically developed as a "fifth dimension" of design (Crampton Smith, 2007), integrating, in a transversal way, the two-dimensions of graphic design, the three-dimensions of architecture and products and the temporal dimension of motion design.
Today, Interaction Design seems to place in an increasingly multidimensional and multidisciplinary scenario, in which the designer is only one of the actors involved, able to dialogue with very different figures and always acquire new skills.

Conversation with Gillian Crampton Smith (2020, July 31)
Carlo Vinti (CV). Once, speaking of your experience in Ivrea, you recalled that for you the terraces of the "blue building", headquarters of the Interaction Design Institute, worked according to the intentions of the designer Eduardo Vittoria: a meeting place where technicians and men of science could exchange ideas informally. Speaking of this, first of all, we are interested in knowing in what relationship that institute was with the Olivetti tradition.
Gillian Crampton Smith (GCS). When I moved to Ivrea in 2001, there were celebrations for the hundredth anniversary of the birth of Adriano Olivetti. Only then

did I realize that I unconsciously shared with him a concept that I often spoke of in London: the humanization of technology. I was proud to be part of the Olivetti tradition. Unfortunately, at that time, Olivetti was in a difficult period, but Olivetti's legacy in Ivrea was still tangible. With the help of other experts in the field of psychology, we were able to include a strong presence of humanistic content in the courses of the Interaction Design Institute.

CV. Could you tell us what are the profiles at the centre of training in the field of Interaction Design today? Are you aiming more to train the classic figure of the consultant designer or a designer who can easily find employment in a big tech company? Or again, can you imagine a startupper profile?

GCS. In the early 2000s, few people knew what IxD was. Today the situation is very different: knowledge passes through many channels, not just through the university. Compared to four-five years ago, what has changed in the profession is that a more large network has also incorporated some historical studios like Frog Design or Ideo. Many firms that used to use consultants now have their studios in-house. Professionals today have more difficulty in finding clients because the companies develop a large part of this work themselves. It is a time of significant change from this point of view.

CV. Today there is much talk about startups and the possibilities of self-entrepreneurship for designers. Is this an opportunity for someone who comes from a design training?

GCS. There are startups founded by designers like Airbnb. Often the starting team is made up of a designer, a computer scientist and a business expert. The design students need to understand computer science in order to communicate with engineers and understand what is possible, certainly not to become computer scientists themselves. The same is valid for business. With a minimum of skills in this field, you can realize whether a company is sustainable or not.

CV. A few years ago in your article for "AIS / Design magazine. History and Research" (2016) have identified eight reasons why the information technology industries have recognized the strategic role of design with significant delay. Today the situation would seem reversed, but can we say that design has entered this type of company? What is your opinion, in this regard, of User Experience design?

GCS. Yes, in tech companies before, engineers did not want designers. Now they have realized that design is fundamental: with the commodification of technology, it is the thing that makes the difference between one product and another. To answer the second question, obviously, at the beginning of a design process, it is important to know the user. However, design thinking or UX design does not design in the real sense of the word, as many people in the business world think. You need to know the users, but then it is the designer who has the task of imagining what to design and how to design it.

Giuseppe Losco (GL). In recent years we have seen a proliferation of new areas of design, not only design thinking but also service design, systemic design, event design. There is a continuous game of adjectives of the term design that tends towards specialization and moves the meaning of the word far beyond the classic work of product and communication designers. How does Interaction Design fit into this panorama?

GCS. So, I like to put it this way: some designers work mainly on two dimensions like graphic designers; others, such as product designers or architects, focus on three dimensions; then some of them work on the fourth dimension, designing animations and films. In my opinion, interactivity represents a sort of the fifth dimension of design. I believe that solid foundations in the first two more traditional areas of design are of great help in tackling a field such as Interaction Design, which is much more fluid and difficult to manage for those starting from scratch.

CV. Perhaps it can be said that Interaction Design – as a fifth dimension – is transversal to the traditional sectors of activity of designers. In your opinion, is IxD a discipline now with its well-defined framework, or has this field now also fragmented and dispersed in multiple directions?

GCS. As I have experienced in my career, the hard thing is that the technology changes on average every three years. The designer must have a solid knowledge base, which allows him to change and be flexible. It is not always necessary to deepen skills and abilities in a particular sector. Indeed, sometimes it is not worth it, because it is likely that that space will be gone in a short time.

GL. Therefore, for adequate training in the field of Interaction Design, you need a foundation in the "classic" training of the designer. Students must have already developed a range of skills and have learned to deal with problems. On the other hand, technologies change every three years, influencing the practice of design. I have the impression, however, that sometimes technology takes over. So I ask myself: should the designer understand technologies as a means or as an end?

GCS. At first, designers used computers as tools equivalent to a pen or something similar. I remember, in the 90s, if you put a designer in front of a computer, he began to wonder «why does it have to be so dull? so difficult to use?» This dissatisfaction has been a strong push for designers to get involved in device and software design. Bill Moggridge, for example, designed the "Grid Compass" computer in 1981, the first that opened like our laptops today. He faced off this work from the product design point of view but, once finished, he realized that people hardly paid attention to the physical shape of the device, because the screen absorbed their gaze. For this reason, he, who was a well-known product designer, decided to start designing the software interface as well.

CV. Bill Moggridge, at the time, sensed that the interaction was moving more and more towards the screen. Do you think anything is changing with the internet of things today? Are we slowly getting rid of the screens?

GCS. In my opinion, we can add many possibilities besides the screen. Of course, eliminate the screen is more convenient, and therefore, designers try to avoid it, but it always depends on the purpose of the use.

Manuel Scortichini (MS). If we overcome the idea of the smartphone, what could be the future device that controls everything? Will we go towards a sort of super-surface, as in the theory of the radical collective Superstudio? A single responsive environment instead of a physical object? What could be the new scenarios?
GCS. The great thing about the smartphone is that it is always in your pocket. It is mine, I have all my settings there, and so I can use it in an environment where there is artificial intelligence. No, I honestly do not think it will disappear in the future. The problem with the internet of things is that it becomes difficult to understand who manages the interaction: me, you, a big brother, the device itself? Home automation, for example, still has problems: I can remotely control the gate of my house, take care of my plants, but I do not know if it is worth it. I remember an interesting speech by designer Bill Buxton in this regard. He said that having many devices, maybe even each one well made, all with different interfaces and modes of interaction, complicates the user's life too much. Every new device we have at home seems to simplify life, but at the same time complicate it, because learning how to use a new device takes a long time.
When I think about how people waste time managing their devices, the software that suddenly refuses to work, the constant updates that change everything, I become a bit sceptical about the advantages of technology.
It is true that it allows us to do unimaginable things compared to twenty years ago, but, without us realizing it, the cognitive burden becomes increasingly demanding. It would take a "reset"!

Conversation with Alessandro Masterdotti (2020, agoust 6)
Manuel Scortichini (MS). An unconventional training path emerges from your curriculum, from the philosophy of science to Interaction Design. I would like to know more about it.
Alessandro Masserdotti (AM). Yes, I graduated in philosophy, but I started programming at an early age, in response to my mother who took away video games from me, so I learned programming languages a little self-taught. Over time, I have combined this technical basis as a programmer with humanistic training. The designer by nature combines these two dimensions: a practical one, oriented to the functioning of the projects and a theoretical one, linked to the needs of people in relation to artefacts.
MS. I notice, within Interaction Design, following a cultural heritage borrowed from the hacker and open source culture, a climate of greater proactive confrontation between colleagues than in other design disciplines. Do you share this statement of mine?
AM. The success of many small companies like ours, which deal with digital, is also due to the fact that they embrace the "opensource" philosophy, that is the free circulation of knowledge. Others like us develop digital projects and then make available the "know how" produced in shared mode. This method triggers a virtuous process also from the business point of view. Right now, we see a shift from patent barriers to open source. I have nothing against patents: in general, I think it is right to protect the project as well as to share knowledge. In my field, however, we cannot think in the same way, with long-term patents, because an IT innovation is already a lot if it lasts five years.
Giuseppe Losco (GL). DotDotDot originally designed installations. To date, how is the firm's activity related to the "classic" culture of design, the one that mainly refers to product design?
AM. Product design as such I would say no. Fifteen years ago digital was still perceived as new and what they were asking for was a kind of "wow" effect. Today it is the exact opposite, in the sense that everyone has something digital and interactive: the digital service, the digital product, the touch screen or the sensor. We design digital infrastructures from a design point of view. Consequently, our work is more aimed at providing information and services: it is a new way of applying Human Computer Interaction to the world of services. We still deal strictly with spaces, but the projects we have been following in the last two years are, for example, digital services for a pediatric hospice, digital infrastructure for offices and for a yacht. Interaction Design has always been a mix of extended skills. The concept of signature has never existed in this field, as in product design. Today, to an increasing extent, the work of Interaction Design is carried out in multidisciplinary teams.
GL. Let's say that, in a classic conception, the product is the infrastructure of services that is created at the end: it is a product resulting from knowledge, skills and technology transfer.
AM. You will probably all know Ezio Manzini, he coined a beautiful term which then became a master's degree course at the Politecnico di Milano: Product Service System Design (Manzini & Vezzoli, 2003). Let's say that this type of approach is a bit what it represents us. The product is not only a product but it is also a service, it is not only a service but it is also a system.
MS. In light of these changes, what does it mean to be an Interaction Design professional today? Looking back over the last fifteen years of DotDotDot's activity, how has the profession changed?
AM. We have always dealt with a very specific area of Interaction Design, that linked to spaces. This subject is approached – and we see it from the Italian studios that are active at the moment – from at least three perspectives: one which is that of video making, many video makers or experts in video production have started making interactive videos, then Interaction Design starting from the video; another is that of the web, many web agencies deal with this line of Interaction Design; then there is us, who are quite unique, in the sense that we started with architecture. Or rather, from the need to make communicative and narrative spaces. We create spaces that can tell stories through the use of technology. From this point of view, we had and still have a great historical reference which is Studio Azzurro (Biamonti & Birindelli, 2005)
CV. The narrative component is therefore central to your work, which I imagine always starts with the contents to be told. Speaking of this, I was wondering to what extent do you intervene in the organization of content and what kind of comparison do you have with external curators or simply with clients?

AM. The construction of the narrative is very important for us and now we have two storytelling experts within the team. Usually they are the ones who start when we do the first briefs and meetings with the client. We have developed a co-design approach with clients. They often come with a series of needs and our job as designers is not to solve them but to interpret and transform them into needs. We usually start this relationship with a series of workshops and interviews: we build a very close and demanding relationship for the client as well. We hardly collect a brief and it all ends there. Where possible, we rather try to establish a dialogue, which usually starts from the narrative element.
MS. In your studio, figures from various disciplines coexist: architects, designers, developers, etc. How do you manage this interdisciplinarity? What does it mean to deal with such different professional figures and connect them?
AM. We immediately started heterogeneous. In 2004 we were two architects, a designer and I, who had a philosophical background but in fact I was a geek. There are other Interaction Design studios that don't have a very strong internal programming component. For us, however, it is very important. We are about thirty people: more than ten of these are computer technicians, developers and electronic engineers; seven or eight who we consider pure Interaction Designers, that is to say – from my point of view – people who also know how to program (maybe they don't know how to get to the low level as a pure developer, but they still know how to write Arduino firmware, they can design frontend, can use Processing and Python); then there are designers of a more traditional nature: architects, designers, design engineers who, depending on their profile, take care of the more mechanical parts or the more set-up ones. Finally, there is the administrative and management part of the project that we four partners follow. In our work, a key part is prototyping. Usually for us the transition from idea to prototype is practically immediate, which means that you physically put yourself there with your hands and with the code and make that thing work. Maybe you do it "quick and dirty", but at least try the interaction and you immediately realize its potential. Five years ago, we opened the OpenDot fablab, where we enhanced the prototyping and digital manufacturing part. At the same time, we have activated permanent internal formation. So, who is a designer maybe explains what speculative design is; who is a design engineer explains how the engineering of a product is done; who is a computer scientist explains how Phyton is used; who is an Interaction Designer explains Processing. The most important thing is the exchange of languages. This does not mean becoming "polyglots" but aiming to acquire the common foundations necessary to facilitate comparison.
MS. Compared to what you said, an article by "Wired" comes to mind in which John Maeda dwelt a lot on the importance of knowledge of computer languages (Stinson & Maeda, 2017). Today access to information is extremely simplified and easily allows the individual learning of new knowledge. However, this vastness of training opportunities makes it difficult to understand what the minimum training baggage is. What advice would you give to an Interaction Design student today?
AM. So, I see the new generations more focused than mine. More stubborn in wanting to find a fair way of doing things too. At the same time, they are certainly much more exposed to even discordant information flows. One of the things I often tell my students when we start the course is that I will teach them how to use Google, and sometimes students take it badly. But I believe that we, as teachers, should not be afraid to say, «I don't know this». We have to answer the students: I learn it with you, we look for it together on the internet. This aspect is part of the nature of the designer today, but it often scares students. It is an extremely contemporary way of moving, of continuous research: the designer is a person who recognizes that he is ignorant on some aspects, but knows how to overcome this ignorance and knows how to find a solution. Furthermore, in my opinion, for an Interaction Designer, learning a programming language is essential. Indeed, I am one of those who say that Phyton should also be taught in elementary school, just like grammar. In elementary school you learn grammar not because you will necessarily become a writer but because the grammatical structure is the basis of language.

[1] Crampton Smith is part, along with Moggridge and a few others, of the small group of people who founded this discipline internationally. She was director of the Interaction Design Institute in Ivrea from 2000 to 2005, and then coordinated with Philip Tabor, over the next fourteen years, an influential IxD program at the IUAV in Venice. Masserdotti, on the other hand, belongs to the first generation of Italian interaction designers and is one of the founders of the DotDotDot studio in Milan, a professional reality that has been dealing with interactive exhibition spaces for customers such as Enel, Coop, BMW and Samsung for over fifteen years and who, in 2014, also gave birth to the OpenDot fablab.

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Design 2030: People, Users, Designers

"Design is a mess" (Jon Kolko, 2018)
The designer has been always a liquid figure, a role that has been able to move and evolve over time in society and in the dynamics of everyday life. The designer is the result of a multitude of disciplines divided and reunited several times in history, assimilating and keeping for himself each time an essential part of the latter, but above all leaving an indelible and recognizable sign of their contribution in industrial, productive, economic and social dynamics. Since his emancipation as an independent discipline, from the years of the Staatliches Bauhaus, the designer has cultivated his own particular culture of design and planning, becoming increasingly interdisciplinary, multidisciplinary and transdisciplinary. It has evolved to such a level of complexity that today even the designer always finds a completely personal way to define its own design and himself. The designer is the reflection of his practice, his own search for design itself. Influenced both by the past and by the aspirations for the future world.
This collection aims to investigate the role of the designer, what he has learned from the past, what is today, to what he would evolve in the future. What will the new generations learn in 10 years from now? Will the current generation be able to inspire the future one, as the masters of the last century did for us? Who is the designer of 2030?

Luca D'Elia

[designer for vocation, designer for art, designer for experience, designer for intelligence, designer for science, designer for trouble, designer for revolution, designer for tradition]

01

02

Designer for vocation

>

If years ago the factory could have been considered a place for men only, while women theoreticians of form or artists, fortunately this cliché has been denied by women who allowed industry and industrial design to make use of productions free from prejudice and projects that look beyond the sex of the designer.

03

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03

Designer for art
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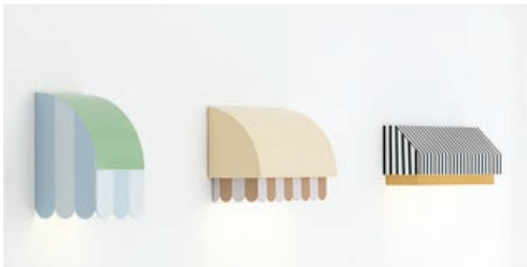
The designer, with his utopian and visionary eye, constantly formulates new ways of interpreting the everyday, the behaviors we adopt in a society made up of objects, products and above all forms, which we interact with and from which we are able to get emotions.



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01

02

03

Designer for experience
>
In the struggle between industry and new technologies, the art of know-how and artisan knowledge do not leave the scene. Skilled hands join the young minds of the designers of the new generations to give new hope of revenge to tradition in the modern and future production landscape.

04

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03

Designer for intelligence
>
The scientific advance moves hand in hand with the curiosity of the designer who experiments, tries, fails and rediscovers in the processes, may those be traditional or innovative, the full potential and the real limitations of technology.

04

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01

Designer for science

>

Increasingly aware of the ecological impacts of the production processes, and the potential that the biosphere itself has to offer, more and more designers take on the task of researching in the natural environment for alternatives to the materials production and consumption, evolving their role to an hybrid that combines design to chemistry, biology, medicine.

02

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04

01

02

Designer for trouble

>

Over time, the designer has identified more and more interesting and often contradictory aspects of everyday life, opening new ways for solving problems: creating them to make them clear. The designer increasingly assumes the position of a troublemaker, thus developing a critical thought towards society and its behaviours capable of opening to new future scenarios.

03

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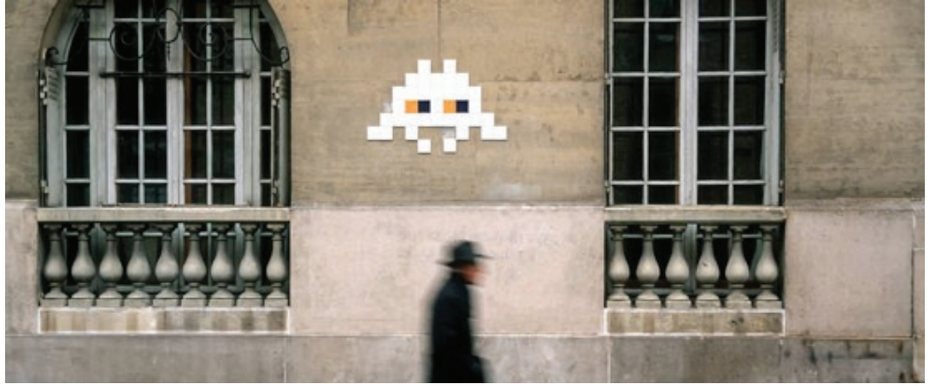

01

Designer for revolution
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The designer recognizes himself through his products, his design. From street art to guerrilla marketing we usually find works on the street where you can immediately recognize the author's signature. When the face is missing, it is the product itself that takes its appearance, almost as being the designer. They are products that pass through the streets, parasitical in urban space and more and more often we find them in the environment that we frequent most of all, the digital one.

02

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03

01

02

Designer for tradition
>
New designer's generations look to the masters of the past with admiration. Figures from which to learn the methods and ideas, hoping one day to know how to overcome them. If those *fathers* of design are also biologically speaking, what kind of impact does they have on the new generation? Emulation or emancipation? Will our *childrens* have to deal with our work tomorrow?

03

04

05

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06

Make

Make gallery > p.112/p.125

Focused practices for future changes

We find ourselves in a challenging moment of big transitions: what is known and well experienced about industrial production has to be re-evaluated in light of the shift to Industry 4.0, of digital transformation, of the progressive fragmentation of knowledge. This article looks at these large-scale changes from the singular perspective of the disciplines of design when they operate in a specific industrial sector such as that of knitwear, where advanced technological innovation coexists with traditional technologies and with the obsessive care of craftsmanship. Through what has been learned during the latest years of research in this field, the article aims to address the contemporary challenges that these changes are bringing in training and education in the knitwear field. The main aim is to understand how to deal with competencies that are becoming fragmented, how to handle the "making" aspect of the discipline, how to manage the intersection of the most diverse domains of knowledge. In light of the evidence that – due to the intrinsic characteristics of the sector – those challenges are somehow faced by knitwear stakeholders since the origins and have therefore defined the way designers use to move, act and know within this environment, the article reports the methods and practices that design research and education put in place to deal with it and how it is working towards new possible answers, perspectives and approaches to address the specific needs of this sector while exploring new and non-sectorial knowledge, to build educational paths and prepare young designers for the increasingly multifaceted reality and the wider questions of our contemporaries.

[knitwear design, fragmented knowledge, updated knowledge, industry 4.0]

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Large-scale changes for a specific field. A reflection on the knitwear industry

We find ourselves in a challenging moment of big transitions: what is known about industrial production has to be re-evaluated in light of the progressive shift towards the Industry 4.0, that requires to companies new strategies and organizational models, changes in infrastructure, manufacturing technologies, human resources and management of practices (Ghobakhloo, 2018) When focusing on the Italian economy, it is important not to distract attention from the local features of a manufacturing (Magni & Noè, 2017) made of small and medium enterprises, often connected in «production clusters with a strong rootedness in a specific local context» (Deserti & Zurlo, 2011). There is the urgent the need to define and pursue an Italian way of Industry 4.0, and this is, to Visconti «an entrepreneurial challenge: we must invest resources, develop skills, innovate in processes, invent original answers for ever-changing markets» (Magni & Noè, 2017). It may be said that the challenge is not just entrepreneurial, but for design is practical and educational: the scientific community is wondering whether and how the methods, tools, and methodological approaches codified so far can face –or help– this transition, and to envision new ones.
This article looks at the change taking place on a large scale from the singular perspective of the disciplines of design when they operate in a specific sector such as that of knitwear, by analyzing the manufacturing context to envision responsive practices.
Often left as a simple variation on the general field of fashion, knitwear is indeed a very articulated industry made of a critically fragmented system of knowledge, an exceptionally complex design process and the coexistence of traditional artisanal techniques with the most advanced technologies.
When the big ongoing challenges and the specificity of such a sector converge, design research needs to codify new perspectives and approaches, to address the particular needs of this sector while exploring new and non-sectorial knowledge, to deal with the increasingly multifaceted reality and the wider questions of the time being.

Contemporary challenges in the DNA of knitwear design

A closer look at the field of knitwear must be given to tracing its borders not just as a manual art but as one of the most important productive industries in Italy (Conti, 2019) and a recognized domain for scientific research and design disciplines (Motta, 2019).
Knitwear is the «sector where advanced technological innovation coexists with traditional technologies and with the obsessive care of craftsmanship» (Noè, 2017) to create the beautiful yet comfortable and easily-worn clothes that have signed the Italian way to make fashion since its birth in the sixties (Motta, 2018). During those years, when knitting passed from being a mainly domestic art to be a productive and commercial activity, the sector evolved within the district system that has established itself as a distinguishing element of our territory and generated a complete supply chain that covers all the various phases of creation and production (Mora & Volontè, 2014). Here, more than anywhere else, the «synthesis between the individual creativity and the collective creativity of places, local cultures, industries» (Bertola, 2008) led to

creative industry (Henry, 2007; Pratt & Jeffcutt, 2009) that innovates by relying more on the know-how shared among the networks of spinners, knitting factories, machine producers rather than on fashion labels or creative directors.
How has this cultural and productive structure, so far, shaped the role designers operating in it? As Volontè (2012) argues, the proliferation of small firms gives to designers the opportunity to gain direct knowledge of the industrial production and its technical and economic aspects, giving shape to a particular way of being designers that is very far from the artistic invention of French *couturiers* yet widely contaminated with technical knowledge. In such a local production lies a tacit system of relations where the designer plays the role of «activator of connection between enterprises and craftsmen» (Deserti & Zurlo, 2011) and is «always working in close collaboration with the artisan communities, and continually confronting these realities, knows how to combine careful planning for techniques, materials, production, while constantly remaining in search of innovation and creativity» (Mazzucotelli, Salice & Mora, 2013).
A mid-way role, still strongly linked to the product while being the director that combines cultural and technical knowledge, artisanal know-how, ability to understand the surrounding environment and to talk, organize, cooperate with people. A well-resuming description of this is given by Conti (2016) when he writes that:

knitwear design aims to create clothes that exploit and enhance the typical features of knitwear, integrating traditional knowledge with technological innovation and experimentation throughout the supply chain. This *modus operandi* that condenses design, know-how and craftsmanship, and is at the basis of the excellence areas of made in Italy, has its perfect soil in knitwear, expression of an ancient local tradition with a strong distinctive style and production quality. (p.31)

Starting from this framework and premises for a deep understanding of the role of designers in such a specific context, the aim of the ongoing research is to understand what can be done in terms of design education in the field, when the industry itself is dealing with fragmented systems and competences, with the "making" aspect that is marking the discipline, and with the forwarded intersection of multiple knowledge towards innovation.
If these are today on the bigger scale some of the most current challenges of the contemporary, they are also the most typical features of the knitwear sector; among the stakeholders they generated with time spontaneous answers from which we can transfer knowledge on the nature of this industry and on the way designers use to move, act and know within it, to envision future perspectives and create new models of action.

More and more fragmented knowledge and skills

Being one of the most fragmented and articulated product chains on the Italian scenario has always been the strength and the weakness of the sector. Being small means being flexible, highly skilled and specialized, rarely replaceable in high-quality and high-value productions, but it also means a lack of resources and a lower investment capacity. The recent economic difficulties generated a strong, diffused fear and a consequent dangerous closure to the sharing of knowledge and the cooperation that nurtures the typical incremental innovation that is the added value of the chain. Dialogue and connection, towards the contamination of the most diverse knowledge and competencies, have always been central assets for knitwear to respond to difficulties, and is for sure one of the main key points for design research and education to preserve and intervene on.

Is knit design still just a discipline of the "making"?

With his "Designerly ways of knowing" Cross (1982) defined design not just as an applied science, but as a synthesis of the two traditional cultures – sciences and humanities – with the third culture, namely technology: the designer became doer and maker. Is there any relation between Cross' research and an industrial sector that directly originated from the traditional manual work of knitting with a yarn and two needles? May be said so. To Petre, Sharp and Johnson (2006), knitwear is a good example of practical design, requiring designers to express artistic flair within pragmatic constraints in the competitive environment of a manufacturing industry driven by market pressures, where «aesthetic design is inseparable from technical realization» (Eckert, 1999).
To design knitwear has always been a discipline of the making, as its technical complexity opens thinking perspectives only to those who know how to realize that product. Frisa and Danese (2011) note that the design of knitted garments is affected by each of the several steps of production, and this leads to an intense exchange of information between the time of creation and the time of production, the people who create and the people who process and physically make.
It is clear that today, within an industrial process of product development that relies more and more on automation and technologies, nobody would entrust the realization of any product totally in the hands of the designer; however, it becomes fundamental for those who imagine having the tools to visualize the feasible and to communicate in an aware way with the specialized figures who operate along the supply chain.
More than the discipline of "making" and putting into practice, knitwear design could be defined today as a discipline of "knowing how to make it": a knitwear designer should have experienced it with his/her own hands, should have practiced skills belonging to many different domains to understand them deeply without however being hyper-specialized in one or the other, and should finally be able to manage daily processes of knowledge exchange and novelty generation.

The collision of knowledge domains to trigger innovation

As a consequence, comes the issue of the relationship between the diverse forms of creative and technical knowledge that converge along with the knitwear design and development.

In the most traditional of simplifications, technicians need to knit what designers think (Eckert, 1999) and make them understand technical limits, while designers encourage technicians to push those limits to seek something new: this intersection has been for decades the way to trigger innovation, but also «the major source of complexity and difficulty» (Eckert, 1997). Today, we have long overcome the idea of a designer with no technical competence and we have just defined knitwear as the design discipline of "knowing how to make it", yet the issue did not become easier to decode.
The supply chain, today more than ever, reveals itself in this twofold essence: an artisanal soul, with the craftsmanship that supports the creative phase, and a highly automated one, with the technology of power knitting machines that improve the production phase. The knowledge in knitwear by now often touches the boundaries of engineering and chemistry of materials, combines fashion design with textile design, and includes CAD/CAM skills and the ability to control the most advanced software and machinery.
A challenge for education, as the variety of competencies that have always naturally spread the design process from the individual figure of the designer to the ones of technicians, modelers, machine programmers (Traini, 2004), becomes even wider with the evolution of technologies in production and materials.

The research towards the knit designer 4.0.

The paragraphs above outline how the knitwear context carries by nature the complexity of big contemporary issues. The understanding of the dynamics that the system has put in place and internalized to respond to daily-arisen challenges constitute a traced path for design research and education at Politecnico di Milano to work towards the finding of updated answers. Observation, studies, applied research activities are suggesting behavior patterns and solutions to develop updated educational paths, towards the evolution of the figure of knit designers in continuity with the industrial context and in the balance between the big opposites of the time being: theoretical knowledge and practical activities, thinking and making, manual work and digital tools, specialized knowledge and contamination with other expertise.
The industrial reality is the starting point for the team of Politecnico di Milano that has developed a twofold approach for research and education with a joint work between enterprises and universities.
The developed framework (Conti & Motta, 2020), composed of three areas of knowledge (theoretical, practical technical and technological, design) and by the related knowledge modules, aims to build the designers' way of thinking with creative competences and cultural values, together with a hands-on deep understanding of the most technical bases and for the learning and control of new technologies, until their application on the design of garments. The added value is brought by the direct participation of diverse stakeholders of the supply chain in every teaching module: companies become part of the progressive process of delivery and acquisition of knowledge by launching reality-based briefs to students and following them with professors during the entire activity, both in the university and in the company environment.
Students learn from the cultural background that surrounds them and are trained as multi-skilled professionals in a flexible network companies-university that is focused on achieving mutual objectives, updating the knowledge capital and sharing experiences.
Intentionally designed as flexible and modular the framework constitutes the foundational structure of the experimental teaching actions, defined from time to time by researchers according to the needs of the students and the company involved.
Here below are three examples of its flexibility, that highlight how, starting from the framework, the activities have been designed and molded according to time, resources, students and the typology of the company involved.
The structure of each experimental teaching action follows the same *modus operandi*:
1) Analysis of the needs of the company and definition of the final goal;
2) Selection of the knowledge modules to be included, considering the time and resources available and the owned knowledge;
3) Planning of the activities, both within the university and within the company environments, to include part of the design process inside the company, visits, dialogue with professionals, full or partial prototyping of projects;
4) Verification of the mutual results both on the educational side and on the entrepreneurial one.

Ghioldi

Type: printer and a knitwear converter company, they take charge of all the phases of product development.
Need: to combine the strong printing side of the company with the youngest knitwear unit, to find new solutions to apply printing techniques on knitted backgrounds.
Brief: create a collection moving from the classic themes of traditional printed silks to be reinterpreted with a contemporary sensitivity.
Activities: Students developed their own project with periodic reviews with teachers and a constant confrontation with Ghioldi on the design part and on technical solutions. They experientially learnt the manufacturing processes, working on the first samples at the university and making further trials and the final prototypes at Ghioldi.

MF1

Type: knitwear factory that develops and produces for high-end fashion brands.
Need: Verify the recent digitization of the wide archive.
Brief: design a capsule collection being inspired by the company archive, consulting it both digitally and physically.
Activities: Students spent three weeks inside the company guided by an academic teacher, working alongside technicians and creatives doing archive research and concept development, design of the knitwear collection, samples and prototypes on manual machines and on electronic machines with MF1 technicians.

Lanecardate

Type: Lanecardate is a spinner of woolen yarn, which is a typical kind of yarn with short fibers, highly responsive to finishing treatments.
Need: To innovate its uses and fields of application.
Brief: With the traditional yarns of the company propose new solutions
Activities: Given the yarns from Lanecardate, the students combined the owned knowledge on knitting machines with what they were learning from the company on materials, to provide design ideas following the feedbacks from the company.
The results were eight collections of knitted fabrics, which entered the catalogue of the company and were presented to customers inside the company stand during the international fair "Pitti Filati 85".
The schemes (Fig. 1, 2, 3) outline how the experimental activities showed that the involvement of a company in teaching activates processes of knowledge transfer in some areas even if students do not attend lectures on that specific topic.

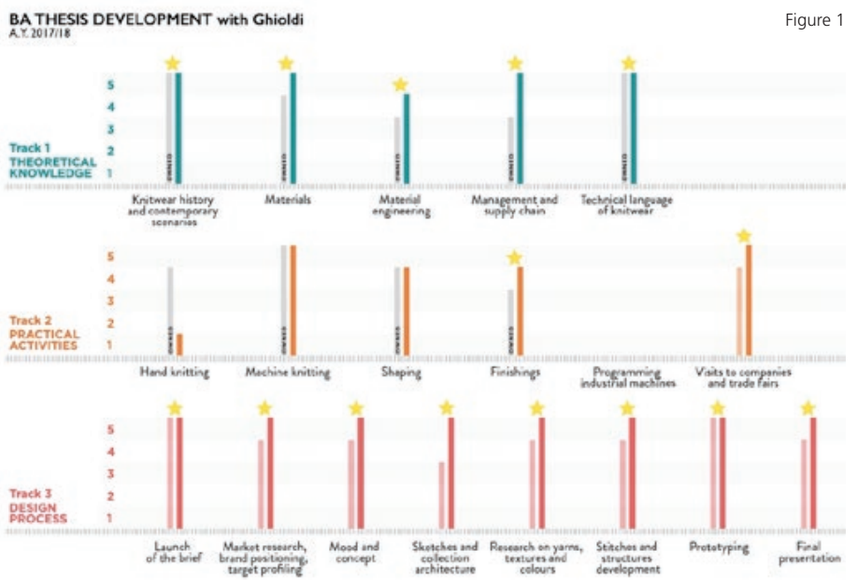

Figure 1

Figure 1, 2, 3. The indicators outline the level of knowledge owned by the students before and after the workshop. Colored indicators are the ones selected and impacted by the action. Stars indicate where the company participation impacted on that module. Motta, 2019.

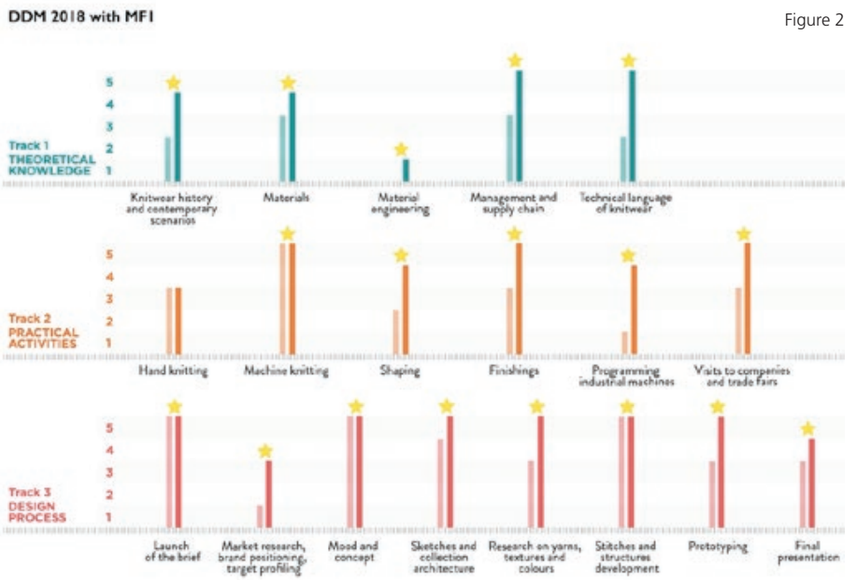

Figure 2

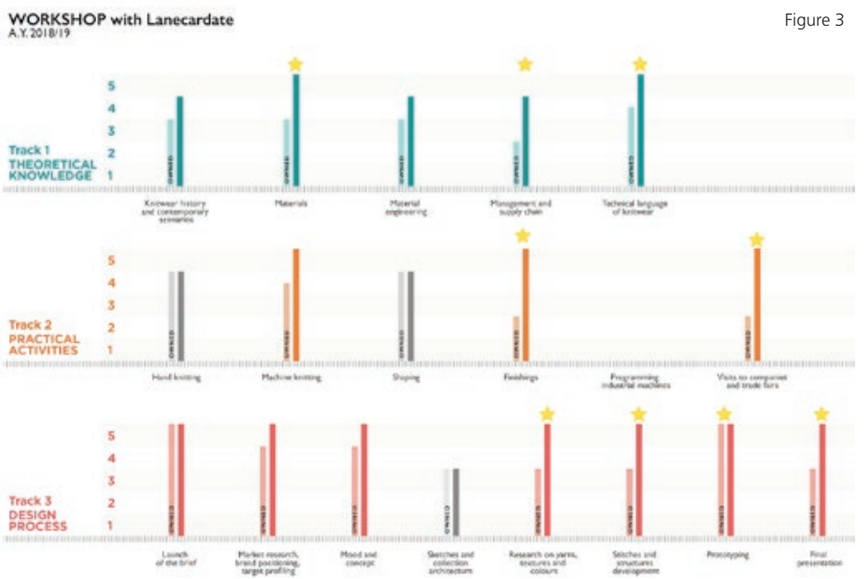

Figure 3

The dialogue with experts and the direct contact with the industrial environment leads to a spontaneous deepening of several areas and expands the previous knowledge provided by the teachers. Students learn faster, by experiencing reality, conversing with professionals and immersing themselves in the real practice of design.
The direct contact with the supply chain during training opens up new professional perspectives in the upstream phases of the value chain, such as spinning mills and knitwear factories, where the deep-rooted predilection for technical figures has led to a lack of knowledge on style and on the current fashion market, and thus a little ability to interpret the requests of client fashion brands.
These companies recognize in the new profiles the ability to understand the dynamics of the fashion system, to propose creative solutions, interact with customers and suppliers, to know the production process, to supervise the phases of power-machine programming, machine knitting, garments assembling.
Tackling complexity with the joint work of training and industrial reality creates fertile intersections between the different levels of knowledge and today allows the knitwear design to respond to the transitions underway, identify new areas of intervention and work on defining the role of the future designer, in charge of bringing together all the manifold ones in the direction of a renewed generation of innovation processes.

[1] Paragraph 3 is written by G.M. Conti. Paragraphs 1 and 2 are written by M. Motta.

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New places of design: nomadic workshops

This contribution presents reflections on design intended as training, research and work together with the theorization of new practices and new places that define the designer's nature in relation to the demands of design and materials and to the relationships between universities, research and small enterprises. In particular, we intend to think about the designer's possibilities of intervention in specific local realities, enriched by their knowledge, while putting in place a virtuous circle made up of relationships and active exchanges of skills.
The figure of the "priest of materials" therefore emerges within a "materiolab", a new type of place of knowledge, that is not necessarily a physical place, but rather a research standard. A nomadic workshop, since the designer-researcher is the bearer of his knowledge, tools and ability to explore and create. The aim of this "place of thought" is to critically highlight the processes that derive from the sedimentation of a specific know-how linked to the territories and experiences that have been able to follow one another over time, increasingly enriching our knowledge. The target is to basically offer a reflection on the need for pre-design in the new design and methodological scenarios and on common sense in the design with materials and of materials; it is an invitation to the contemporary designer to bring his specific contribution on the methodological dimension of the project activity in which the experimentation with materials becomes an experimentation of the space of possibilities intrinsic to their very nature.

[materiolab, material design, designer-researcher, laboratory, know-how]

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Design in the contemporary world

The increasingly globalized competitive context in which we are witnessing a rapid evolution of the market and the high variability in the ways of using products and services requires companies to have a renewed capacity for vision. Within this evolutionary framework, design increasingly plays a main role as an essential value of the product-system. In its contemporary form, design has definitively overcome the *status* of "applied art" or "artistic-creative" discipline, thanks to its multidisciplinary line evolved in relation to society, imposing itself as a possible, if not unique, line of renewal of the system consisting of small and medium-sized enterprises. It is precisely this multidimensional approach that contemplates the theoretical, historical, economic, social contexts that are essential to understand and analyse the methodological and ontological problems of design in order to fuel the contemporary debate about the transformations taking place on the essence of doing and thinking. In other words, there is a dimension of co-responsibility among the society that makes it essential to be able to recognize problems in relation to other fields of knowledge, such as philosophy, psychology, but also certain instances of the history and criticism of art, in order to be able to reach to the definition of possible application areas of the project in this social reality, in its complexity. A reality in which the economic, socio-technical and cultural conditions require a rethinking of the contents and methods of design, together with an investigation of contexts and conditions, addressing the need for reflection and critical action as the foundation of doing design.
Different "histories" of design coexist and the one of design as a problem solver, together with that of design as a creator of meanings, interact, influence each other, but without one reading is a function of the other: design is a culture and a practice regarding how things should be to achieve the desired functions and meanings (Manzini, 2015). Specifically, this contribution[1] aims to describe a new practice of training, research and work for the designer as a sense maker - specifically compared to the reflections on design with and with materials - that is «openness to unprecedented possibilities able to contribute to imagining solutions that do not yet exist and to find new ideas around existing ones through a necessary path of exploration of other expressive, cultural, philosophical, social and technical worlds» (Bassi, 2017).

A renewed capacity for vision

Therefore, the two strategies according to which one can act concern the relationship between research and enterprise. On the one hand, there is the possibility of offering the consulting service in research and development for small and medium-sized enterprises, which in most cases do not have research laboratories and must make use of university collaborations in order to implement innovation and allow to explore a mediation of different mentalities between entrepreneurs and university experts.
On the other hand, there is a possibility of setting up joint laboratories to carry out basic research without providing for specific possible applications, but rather showing a more open and capable of "doing to know" mindset. In the current context of

globalization and liberalization, it is certainly a challenge to be able to understand how universities and the world of research can interact by offering their own specific dimension with the aim of enhancing the project on the one hand and enterprises with their local knowledge on the other, setting in motion a virtuous circle made up of connecting networks and exchanges of skills. «Only through the dialogue between academia, designers and the business world, it is possible to innovate in a sustainable and coherent way» (Russo & Tamborrini, 2019).
The phenomenon of globalization sees a real strength in the standard and in the economic, social and cultural integration, standardizing strategies to the detriment of certain diversities and varieties of the countries involved. The result is the change in production and consumption models, which are increasingly uniform and converging, which also force small local enterprises to adapt to market demands. The major changes in the social and environmental level make the debate widely open (Russo & Tamborrini, 2019), therefore it is necessary to rethink the ways and means by which the designer will interface with today's challenges.
The intention is to bring out how the know-how of tradition is combined with innovation themes: traditional material cultures become an opportunity to study and rediscover hybridized and intertwined ways of doing in a new way – by relating one's own local cultural identity with a globalized context – and therefore how the processes deriving from the sedimentation of specific know-how linked to the territories increasingly enrich knowledge, taking shape in the "sensitive" surface of the artefact in which materiality manifests itself «in its double sense of haptic mediation and emotional connection» (Bruno, 2016). In order to pursue a new "materialism", it suggests to carry out critical acts of investigation on the surface that reveal its wide potential for material expression with the aim of communicating the sense of the transformation of these relationships. At the base is the idea that materiality involves remodelling of our perception of space and contact with the environment; rethinking materiality, therefore, means adopting new forms of connection and relationality.

Design matter

The experimentation with materials which can ignore the shapes of objects has been examined and it is based on the transversality of surfaces when the design action concerns the relationship between different materials, or different material densities, or different chromatic nuances, as the core of the reflection on the material that in changing brings out its true nature (Bruno, 2016; Carullo, 2017). This method, developed in the INMATEX laboratory[2] at the Polytechnic of Bari, coordinated by Rossana Carullo based on the twentieth-century reflections on the principle of coating, the Bauhaus experiences, the ideal of total internality and, finally, the lectures on Klee's chiaroscuro scales, classifies materials through scales of sensory gradients, evaluating their perceptual-sensory characteristics based on processes of interaction between surfaces to define taxonomies of relationships between materials as an enhancement of the conceptual instances of the material experience (Rognoli & Levi, 2011; Carullo, 2017; Carullo & Pagliarulo, 2018). So the study continues to try to highlight how the material is no longer just the result of a research aimed at improving its technical and functional performance but is itself a "matter of invention" (Manzini, 1986), a conscious design ground to discover how it can interact more and more with the sphere of emotions and senses. Crucial is the theme of the selection of materials, therefore a critical reading of the relationship between design, university, enterprise and territory, raising questions on design practices in the contemporary context that aim to «defend the know-how to defend the know-how to design» (Arquilla *et al.*, 2005) and which see the need for a renewed dialogue between designer and business. By understanding what contemporary daily needs are, the designer can connect the science of materials with social and cultural reflections by actively placing himself within the process of creating scientific knowledge and, at the same time, in the research process itself: this is revealed to be a great opportunity for the design discipline as it can investigate and exploit the relationship between production processes and the coordination of the performative nature together with the expressive-sensorial one of the materials.
The "Hydros Phobia" project, developed by the author, is the result of experiments with prototyped surfaces with variable gradients to verify the perceptual-sensorial qualities of native Apulian materials. For the development of the project, we turned to the start-up Pecore Attive which, in Puglia, carries out a work to enhance the wool of Gentile sheep and to reconstruct the links between territory, production and society. Thus the university-research-business relationship has made it possible to explore in detail the limits, but also the potential and the expressive-sensorial properties of these traditional as well as unusual wools, to understand how they can be inserted in a mechanized production process.
Aimed at research on the polysensory nature of materials, the project starts from the elaboration of a tactile scale in which different layers of materials activate mutual relationships to compose a surface with different softnesses with a last white layer of fabric that hides the layering from view, forcing to a purely tactile experience by points. The challenge was to transform it into a surface that can be used as a covering on both horizontal and vertical planes, as well as a concept of soft skin. Where the wool felt is present, the colour is not absorbed, it retains its vividness and spreads horizontally on the surface. Where there are layers of carded wool with a capacity to absorb the colour, penetrating into the depth of the layers, it loses its vividness in relation to the depth of the same. Therefore, colour has become a detector of tactile materiality and, as an optical sensorial parameter par excellence, it becomes capable of retaining the materiality of the surface, it is itself a corporeal entity. The experience recalls the construction of chromatic-material palettes in the research conducted by Hella Jongerius (2016) for Vitra on the material aspect of colour as a constantly changing reacting entity. On the international scene, then, the rich tradition of Dutch weaving has also led the visual artist Sigrid Calon to intertwine her research with the operation of "widespread innovation" carried out in Calabria

by Emilio Leo of a Fablab *ante litteram* with a process of productive and cultural reactivation and consequent conservation of the tangible and intangible heritage of the family business, Lanificio Leo, founded in 1873: even this reality of "project laboratory" confirms the fertile ground for new practices and new places of design.
If the daily life, pervaded by science and technology, requires an interpreter-translator-connector who takes into account the progress and results obtained, making society participant, then it is up to the designer to reformulate his own attitudes and skills by assuming the role of the one who Verganti (2009) would define "radical researcher". Verganti refers to the case of the designer who, with his ability to investigate and imagine the meaning of new artefacts, is able to implement a cultural reading – which is also a social, economic and technological reading – of the same artefacts. We are therefore faced with new professional figures of designers defined by the tools with which design works in the project "of" and "with" materials, determined by the establishment of a new paradigm of multidisciplinary collaborations. Research on materials, today, induces a type of design that is not based only on functional and performance needs, or on the economic needs of society as a whole, as well as cannot be based solely on the often abused instances of ecology and sustainability: «New scenario is governed by new design and methodological phenomena. Interdisciplinarity, hybridization, new tools and new places that take over from the outdated material libraries» (Migliore, 2016).

Project laboratory

The "materiolab" is then a new type of place of knowledge, not necessarily a physical place, but rather a research standard. It is intended to mean a type of methodological approach towards materials, based on their sectorized collection which, specifically, is offered to us by the innovative experience conducted in the INMATEX laboratory: not just a service to companies or designers or students, nor a database, but a generative device in which surfaces/materials are organized according to serial principles. The "materiolab" contains a way of thinking, an attitude, a research and project service that sees the designer-researcher working closely with the company. A nomadic workshop, therefore, because it does not need a physical and fixed place, because the designer-researcher becomes the bearer of his knowledge, tools and his ability of "space-visual" explorations and material creations (Bruno, 2016). The intention of this "place of thought" is to critically highlight a new way of categorizing materials, which responds in an innovative way to the need to create knowledge about the binding theme of their selection, and therefore an opening towards new possible design practices.
This method classifies the materials assessing the perceptual-sensory characteristics based on the processes of interaction between surfaces with the aim of defining taxonomies of relations between materials and shift the focus in the choice of materials, from a technical cataloguing to a conceptual categorization.
A display case intended not only and not so much as a library of materials, but as an archive of manufacturing processes aimed at enhancing the sensory values of surfaces that can be produced with those materials. Surfaces then also become the place of communication of a specific identity of the material culture of places «within a perspective of international comparison that does not want to be global as the existing material libraries are, but rather transcultural» (Carullo & Pagliarulo, 2016). Therefore the proposed research site, a metaphysical place, does not ignore the knowledge on materials from traditional material libraries, but it enriches it and is substantiated by the designer's cultural background and knowledge of the manufacturing processes in order to be able to act rationally on them: the relationships between the material connections in favour of the individual samples, the humanistic-sensitive logic that integrates with the performative one. In this way, we imagine how the critical dimension of the research would lead to the critical dimension of the project with and of materials: the role of the designer that takes concrete form in the theorization of identity tools for the company in which he operates and whose production processes he knows, up to the creation of an *ad hoc* cataloguing system, as a contemporary product-service and design mediation tool. The experiments on compositions of sensory gradients become those «prostheses of concreteness» (Dal Bò, 2016) which offer the possibility of broadening abstraction and contrasting engineering and virtual environments, becoming a tool for reflection on the design of the meaning of things. Design must come into close contact with the concrete dimension of the territorial context, therefore the designers become enabled "antennas" at the local level through which design – in its strategic dimension – operates in the processes of competitive enhancement in the first instance of the individual company, to a higher level of the local systems of enterprises, and finally of the different local systems of resources of the country. The disciplinary contribution that design can bring into play concerns, above all, the possibility of making the manifest identity of the local production system as a whole, an identity that emerges from the knowledge of the local tissue and that is made explicit not only to the system of external actors, but also and above all internally. Finally, the design consultancy can be configured as a "project laboratory" where research and innovation are the results of a continuous relationship between the local system and the complex system of skills that design puts in place. The typological invention of a design-oriented research center is one of the experiences of enhancing heritage know-how, a place where reason with materials in their experimental potential, with a metadesign perspective.
To describe this figure of designer-researcher, who here we shall call a "priest of materials", the words of Pareyson (1991) seem fitting: «[He] lovingly studies his subject, scrutinizes it thoroughly, spies on their behaviour and reactions; he questions it in order to be able to command it, he interprets it in order to be able to tame it, he obeys it in order to be able to bend it; he deepens it so that it reveals the latent possibilities suited to his intentions; he digs it up because it suggests new and unprecedented possibilities to try». Knowledge of materials and related production processes often suggests many design paths, some of which tend to bring together design skills and technical skills in a single figure. However, in some cases, being too involved on a

technical level prevents you from having the right distance so that you can also have the freedom to dare. For this reason, teamwork remains of primary importance; teamwork in which the designer has sufficient technical skills to avoid thinking about unattainable things, just as the technicians should have sufficient open-mindedness to be able to solve the creative direction without constituting an element of obstacle to the experimentation. The designer-researcher intended in this way is responsible for a reflection on the use of materials, on the design of surfaces through reflections on the combination of materials and on the synergies that are created in them, therefore a figure that places itself in a close relationship with the small enterprise – especially artisanal – with whom it operates by introducing innovation, not through new forms (styling), but through critical reasoning on the production processes and therefore on the materials it already uses, based on specific cataloguing of the latter that is built on the juxtaposition or of different materials or different material outcomes deriving from the various process options of that company. The example of the collaboration with the startup Pecore Attive is a demonstration of this.

Thus, the figure of the "priest of materials" for design emerges, equipped with an articulated baggage of tacit and non-explicit knowledge, as the result of curiosity, attempts, experiments, skills, previous elements of a cultural, experiential and professional nature, but also of unexpected epiphanies. The objective is, in conclusion, to offer a reflection on the need, even more than in the past, of the pre-design in the new design and methodological scenarios, on common sense in the design with materials and of materials, focusing on the expressive-sensorial qualities capable to transform the intangible into tangible; an invitation to the contemporary designer to bring his own contribution on the methodological dimension of the project activity in which the experimentation with materials becomes an experimentation of the possibilities inherent in their nature.

[1] This contribution is the result of the research conducted by the author jointly in the training course carried out at the Polytechnic of Bari and the Iuav University of Venice. Specifically, it refers to the research thesis works *Hydros Phobia* of the 2015/2016 academic year with supervisor Prof. R. Carullo (Polytechnic of Bari) and *Sense Making Material* of the academic year 2018/2019 with supervisor prof. A. Bassi and co-supervisor Prof. R. Carullo (Iuav).

[2] For more information, consult the website www.inmatex.it

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Prototype-Driven Design in the IoT Age

The complexity involved in developing increasingly smart and interoperable objects, typical of the Internet of Things, is determining new dynamics of interaction between humans and artefacts, prompting us to rethink prototyping methods and practices. With the traditional conception of "doing design", prototyping refers to an activity that allows designers to assess the validity of a specific design outcome, whilst nowadays, this practice is becoming a driver in the theoretical, methodological and experimental development of both human-centred design and participatory design, in at least two different ways. On the one hand, the prototype is used as a collaborative toolkit for idea generation or to boost co-creation between users and designers. On the other, the prototype becomes a smart object and partner of the designer, capable of co-designing innovative solutions in response to modern complexities or even of defining new alternatives for future research, at the same time prompting reflection on possible implications of digital technology that are not immediately evident. Many changes are shaping a central role for prototyping in the various operating contexts of design. This paper reflects on the opportunities created by the prototype-driven approach, analysing three projects that utilize prototypes from three different perspectives: the prototype as a project guide, as a co-ethnographic agent, and thirdly as a provocateur. Finally, the article considers the potential of these new interpretations of the role of prototypes to foster a fresh design perspective aimed at generating new forms of value.

[prototyping, design research, human-centred design, co-design, internet of things]

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Rapid advances in technology are causing radical changes in the contexts in which design is active. The key changes are due to the impact of digital transformation on human activities and on product dematerialization and transition towards increasingly intangible, digital services. In particular, the complexity generated by the Internet of Things paradigm is determining new dynamics of interaction between humans and artefacts, prompting us to rethink prototyping methods and practices. On this basis, the article aims to examine the prototype through recent redefinitions of its role, in order to identify those capable of determining new human-centred design methods. Specifically, the paper discusses the opportunities offered by the prototype-driven approach through analysis of three projects that adopt this model in different ways.

Prototype evolution

From the traditional perspective of Industrial Design, the prototype is considered as a tangible synthesis of all conceptual design thinking – charged with design knowledge and practical mastery (Lim *et al*., 2008) – that designers use for product ideation (Cross, 1999). Normally, the technical and morphological qualities of the prototype are necessary to assess compliance with market demands or expected requirements deriving from manufacturing constraints. With User-Centred Design (UCD), the prototype takes on a new role in applied research design because it permits the progressive refinement of a specific concept through iterative development based on interaction with users. Such a model can identify and answer unexpected questions that arise only through interaction between user and artefact (E. Zimmerman, 2003). Therefore, UCD works in harmony with the methodological approach of applied science and the prototype becomes a practical exploratory tool, e.g. a low-fidelity mock-up of an interface, for implementing design knowledge (Stappers & Giaccardi, 2017) to generate or analyse data, hypotheses, theories or design methods (Wensveen & Matthews, 2014).

The successive expansion of design into new areas, such as services and systems, requires designers to deal with a multitude of new economic, technological and social factors, which consequently impose a different – more organic, multidisciplinary and flexible – methodological approach (Mincolelli, 2017), but above all require the active participation of a wide range of co-designers, no longer considered as mere users or stakeholders. In this new context, termed "diffuse design" by Manzini (2015), expert designers and non-designers reformulate the UCD process in the participatory approach of co-design and promote prototyping as the core element in the generation of knowledge, creativity and innovation in all areas of design research. The designer, acting here as a facilitator, enables the prototype to become an experimental research driver to identify and anticipate emerging phenomena or latent needs that have not yet reached maturity. This is done by stimulating users to develop innovative solutions through a collective and participatory vision of the future (Codarin & Giacobone, 2019). For this purpose, the designer transforms the character of the prototype

into toolkits, namely a series of artefacts capable of involving users in co-design by facilitating the manifestation of their creativity (Sanders & Stappers, 2014).
In recent years, prototyping has become increasingly connected with design-oriented research due to the opportunity of transforming both prototype and processes for its realization into true experimental research products (Odom & Wakkary, 2015). Indeed, Gaver argues that much of the knowledge generated by a design approach is not readily transformed into a verbal abstraction of a particular concept but instead is better conveyed through inherent qualities of the prototype itself (2012). For this reason, starting from the three terminological distinctions of "doing research" in design established by Frayling (1993), other authors (J. Zimmerman *et al.*, 2007) identify Research-through-Design (RtD) as a valid contemporary research model. This is because the methodological process itself is characterized by a learning-by-doing strategy and is led by a prototype-driven approach. The prototype is assigned a guiding role in research because during its development designers and users can identify problems, explore hypotheses or co-design new solutions for particular social challenges or questions related to specific research topics (Stappers & Giaccardi, 2017).

From prototype to smart thing

The recent Internet of Things paradigm offers designers the chance of investigating a new type of artefact –smart objects – operating in the context of progressive integration between humans and computational objects within everyday social practices and characterized by an increasing capability to sense and adjust the surrounding environment. The distinguishing characteristic of these objects is an ability to act, react and interact in a specific context without human control, through dialogue with other similar objects mediated by Artificial Intelligence (AI) decision-making systems (Celaschi, Di Lucchio, & Imbesi, 2017; Rozendaal, Boon, & Kaptelinin, 2019). Therefore, if the practice of co-design has so far been based solely on the cognitive and practical abilities of humans, today RtD takes on a new role where the prototype is able to co-participate in the design process as an active design partner, almost as important as humans themselves. The information processing capacity provided by these smart objects allows data itself to become the raw material of new design practices (Zannoni, 2018). Indeed, data generated or processed by prototypes can be merged with that produced by human participation to foster new ideas or facilitate particular decision-making processes during the design phase. This is because smart objects can use digital filters to identify particular patterns of interaction or behavioural trends in their datasets that were previously concealed or not immediately recognizable to the human eye (Giaccardi *et al.*, 2016). The capability to monitor the context through mathematical models processed directly by the prototype also offers opportunities for new RtD studies, not only for analysis of the current context but also for simulation of future scenarios.
On the basis of these considerations, we explain our exploratory research experiences regarding new prototyping applications in RtD, particularly emphasizing the impact of digital technology on research practice, results and the dynamics of interaction with the individuals involved.

Prototype as a project guide

In cutting-edge co-design practices, the main role of the prototype is to guide the design process in the identification and experimentation of solutions that can be used to respond to specific problems or needs. The prototype can have different functions and intentions, based on the purpose of the specific research: it can be used to develop theories, confirm or re-examine hypotheses, establish the scope of a project or even anticipate unexpected design spaces. Each of these functions can be investigated thanks to an iterative and participatory prototyping process, which begins with visualization of the life experiences of users and proceeds, in a sort of cyclical spiral, towards the generation of new ideas for the future (Stappers, 2007). In particular, the direction of design is determined by the physical manifestation of the prototype, which can generate contextual knowledge through interaction with people. The prototyping experimentation of "Inception", a European research project funded by the Horizon 2020 programme, was based on these principles and aimed at creating a virtual and open-source platform to make Europe›s cultural heritage accessible through digital 3D architectural models. The overall layout of the platform, from its architecture to definition of the individual components and methods of interaction, was also generated through co-design workshops, in which the designers and a large and varied panel of international stakeholders worked together in order to define the key aspects of the user experience, using specially developed prototype toolkits. The toolkits consisted of sets of cards describing actions or functions related to the service. These enabled users to generate multiple and heterogeneous solutions, while ensuring alignment between the direction of the process and the goal set for the research. In the end, ongoing interaction and manipulation of prototypes by users allowed a generation of unexpected results compared to the objectives set at the beginning of the project, as the process allowed users to be included in the design phase that otherwise would only have participated in the project through surveys or interviews. Considering that "Inception" has the objective of increasing accessibility and inclusion in the cultural heritage field, the co-design phase was based on a translingual and transcultural toolkit that must be considered not only for its effectiveness, but also for its intrinsic inclusivity.

Prototype as a co-ethnographic agent

Unlike the first category, where prototypes are always developed by manifesting a human perspective, there are cases where such objects, in the form of smart objects, are independent actors and actively participate in the design process. In this way, prototypes become powerful tools that can act, together with the designer, as social observers or co-ethnographers, helping to process data collected through interaction with people to generate frameworks, analyses and plans that allow identification

of behaviours and behavioural trajectories that would otherwise be invisible to the human eye. In this case, the prototype is no longer simply a research support for the verification of human assumptions, but instead allows enrichment of the design process thanks to the integration of the human perspective with that deriving from data collected by sensors and processed by software. This helps research reduce cognitive *bias* and avoid conditioning of a preconceptual nature.
The concepts described above can be identified in the two-year "Habitat" project funded by POR-FERS of Emilia Romagna, involving the creation of an IoT platform and reconfiguration of common objects as smart objects. The aim was to monitor a self-sufficient elderly person in his or her home environment, in order to provide useful tips for a healthy lifestyle, independence and personal fulfillment. The experimentation of such devices, mainly aimed at evaluating usability and methods of interaction, was useful as a true anthropological analysis because it allowed observation of relationship dynamics linked to development possibilities that had not been identified during the previous analysis. In essence, the continuous and non-judgmental interaction of smart objects with users enriched the project with otherwise undetectable data and allowed the development of new lines of research.

Prototype as a provocateur

In previous cases, the prototype is used to experiment solutions aimed at solving problems. Instead, in the last example, this object is used as a diegetic tool to stimulate questions about the future through Speculative Design. This modern discipline resorts to prototypes that are not necessarily realistic, nor aimed at verifying performances that are set in future scenarios, hypothesized on the basis of current trends, through which the designer can conduct ethical-social evaluations of hypothesis that are difficult to describe otherwise. The objective of the prototype is not to demonstrate what is possible today, but to develop pervasive and immersive narrations, as possible alternatives of a credible and desirable future to trigger the critical debate, revealing problems, ethical or moral conflicts, in order to improve the integration of technology in daily life (Dunne & Raby, 2013).
This category was used in "Pleinair", a still ongoing two-year research project, also funded by the POR-FERS program of Emilia Romagna, which involves the construction of an IoT public park, to promote the adoption of active lifestyles for all age groups, in order to encourage – through the design of specific artificial Outdoor Smart Objects (OSO), street furniture and recreational tools – physical activity, conviviality and socialization between people. Being an unprecedented project in which it is not possible to imagine and foresee the technological consequences of the IoT model, several connected prototypes defined with the criteria of the Speculative Design are under construction, in order to simulate possible scenarios through the direct interaction with real users. This experimental report is able to generate innovative data and dynamics, therefore can act as a truly critical element of investigation to verify the implications of future scenarios in the present, which, otherwise, would be unthinkable with traditional design methods. The COVID-19 emergency has occurred at the peak of the prototypes' development phase. As a consequence, the provocative prototypes are readjusted to allow an efficient remote interaction, producing a simulation within the simulation, even opening a new perspective on the role of the prototype in the practice of the remote Speculative Design.

Conclusion

Taking into account the three mentioned examples, it is easy to understand how technological evolution is shifting the practice of prototyping, especially in the IoT field, towards a role of absolute strategic importance within any contemporary participatory design process. Compared to the past, the prototype is multifunctional and multiform as it is able to adapt to the different intentions of a specific research: for "Inception" it is a dialogue interface to guide the project, for "Habitat" it is an ethnographic observation tool, for "Pleinair" it is a provocateur that stimulates design considerations. Furthermore, the comparison between the first and the other two projects shows how the RtD design logic – especially addressed to the construction of IoT scenarios – is no longer limited to investigate only the technical-morphological aspects of a specific prototype, but directs the focus on the impact of an object on the context and behavioural dynamics of the people who are settled in. The «smart» prototype simplifies the modeling of the experiment and the collection of data in the RtD, and allows the adoption of more sophisticated and more suggestive processing tools.
Sharing the statements of Giaccardi (2019), it is observable how this shift of value towards data is leading to configuring the research in a new and alternative way compared to the past, through three main aspects. The first one underlines a mutation of the role of the prototype: from an object of study that enables and embodies the ideas and will of the individual (e.g. "Inception"), the artifact becomes a potential partner in the construction of meaning (e.g. "Habitat" and "Pleinair"), as, in an IoT scenario, it becomes an active and independent actor in the development of a project thanks to its purely artificial qualities. The second aspect identifies a transformation of the way the design is carried out: if in "Inception" co-design is understood as an interactive practice, circumscribed in a well-defined space and time such as those of a workshop, in "Habitat" and "Pleinair", the phenomenon IoT is able of decentralizing this practice by expanding it over time, throughout the development process, and in space, allowing the remote interaction. Effectively, thanks to a «sustained» interaction between users and prototype it is possible to explore new research opportunities through the hidden information, which is only obtained observing the evolution of the complementarity between anthropic and artificial space (Kuijer & Giaccardi, 2018).
Finally, the third point highlights the change in the value of the knowledge that is generated by the prototypes themselves: the meaning of each described project is no longer achievable only through an ex-post prototypes' evaluation in relation to the expected objectives of the research, but is directly generated within and during the design process itself. This because the developed values cannot be entirely placed a

priori by the human thought, but they are generated, in an unpredictable way, during the open and changing dialogue between artifacts and users.
In conclusion, thanks to the evolution of design practices, we can observe an opening towards intervention spaces in which even the methodologies associated with the anthropocentric logics of the Human-Centred Design start finding a new ontological perspective, where the artifact is not only subordinate to human practices, but also takes on a symmetrical and independent role in relation to the individual (Cila *et al.*, 2017). For this reason, the prototype will require greater design attention, in a thing-centred perspective (Giaccardi *et al.*, 2016), through which non-human issues can be solved, in order to make the collaboration between the actors of the system more effective and, above all, to increase the co-performance capabilities originated from the data obtained from the artifacts to imagine new design solutions.

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Avant-garde CAD: Generative Design

With the advent of Additive Manufacturing (AM), it is possible to realise complex shapes and structures which would have been difficult to manufacture by conventional processes, therefore AM offers unprecedented morphological freedom. It enables a wider diffusion of Generative Design (GD), a design approach empowered by advanced computation, allowing the designer to define initial constraints and objectives, then instruct an algorithm to generate numerous variations and optimize the design until the desired solution is achieved. The idea of generative potential was present already at the birth of Computer-Aided Design (CAD) over half a century ago, but emerged mainly in the past decade through widely publicized experimental research projects both in the academy and in the private sector.
In the next decade until 2030, GD is expected to spread across various industries due to advantages including optimised weight and mechanical performance, better use of raw materials, but also because it enhances the creative process by helping designers to explore and objectively evaluate many unconventional solutions in a brief timeframe. The paper starts with describing the place of GD in the evolution of CAD, then it outlines current technological directions, including topology optimisation, morphogenesis and biomimicry. Afterward, we examine how the design research community and design professionals use GD to achieve various goals, with particular attention on transportation design (from motorbikes to spacecraft), as this field received the most GD effort so far. Finally, the article concludes by observing how the designer's role is shifting towards being a "curator" of input data and output geometry, with the consequence that they will need to adapt their tools and their skills. This means not simply new technical knowledge but also a more flexible approach, where research and critical reflection become more and more important and the creative act become an attempt of collaboration between designer, data, environment, people and algorithms.

[generative design, additive manufacturing, innovation, lightweight, optimisation]

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Introduction

The evolution of the material culture in the 2010-2020 decade was dominated by a proliferation of digital intelligence: in content-driven digital devices, integrated into various kinds of physical objects (Internet of Things), in sophisticated product-service systems, as well as in the tools of the design practice – even when designers tackle with purely analog, conventional product categories. We start with the assumption that the next decade (2020-2030) will develop further all the above-mentioned trends, but we focus on an evolution of the form-giving practice through a truly "digital native" attitude, through the advanced CAD tools of GD.
In the design practice, Louis Sullivan's «form follows function» has been a returning slogan (1896), inviting a sober handling of forms – sometimes countered (half-jokingly) by alternative versions such as "Form follows fun", "Form follows fiction" (also name of an Alessi product line by Stefano Giovannoni) – or simply by the observation that digital technology detaches function from form. On the other hand, the use of advanced computation in the design phase opens new frontiers of functional form-giving: advanced CAD tools enable a "Form follows force" approach (Li, 2018) through physically realistic simulations and generative algorithms that evolve forms gradually, just like Darwinian natural selection does.
This approach, called Generative Design (GD), often leads to surprising results, extremely complex geometries that would be hard to imagine and even harder to draw (or model) with conventional CAD tools. Therefore, beyond its performance-enhancing potential, the evolutionary process of GD implies also a new aesthetic language, reminiscent of natural forms, but result of a design process that is fundamentally different from the "conventional" biomimicry, where a designer emulates forms of biological entities to achieve desired functional or aesthetic outcomes. Some examples of biomimicry are the improved aerodynamics of Japanese the "Bullet Train" inspired by the Kingfisher bird's beak (evolved to smoothly pierce water) or the velcro fastener inspired by burdock seeds (evolved to cling on animal hair). By contrast, GD does not necessarily imitate already existing biological forms, but it evolves forms which often become similar to natural forms.

A step forward in the development of CAD

Following the early development of Computer Numerical Control (CNC) starting from the fifties (e.g. the "Pronto" language by Patrick Hanratty in 1957), the idea of Computer-Aided Design (CAD) software emerged already in the sixties and, already then, it was meant as something more profound than a simple drawing tool. As CAD pioneer Sutherland argues, such transformation requires a profound change also in the way designers think, «an ordinary draftsman is unconcerned with the structure of his drawing material. Pen and ink or pencil and paper have no inherent structure» instead […] «the computerized version of the design [should be] the master document from which all auxiliary information is derived» (Sutherland, 1975). In fact, already his experimental "Sketchpad" software was capable of Parametric Design, whereby

modifying one element could trigger a modification of all related elements according to the constraints established by the designer. Such possibility has been a driver of qualitative development because, as Parametric Technology Corporation (PTC) Inc. founder Samuel Geisberg expressed, «The goal is to create a system that would be flexible enough to encourage the engineer to easily consider a variety of designs. And the cost of making design changes ought to be as close to zero as possible» (Geisberg quoted in Teresko, 1993).
After simple freeform CAD and parametric solid CAD, the Noughties brought to a democratization of Algorithms-Aided Design, as Tedeschi, Wirz and Andreani call it (2014), thanks to new visual programming languages (Generative Components, Grasshopper, Dynamo) integrated in popular CAD packages. While John Maeda already in 2001 urged designers to learn creative programming and "Design by numbers", at least for graphics/art, for the design of physical objects this became feasible only thanks to the user-friendly approach of programming through visually connected nodes. Since that, however, "parametricism" became a fairly popular (albeit debated) architectural style, characterized by mutually adaptive elements in correlation also with outside influences, leading to differentiated components rather than repetitive modularity (Schumacher, 2016). As Carpo observes (2015), advanced digital fabrication hardware and advanced parametric design software allowed architecture to go beyond the paradigm of constructing from an alphabet of pre-fabricated elements and move towards algorithms controlling dynamically each element of the design.

Generative Design: types and tools

Generative (product) Design today is a further step in the evolution of CAD, enabled by the proliferation of Artificial Intelligence. Advanced implementations rely on Machine Learning and Artificial Neural Networks which allow computers to learn how to perform "creative" tasks without programming explicitly the single tasks: the programmer/designer's job consists of specifying the requirements and supervising the process.

[With GD] the designer formalizes the constraints and objectives required of a satisfactory design in some expert system and defines some optimization system to algorithmically satisfy these requirements. GD methods range from fully autonomous implementations that generate absolute solutions, to interactive systems that efficiently generate potential solutions for evaluation by the design team. (Leary, 2019)

This generic definition can be branched according to different generative principles that lead to fundamentally different functional advantages and aesthetic values. Custom implementations (e.g. through Grasshopper) may operate on just about any kind of parametric geometry and the generated models can be evaluated according to a multitude of criteria. However, the last few years of development is more characterized by voxel (3D pixel) based approaches; Jackson (2019) distinguishes three types:

a) Topology optimization, where an existing piece of user-defined geometry is analysed based on which material is removed from areas that do not carry a significant load. It is a subtractive type of GD as it removes (virtual) material repeatedly to achieve the final result.
b) Biomimicry, where the behaviour observed in nature are mimicked. It includes replication of bacterial colony growth, bone structure evolution, as well as the growth of roots and branches in trees. It is an additive type of GD as it involves growth of the virtual material.
c) Morphogenesis, where the algorithm maximises the advantage of research based on the response of groups of cells to their environment. The growth of actively loaded cells is stronger whereas unloaded cells are discarded.
To practice these three types of GD, there are already various software solutions available:
- Autodesk – Fusion 360 (Implements Morphogenesis in combination with Biomimicry)
- Dassault Systemes – Functional GD (Topological Optimisation in combination with Biomimicry) and XGen (Combination of graphical visual scripting and interactive 3D-modelling
- PTC – Creo GD (Topological Optimisation in combination with Biomimicry)
- Siemens – NX GD (Topological Optimisation in combination with Biomimicry)
- MSC – Apex GD (Topological Optimisation in combination with Biomimicry)
The generative process results in a voxel-based geometry which is then converted into a faceted (mesh) geometry, which is ideal for AM, or it can be optimised for conventional mass manufacturing methods. To sum up, Jackson (2019) highlights four key characteristics of GD: it is component focused, goal-driven, constraint bound and executes autonomously.

Generative algorithms in design research

In practice, this means that designers do not define the shape directly anymore, but they collaborate with an algorithm, manage a (non) natural selection process, exert evolutionary pressure, and judge the results. Such judgment can be even shared with the users, as demonstrated with the experimental platform "Endlessforms.com", which allows the evolution of 3D geometries through a web interface which takes crowdsourced user input as an evolutionary force to guide the development of abstract virtual forms (Clune & Lipson, 2011).
Research in design has long used GD tools to achieve extremely complex, biologically inspired shapes through the simulation of biological growth; most notably MIT's Neri Oxman has experimented with the simulation of numerous growth principles (Bader *et al.*, 2016), sometimes integrating it with real biological growth or inventing completely new ways and materials for digital manufacturing (Mogas Soldevila *et al.*, 2015). Also Italian designers have worked with the expressive potential of bio-inspired generative morphologies, such as Alessandro Zomparelli who uses it for fashion accessories.

By now, even renowned design-oriented companies have embraced GD as a valuable design tool: in 2019, Kartell has launched the "A.I." chair, a collaboration between Philippe Starck and Autodesk, which uses GD optimization to achieve a lightweight chair that is also beautiful and coherent with the personal design language of Starck himself. Weight and performance optimization is, in fact, a major driver in the development of product-focused GD. Such optimization is particularly relevant in the field of transportation: vehicles must be safe but as light as possible in order to minimize fuel consumption; therefore, many researches and industrial actors have invested in advanced experimentation. As usual with technology, high-end applications might soon transfer to various fields of the consumer market, therefore it seems timely to examine some of the most advanced experimentations in the field of transportation design.

Applications of Generative Design in transportation design

NASA | Starting from the most ambitious of our GD examples, NASA's Jet Propulsion Lab (JPL) developed a new lander which will be sent to the moons of Jupiter and Saturn for exploring life or signs of it. As with any space exploration mission, minimizing the overall weight of the spacecraft is a critical aspect, which motivated a GD research effort in collaboration with Autodesk. Optimising the lander frame using Fusion 360 GD software allowed a 35% weight reduction with respect to the original design, while the time required to carry out revisions also reduced from initial two-four months to two-four weeks (Mraz, 2018).
In another project named "Artemis", NASA collaborated with Jacobs Engineering to develop the next generation spacesuit – the first major update in the past four decades – for the 2024 moon mission. In the case of the Extravehicular Mobility Unit (xEMU), PTC's Creo GD software allowed some components to become 50% lighter, while the internal lattice structure also enabled constant heat dissipation, thus helping to maintain the temperature inside xEMU (Oberhaus, 2020).

Airbus | In the "A320 Aircraft" a partition is used to separate the airline crew from passengers, as well as to support the structure of the airplane's frame, to which it is attached on 4 locations. GD helped to generate multiple design variants based on the algorithm of slime mold, a single-celled organism by utilising Autodesk's Fusion 360 software. Each variant was carefully analysed and finally, the optimal design was selected as it weighed 45% less; there was an even more dramatic improvement in terms of raw material usage, reduced by 95% thanks to the AM process used to fabricate the partition (so-called buy-to-fly ratio between material bought and material in flight). The same structural principle could be extended from the partition to the entire airplane frame; according to Airbus (2018), adopting GD in their entire product line could save 465.000 tonnes of CO2 emissions annually.

BMW | Shifting to examples on the ground, BMW has developed an alternative experimental frame and swingarm for the "S1000RR Motorcycle" by using Autodesk's Fusion 360 software to render a bionic shape to both structures (Jackson, 2018). While this remains an only concept vehicle so far, it might indicate a shift in motorcycle design, where the frame has been traditionally exposed, visually "advertising" the performance advantages brought by GD. BMW, which has an extensive AM centre, has used GD also in projects aimed at serial production, such as a mounting bracket which is utilised in the retractable roof assembly of the "i8 Roadster" (Putre, 2018).

Buggati | The automobile company has developed the world's first eight-piston monobloc brake caliper with minimum weight and maximum stiffness in collaboration with Laser Zentrum Nord for its "Chiron" model. Weight has been reduced by 40% as it has changed from 4,9 Kg of aluminum to 2,9 Kg of titanium by AM process (Bravo, 2018). With another project they halved the weight of the world's largest hydraulic rear wing control system using Siemens NX GD software for "Chiron Pur Sport" model. The structural components which assist in regulating vehicle aerodynamics are made of SLS sintered titanium, but in this case, the optimal structure is achieved through a combination of different materials, as the connecting rods are made of carbon fiber (Sher, 2018).

Volkswagen | For its "Type 20" concept, VW redesigned multiple parts of its 1962 classic "Transporter" microbus, including the steering wheel, the rear-view mirror mounts, the rims (wheels) and the support structure for the rear bench inside the vehicle (Deplazes, 2019). The GD process (powered by Fusion 360) was used across the vehicle for purposes that clearly go beyond performance and might belong to communication design as much as to engineering: in its current state, GD can be used to create a rhetorical visual language in order to convey and reinforce a company's identity as an innovative enterprise.

Il Gladiatore | With the last of the examples, we report on a direct experience with GD. One of the authors, Sarvpriya Raj, has developed a chassis for a racing motorcycle for his master thesis in Product Design. Here, the initial structure developed was fed into the software along with the parameters like the forces which act on it, the manufacturing process and the material used. Following the principle of topological optimisation, the Functional GD of Dassault Systemes software came up with optimised solutions applying the right amount of material to the areas undergoing deformation and stress, thus reducing the mass by 25%, from 8 to 6 kg. These structures were refined to generate the final structure to be produced by AM process. The other major advantage was part consolidation, e.g. the reduction in the number of parts as a single structure is created instead of multiple parts which join together to form the chassis, thus helping to avoid the problems arising out of limit, fits and tolerance between multiple parts.

Conclusion

The above examples illustrate that GD-driven topology optimization, biomimicry and morphogenesis can help to generate and explore previously inconceivable geometries

that not only improve the product's performance (e.g. weight) but also imply a new visual language. To utilize GD's full potential, ideally, AM should be used which, although still has limitations in terms of production speed and cost, it also helps to minimize raw material usage as well as harmful manufacturing by-products, therefore GD can be viewed as a design practice to help the transition towards a sustainable material culture. To practice GD, the designer needs to start from a comprehensive set of information regarding which are the areas that are critical for the function and performance; which sections of the part are undergoing high stresses and which areas are free of them; what are the values of loads and forces that act on the part; what is the manufacturing process which will be used to manufacture the product.

As 3D forms are generated automatically and the designer becomes a curator of input data and output geometry, design iterations become much faster, thus saving a significant amount of development time. In the future we might expect a further expansion of AI in design, for example in the early conceptual phase: a speculative design video by Foster for Google X hypothesizes an AI that gathers information about individual behaviour to construct a deep understanding about the users in order to help them to achieve their long-term goals of personal growth through generatively designed products (2016). While this might be a longer term vision, already by 2030 we can expect a new niche of Generative Design expert becoming a fairly recognised and widely used professional figure. To do so, however, designers will need to adapt their tools and their skills, not simply with new technical knowledge but also with a more flexible approach, where research and critical reflection become more and more important compared to conventional geometry definition, and the creative act becomes a collaborative endeavor between designer, data, environment, people and algorithms.

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Design Interstitial practices

Design processes and practice represent the basis of theoretical and reflective thinking in its cultural, disciplinary and applied (practical) dimension. The phenomenological approach characterizes every action of Design: through the creation of artefacts (tangible and intangible) and the analysis of the corresponding design process, a new theoretical and critical vision is generated. The current post-industrial context has formed the attitude of Design to overcome barriers between disciplines.
Based on the experience gained in the De_FORMA research, related to the collaboration and contamination between bio-fabrication and *Digital Fabrication* processes, this paper proposes a projective reading of the contribution of Design as a holistic discipline in the redefinition of materialisation and production processes. Thanks to the use of *Digital Fabrication* as an enabler for the construction of ecosystems for the cultivation of *Growing Materials*, we want to explore the possibility of constructing an experimental and flexible production system that enables the integration of formal choices, surface/aesthetic treatments and additional elements, utilizing zero waste processes. The De_FORMA project, of which preliminary research premises and results are presented, is a framework for investigating issues related to the new places of collaborative and interdisciplinary knowledge generation, and to the new possible dimensions that the multi-faceted designer and the project will be able to assume within this recombinatory process. The design activity carried out constitutes that reflective practice that allows to figure out the possible futures for Design Research and Practice.

[digital fabrication, growing materials, reflective practice, constructionist design, learning by doing]

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Constructionist Design

Design, conceived as culture, discipline and profession, has historically been characterised by the adoption of a phenomenological approach: the observation, modification and analysis of reality, design processes and artefacts, in order to gain new knowledge and new meanings (Schön, 1993; Bertola, 2004). Knowledge, therefore, derives from a poetic attitude to design practice: through the creation and study of tangible and intangible artefacts, a new theoretical and critical vision is generated (Floridi, 2020; Bertola, 2004).
The post-industrial context has radically changed the interactions and links between actors involved in the design process, especially between designers and industry, markets, production processes and products (Maffei, 2011). This change has represented an opportunity to modify the general mandate of Design, widening its field of investigation and application exponentially: Design assumes strategic, political and social guidance roles in new domains, and creeps into the interstitial areas of the different disciplines. In an interview-dialogue with Obrist, Maldonado (2010) reinforces this vision of the research and practice typical of Design, arguing that «interdisciplinarity and transdisciplinarity not only respond to an increasingly pressing need for cooperation between disciplines, but are also the expression (and always have been) of an indeclinable universal vocation for knowledge» (p.11 - translated into English by the authors). Precisely because of his generalist nature and training, the designer must strengthen his role as a mediator between cultures and disciplines, assembling and connecting different knowledge –technological, environmental, socio-cultural and political– with that of Design, in order to build a new one (Caccavale & Quinz, 2020).
By now pervasive and characterized by a multiplicity of areas of knowledge, Design can assemble and connect these cultural nodes to create new ones, generate meanings, to define directions and design initiatives (Deserti, 2013). A possible disciplinary contamination is represented by the blending of the design of forms and functions through *Digital Fabrication* (DF), with the ability to design new processes of bio-fabrication of new materials. In this context, the present contribution, starting from the experience gained in an empirical research project, proposes a projective reading of the contribution of Design as a holistic discipline in the redefinition of materialisation and production processes.

Design in the interstices: The Growing Materials

In recent years, there has been a growing interest in bio-fabrication among designers and the academic community, namely the process of producing materials (Camere & Karana, 2017) and complex objects through the growth of living organisms, thanks to the dialogue between the world of Design and that of applied sciences (Antonelli, 2012; Miodownik, 2007). While designers have always been involved in the process of selecting materials (Ashby & Johnson, 2013), today the focus is on the creation of experimental materials (Wilkes *et al.*, 2016; Rognoli *et al.*, 2015).

We are witnessing the emergence of a new field of investigation in which designers can make their own contribution, that of material activism (Ribul & de la Motte, 2016), operating through practice-based research in the development of materials and related production cycles. In such a framework, characterized by a marked experimental nature of *Do It Yourself*, the designer resembles the role of a modern alchemist, able to combine design and material science with know-how, interpreting future needs to generate new materials in which sensory characteristics, imperfections and variations over time are an integral part of the project.
In response to the increasing interest in experimenting on and with such materials, however, there is a lack of the necessary in-depth study to understand their uses, their contribution to economic, social or environmental sustainability, and their scalability in manufacturing processes and applications.
Precisely the practical dimension of Design becomes central in bridging the gap between experimentation and application of the *newborn* materials. In this sense, the anticipated interpretation of future solutions and needs, combined with the ability to manage complexity, typical of designers, make this professional figure strategic for the development of new virtuous synergies in new application fields. The progressive modification of the production processes through the transformation towards digital manufacturing and technological integration, today determines a strong impact on the production systems and therefore also on the design processes, redefining at the same time both the conception and materialisation phases. This also involves a transition of the organizational models and management roles of manufacturing process control systems. Design, intended as culture and practice, is part of the research process that anticipates and feeds the theoretical dimension in the generation of the necessary knowledge and skills, through the study of the activities and actions peculiar to the new profession of the designer.
The research project by De_FORMA is an example of how Design as a discipline and the designer as a professional can play a decisive role in the practice of the future. From the use of DF as an enabler to the construction of ecosystems for the cultivation of *Growing Materials* (GM), derives an observation and reflection on the possibility of building an experimental and flexible production system, to integrate *a priori* formal choices, surface/aesthetic treatments and additional elements. The integration and hybridization of bio-fabricated materials with other materials or other DF technologies and tools, offers an opportunity to reflect on the professional of the future.
Complex ecosystems such as GMs, make it possible to explore production processes and systems to integrate, in a holistic approach oriented towards sustainability, *a priori* application and functional choices of material-technical (resistance to atmospheric and chemical agents), sensory and intangible characteristics, and formal choices (planar or three-dimensional characterization), surface/aesthetic treatments also selectively integrated (surface qualities, textures, chromaticity finishes, olfactory characteristics). While GMs are inherently sustainable as renewable and biodegradable (Camere & Karana, 2018), a further level of experimentation concerns the integration of technological features, meaning circuits, actuator systems (e.g. LED) and sensors (e.g. photoresistors or humidity sensors), that can be used to make materials sensitive, programmable, dynamic (Cochrane *et al.*, 2011; Choi *et al.*, 2018).
This integration generates materials that are not only originally programmed, but can also be reprogrammed during the production process, in order to monitor and convey the variations in growth and use, through the management of integrated technology behaviour. The integration of technologies within GMs opens up to reflections on the compatibility between hardware components and biodynamic materials and on the best production strategies to be used in the growth process of the entire system, in order to achieve perfect coupling with the material, stable functionality during use (e.g. flexibility, robustness, softness, brightness, washability), and subsequently, to encourage the disassembly of components in a sustainable perspective (Morlet, 2017). It is indeed desirable to address this issue in the preliminary design phases, considering the recycle-refurbish-remanufacture cycle, through programmed obsolescence for disassembling.
The innovative character of De_FORMA's research lies in the shift of attention from the simple growth of the crop, to its programming and design, depending on possible applications. By building a material from the beginning, it is possible to modify the traditional manufacturing chain, anticipating needs and constraints, which are currently left to post-production, and enabling new productive and entrepreneurial paradigms. The element of interest in this new approach towards GMs is the choice to use DF's technologies not for the rapid prototyping of artefacts or the direct production of digital products in limited series, but rather for the production of customizable tools that allow the growth of the material itself. DF is used for flexibility, speed and optimisation (Rayna & Striukova, 2016) within an experimental and applicative production scenario.

The reflective practice: assembling and connecting

The chosen approach is typical of experimental research (Bang & Eriksen, 2014), to create a filter for systemic analysis of causal relationships in new ecosystems for GM culture. Among the variables that can be observed, analysed and modified, we can identify the growth of the material, the manufacturing processes, the selection of technology and components, and the consequent ways of integration and interaction within the material itself.
This control and monitoring, repeated iteratively, is supported by the application of techniques and processes typical of the Design practice, such as the conception and realization of tools, aids and prototypes. The following reflective practice plays a crucial role in the development of innovative theoretical content (*research through design* & *research prototyping*).
To formulate replicable standards for the cultivation and growth of GMs and their hybridization with other materials and/or sensors, the experimentation phase focuses on a series of empirical tests to verify the cultivation processes and to define and evaluate possible fields of project application.

The growing process is then oriented through ad hoc systems and tools, realized using DF technologies, to define variables of material and formal characterization, with particular attention to the surface (e.g. texture and flexibility), optical (e.g. transparency and colour), and dimensional (e.g. thickness) qualities, and the related technical profile. Finally, in the experimentation of the culture processes, time is also taken into consideration in order to select the most effective and efficient way, also in consideration of a possible hybridization with other materials and sensors. This methodological approach not only allows to verify the actual feasibility of some intuitions, but also enables new understandings that have not yet been fully explored. The innovation consists precisely in the possibility of conceiving, producing and applying new manufacturing techniques through DF, aimed at shaping biomaterials to zero or reduce waste production as much as possible (Chan, 2017; Rissanen & Mcquillan, 2016).

The situated collaboration

It is important to point out that the practical and experimental dimension, always attributed to Design culture (Schön, 1993), is crucial in verifying application scenarios to be applied to future projections of both materialisation and processes. Places play an elective role in conducting this experimental and knowledge validation process, shared through innovative and integrated processes in GM's prototyping. Makerspace and Fab Lab show a particular tendency to accept this type of activity. More specifically, De_FORMA has been carried out with the instrumental support of some research laboratories of the Department of Design in Politecnico di Milano, in which academic and making culture converge. These spaces embody the vocation of building, sharing and transferring knowledge, ideas, experiences and know-how acquired during collective, interdisciplinary and international research projects. Places populated by technological equipment, but also by passionate people from different disciplines and/or expertise in the same discipline, able to apply their direct knowledge with cultural exchange. In De_FORMA there is a horizontal and synergic collaboration of heterogeneous competences within the same discipline of Design: specialists of self-produced materials and biomaterials, DF experts, operators specialized in the fashion, lighting or healthcare sectors cooperate for the enhancement, integration and development of knowledge, converging on methods, tools, and models.

In this scenario, the design practice should be aimed at a wider integration in the internal –but also external– dynamics of the discipline of Design. The development of complex materials and products involves complex manufacturing processes that are configured through the dialogic exchange between the world of Design, the world of applied sciences, engineering and chemistry (Antonelli, 2012; Miodownik, 2007). In this sense, it is possible to think that in the future there will be an increasing shift from the monodisciplinary focus of Design towards other disciplines, to collaborative openness towards shared and interdisciplinary contents and methodologies.

The dimensions of the designer

From the premises and from the evidence that emerged thanks to the project, it is possible to evaluate potential effects in the paradigm shift of the interdisciplinary and transdisciplinary designer, managing complexity and technique, both in hard and soft skills. In detail, some evidence may emerge for the redefinition of the role and skills of the designer, in a perspective of updating his or her multiform perception in the different professional fields. Design acts as a guide to the entire creative and innovative process, and the designer is no longer seen as the traditional creator of unique meanings, forms, functions, products and artefacts, but assumes new significant roles in the broadest sense of the term design. Within this recombinatory process, some identities of the multiform designer can be traced:

- *Creative and maker* of artefacts or concrete, functional and sustainable applications that concretely introduce material and scientific exploration into people's real lives;
- *Creative and critical generator* of innovative approaches and processes in terms of modification of material practice, experimentation of new design processes and questioning of consolidated production protocols;
- *Facilitator and coordinator* in the systemic design of the biomaterial production, for a better understanding of the processes that manage the experimental complexity and for the application effects in various product contexts;
- *Intradisciplinary and interdisciplinary facilitator*, to establish a fruitful dialogue of understanding and cultural mediation between different sectors and disciplinary domains;
- *Storyteller and disseminator*, able to communicate the design process and the results obtained to an audience ranging from researchers to makers, from experts to the general public, using ad hoc linguistic registers to allow fruition in line with different audiences.

These skills are already recognisable in contemporary designers, but it is also true that these are not the main qualities used to describe the professional profile of the designer. The question that may arise is if there is an exhaustive definition of the possible skills of the professional of the present and future in the short and medium-term. This is not intended to argue that basic training should be called into question, but rather to rework how knowledge and skills are learned, used and experienced. It is hoped that in the future, by breaking down the concept of vertical, passive and imitative reception of information, new pedagogical approaches to knowledge will be implemented to make a paradigm shift possible, in order to elaborate and adopt a new conceptualisation of processes/products.

The next generation of designers will have to be challenged towards new proactive and critical forms of research of information and therefore of knowledge, open to new design and intellectual practices, among disciplines. Designers will have to overcome the limits of their own language and learn new ones; an approach with which nodes of meaning can be read, interpreted and connected, to attribute a new value of meaning. As new possible nodes are inserted or created, bridges are built for the future, all to be invented.

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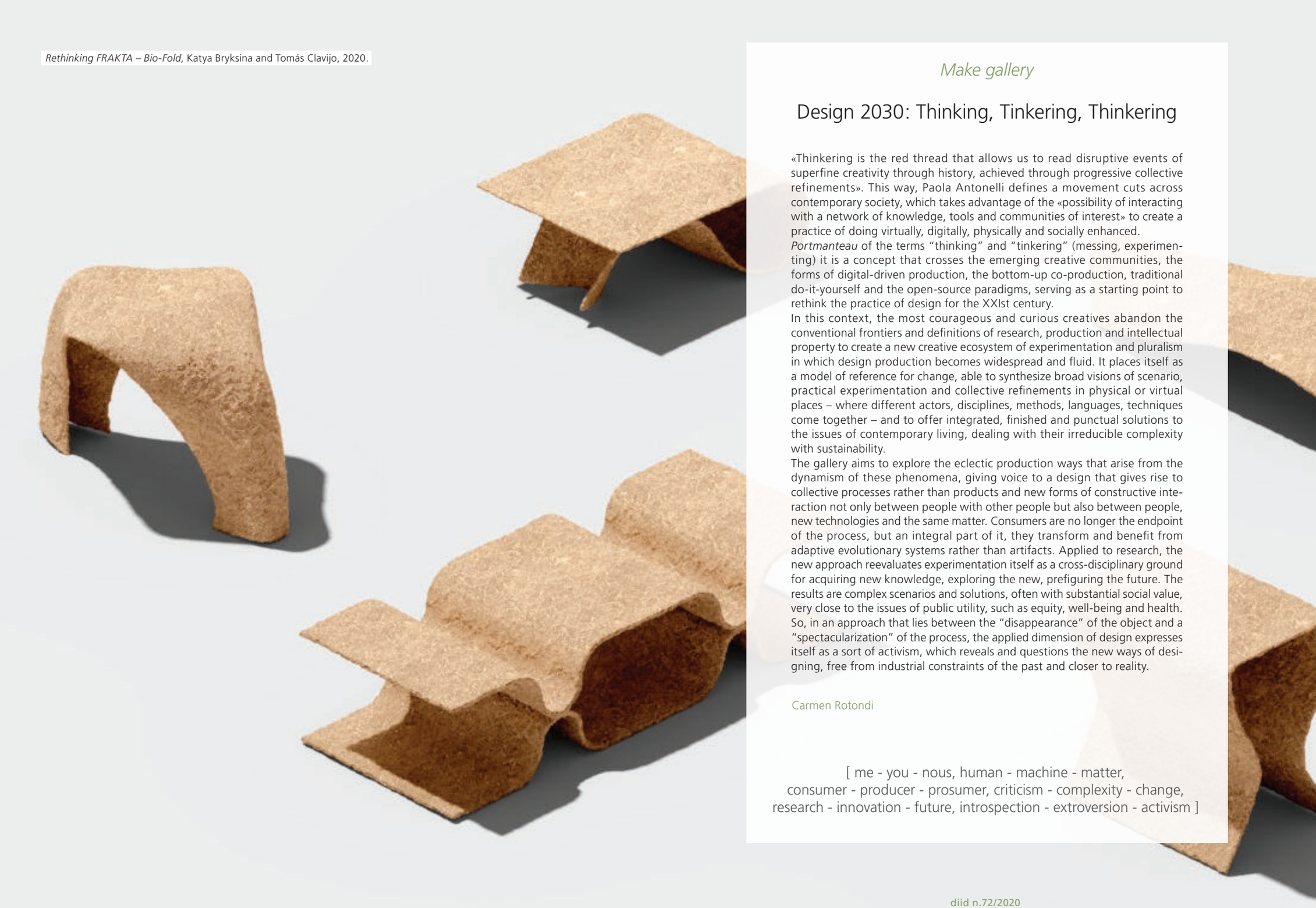

Rethinking FRAKTA – Bio-Fold, Katya Bryksina and Tomás Clavijo, 2020.

Design 2030: Thinking, Tinkering, Thinkering

«Thinkering is the red thread that allows us to read disruptive events of superfine creativity through history, achieved through progressive collective refinements». This way, Paola Antonelli defines a movement cuts across contemporary society, which takes advantage of the «possibility of interacting with a network of knowledge, tools and communities of interest» to create a practice of doing virtually, digitally, physically and socially enhanced.
Portmanteau of the terms "thinking" and "tinkering" (messing, experimenting) it is a concept that crosses the emerging creative communities, the forms of digital-driven production, the bottom-up co-production, traditional do-it-yourself and the open-source paradigms, serving as a starting point to rethink the practice of design for the XXIst century.
In this context, the most courageous and curious creatives abandon the conventional frontiers and definitions of research, production and intellectual property to create a new creative ecosystem of experimentation and pluralism in which design production becomes widespread and fluid. It places itself as a model of reference for change, able to synthesize broad visions of scenario, practical experimentation and collective refinements in physical or virtual places – where different actors, disciplines, methods, languages, techniques come together – and to offer integrated, finished and punctual solutions to the issues of contemporary living, dealing with their irreducible complexity with sustainability.
The gallery aims to explore the eclectic production ways that arise from the dynamism of these phenomena, giving voice to a design that gives rise to collective processes rather than products and new forms of constructive interaction not only between people with other people but also between people, new technologies and the same matter. Consumers are no longer the endpoint of the process, but an integral part of it, they transform and benefit from adaptive evolutionary systems rather than artifacts. Applied to research, the new approach reevaluates experimentation itself as a cross-disciplinary ground for acquiring new knowledge, exploring the new, prefiguring the future. The results are complex scenarios and solutions, often with substantial social value, very close to the issues of public utility, such as equity, well-being and health. So, in an approach that lies between the "disappearance" of the object and a "spectacularization" of the process, the applied dimension of design expresses itself as a sort of activism, which reveals and questions the new ways of designing, free from industrial constraints of the past and closer to reality.

Carmen Rotondi

[me - you - nous, human - machine - matter,
consumer - producer - prosumer, criticism - complexity - change,
research - innovation - future, introspection - extroversion - activism]

01

02

Me, You, Nous

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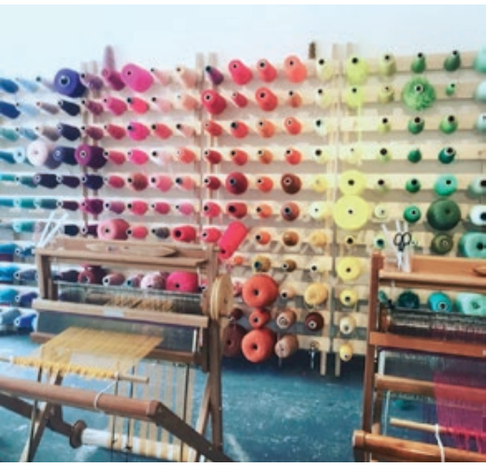
The spread of digital networks and the open-source paradigm shifted the focus of design practice to production processes with a high level of experimentation and pluralism, in which the convergence of knowledge, languages, between producer and consumer, between tradition and innovation, thus as between research and the community, creates creative universes and symbiotic exchange activities able to steer change according to a collective growth logic.



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Dot One, Iona Inglesby, 2015. The project, now a company, aims to convert data from DNA into graphic languages and patterns, then reproduced in hand-made fabrics. The data collected is valuable information for research in genetics, while a legible and tangible language helps the community to understand science and its importance, to feel like an active part of the process, but at the same time to "claim" its own identity, defined from custom patterns.

01 02 DNA analysis starts from a saliva sample, then to each component (ATCG) is assigned a color and a percentage and to each combination of them a graphic pattern.
03 04 The places of production, from the classic workshops with chassis to the scientific laboratory, where some activities are also held to fully involve people.
05 The final products can be scarves, sweaters, bags, rugs, of which the consumer can choose their color combination.

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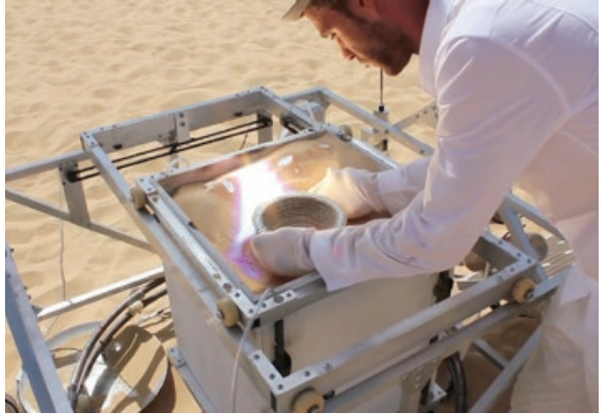

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Human, Machine, Matter
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Changing cultural and technical conditions allow us to interact, exchange information, cooperate, design and produce not only with people but also with other entities, equally responsive, often autonomous and evolving, such as digital technologies and the same matter. The open-source culture that is emerging extends its boundaries to unprecedented collaborations that push designers to explore new channels of contamination and production of ideas.

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01 *Solar Sinter 3D Printer*, Markus Kayser, 2011. A new type of 3D printer designed and created by the designer to sinter the desert sand through sunlight, guided and pointed through Fresnel lenses, and transformed into glass artifacts.
02 *Terraform furniture*, Gavin Keightley, 2019. Furnishing elements whose shape and surface finish are given by the use of sustainable molds, made with food waste combined and reacted, to create new aesthetics and expressiveness.
03 04 *Sketch Furniture*, Front Design, 2005. Taking up the light painting technique, the products are made from sketches freely drawn with light in space, then captured by a camera and transformed into a 3D model for printing.
05 *Terra Cotta*, Talia Mukmel, 2011. Unpredictable organic shapes given by a mixture of sand and flour cooked at high temperatures.

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Consumer, Producer, Prosumer

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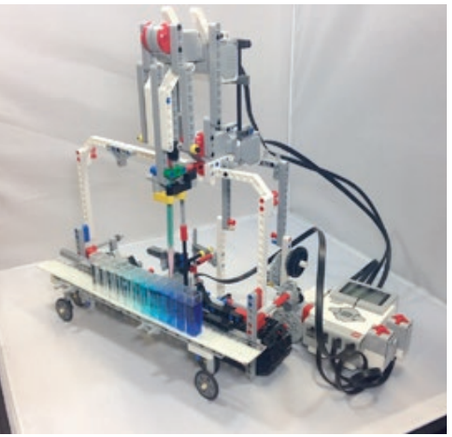
In the past, reaching the consumer with a finished product meant reaching the end of the design process, but today it is the production process that is codified and communicated in the form of instructions to be implemented independently. The consumer becomes an active part of the design and generative process of the artifacts: the products are incompletely received by him, as semi-finished products to be implemented and completed according to free and personalized choices.



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01 *Amateur workshop*, Jerszy Seymour, 2010. Exhibition in which the author put some pieces of wood and a special polycaprolactone wax in front of visitors, stimulating their creativity and leaving the production of the final masterpiece in their hands.
02 *LEGO Liquid Handler,* Stanford University, 2017. DIY robotics kit, to give young students of STEM disciplines the opportunity to create by themselves a tool for automating biological experiments. The structure is entirely made with the famous LEGO bricks.
03 04 *Grow Your Own Couture*, Piero D'angelo, 2018. DIY fashion kit, for making lichen-covered garments, which thanks to their ability to absorb pollutants and metabolize them into less harmful compounds, make the DIY bio-garments simple to make but also useful to protect the wearer from the harmful air around them.

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Criticism, Complexity, Change
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Design becomes a useful tool to deal with critical issues, social, political, cultural and environmental problems; even to assume proactive or activist roles, which pursue their goals thanks to the degrees of freedom given by the network and new technologies. Communicative, demonstrative, cognitive, as well as pragmatic purposes, to provide concrete answers to the management of complexity and make attractive and desirable to all a constructive and regenerative vision of the future.

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Precious Plastic, Dave Hakkens, 2013-now. Open hardware project for plastic recycling. The author has designed several machines that can be made autonomously following the instructions, but also implemented by anyone. Acting through digital networks, Precious Plastic has become a real global community and has stimulated the opening of several laboratories worldwide, where plastic is collected, melted and transformed. The goal is to maximize the recycling of plastic, but also to favor local economies.

01 David Hakkens, Dutch designer, who uses one of his open hardware machines.
02 03 The places of production are widespread, independent but united by the network, towards a common attitude to sustainable change.
04 The possible end products are potentially infinite, in fact the machinery can melt the plastic and transform it in different ways (filament, sheets, shavings, different semi-finished products ...) and each creative reality belonging to the community creates its own projects and sell them online.

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Research, Innovation, Future
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The changes that affect society, the project and the economy are also changing scientific research. The experimental component of design becomes a place of convergence and investigation, in which different figures overcome sectoral boundaries and hybridize towards more complex and fluid permutations. The practice of doing, therefore, becomes a vehicle for new knowledge and a starting point for prefiguring visions of scenario projected to the future.

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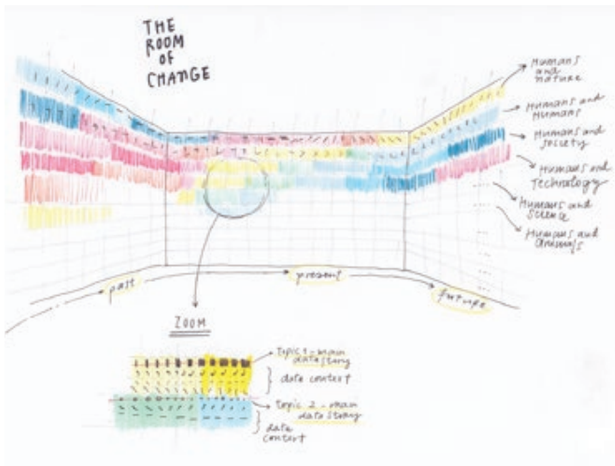

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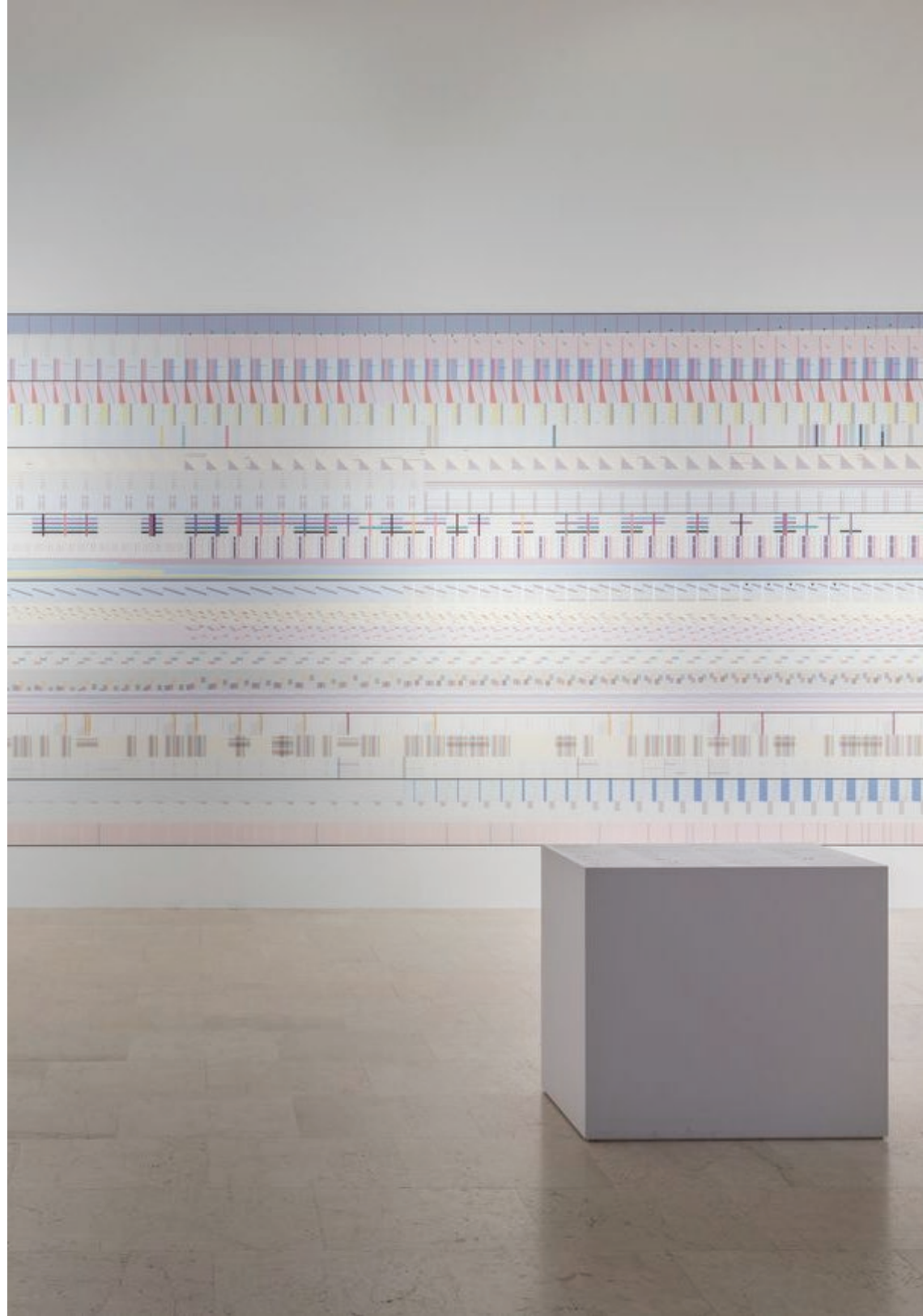
01 02 03 *Symbiosis*, Jelte van Abbema, 2009. In response to the pollution and the vast resources consumption caused by the advertising printing industry, the Dutch designer is experimenting with a way to "grow" letters, thanks to the use of bacteria that produce ink. Their growth is monitored through nutrients to obtain a typeface that changes color and configuration over time until it disappears. For this reason, the author imagines future "living" billboards in which bacteria will grow and create messages.
04 05 *The room of change*, Giorgia Lupi, XXII Triennale di Milano, 2019. From Big Data to a large infographic that shows how multiple aspects of our environment have changed in the past, are changing now and will change in the future. By combining different sources and disciplines, the project intends to describe the world both from a global perspective and from a local and individual point of view, stratifying dense and granular information that highlights how widespread the changes are at every scale.



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Introspection, Extroversion, Activism

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Innovation overcomes the simple dualities of the past of form-function, objectives-means, needs-desires, but it is the result of a multidimensional research process, made up of phases and interactions, of models, ideas, visions and "productive messes", trial and error; of a series of relationships through which design reveals and questions the new ways of the project. Introspection and openness towards the outside combine themselves for a sort of collective redefinition of the discipline and its role.

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01 *Design Museum Dharavi*, Jorge Mañes Rubio & Amanda Pinatih, 2016. Traveling showcase that exhibits the intensely creative and craft tradition of Dharavi, a crowded and lively district of Mumbai. Used as a tool to promote local change, the project highlights the ability of the locals to adapt and reinvent themselves daily.
02 03 *Breathing Colour*, Hella Jongerius, London Design Museum 2017. Exhibition where phenomenological studies, practical experiences, design stories and ideas behind the most important works of the designer on color are shown.
04 *Everything but the end product*, Design Academy Eindhoven, 2016. During Milan Design Week, a group of graduates from the Eindhoven Academy wanted to exhibit only semi-finished products deriving from their research and experimentation on materials, in response to the vast amount of products on display.

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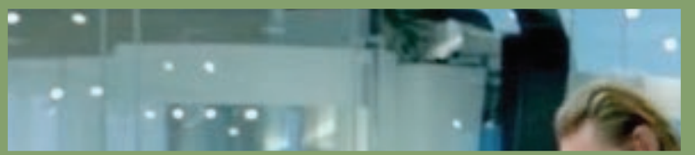

Focus

Focus gallery > p.162/p.173

AI, Design Fiction, and Critical Thinking

Disruptive Technologies are changing the way people behave, act, interact and think; they have extended the capabilities of human by substituting and enhancing activities and daily tasks. Artificial Intelligence (AI) in particular, can easily mimic human intelligence and execute different tasks, from the simplest to those that are even more complex (e.g. voice recognition, answering, delivering, translating etc.).
AI is then becoming a growing matter not only in computer science but also within the Design community, in particular Interaction Design. Social and technological transformations and various cultural and ethical factors are becoming very important elements to consider when it comes to the use of AI. Critical Design practices and theories, such as Design Fiction, offer principles able to trigger critical thinking and help in understanding the possibilities, limitations, constraints, and application of such a technology, with the purpose to design more consciously technological artefacts and their interactions with the users. In this regard, the article proposes to exploit Design Fiction principles such as diegetic prototypes and "What if?" scenarios to approach critically the reality as a field of possible actions and for envisioning and prototyping not-yet-existing interactive technological artefacts and systems based on AI. Design Fiction allows us to explore, contextualize, and socialize technological artefacts through critical introspection to propose new interaction rituals and forms that embed ethical and societal values. The authors suggest the use of design fiction principles through a protocol designed to help the construction of a future scenario through which we can investigate the possible implications and concern of AI on several levels, with a purpose to rethink the needs of the real-world. Finally, the authors discuss on the new critical approaches for designing technological artefacts using AI and further development.

[artificial intelligence, design fiction, critical thinking, technological artefacts]

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Introduction

Artificial Intelligence (AI) has been changing the way we live and experience the surrounded enabling new products, services and interfaces' development; this, cannot just lie in their technological development but also in the meaningful use of it for the final user: as researchers and practitioners in design field we need a shift from an instrument-oriented view of the technology towards a broader view that includes aspects like aesthetics, acceptance and ethics (Winograd, 2006).

AI is giving life to unexpected scenarios and possibilities; for instance, by continuously learning from user and environmental data, new digital products, services and interfaces will grow and evolve on their own.

AI's spreading is creating a controversial debate. Is AI a friend or foe to people works and activities?

If from one side, we witness a dystopian vision according to which AI will completely replace human tasks and activities, from another side we can affirm that AI likewise any other technologies has to be considered an extension of human capabilities, an augmentation of our skills and abilities.

In this regard, which approach should we take on as researchers and practitioners while shaping AI in new products, services and interfaces in consciously way? In an era where human being is pervaded by applications, software full of (our) data and able to overtake human brain and capabilities how should we deal with the social and ethical aspects?

Based on formal algorithmic rules, once the AI paradigms were focusing mainly on the function and benefits of the technologies. Now we need to consider new applications and human factors (Winograd, 2006; Wong & Flow, 2018).

In particular Interaction Design, that is taking care of the experiences and the interaction rituals between the human and the machine, has an important role in these processes (Winograd, 2006). Designing with AI is becoming a complex assignment for designers because it involves a wide system embracing human beings in relation to technologies, complex socio-technical systems and requires a heterogeneous approach (Ballard, Chappell & Kennedy, 2019).

Thinking like a human is «a complex developmental interaction between the whole organism and its environment, including other people» (Winograd, 2006). We tend to attribute always more the human characteristics to the AI systems and products. They have a gender, name, voice, and these forms of artificial lives (i.e. Alexa or Giboo) are embedded in numerous products and interfaces, from the on-screen interfaces to more complex artefacts. The relationship between the user and these systems relies on the trustworthy, engagement, aesthetics, and it's shaped by ethical, political, economic, and societal values.

The authors suggest that the critical design practices and theories, offer principles able to trigger critical thinking and help in understanding the possibilities, limitations, constraints, and application of AI technologies, with a purpose to design more consciously technological artefacts. The focus is on Design Fiction that enables us

to use the future as a medium for speculation about what could be and accordingly approach critically the reality as a field of possible actions (Dunne & Raby, 2013; Bleeker, 2009). Design fiction principles, such as diegetic prototypes and "What if?" scenarios can be used for investigating the potential future applications and implications of AI, but also new physical forms, experiences and interaction rituals.
Here and after, authors introduce AI uses and applications, how critical design thinking can be implemented in design research and practice to help to design more consciously the technological artefacts with AI by using a protocol developed by the authors themselves, introduce insights and reflections on the use of design fiction principles and provide further developments.

Why the need to design consciously for and with AI?

The early explorations of AI, learning machines and automatization begun in '50s (Simon, 1995). As the understanding of how to apply behavioural models (psychology), and how to enhance computers (technology and engineering) grown, also the number of applications of AI increased. Biometric recognition, Natural Language Processing, Machine Learning, Emotional AI, Deep learning and different applications of robotics and smart tools, disease mapping, health management, virtual assistants, etc. The current development of AI is always digging more into ubiquitous AI (home, games, driver assistance, etc.). In the home environment we are familiar with products such as learning thermostats (i.e. Nest) that take control of our home concerning our habits. Then several conversational assistants like Amazon Echo, Google Home (Alexa), Siri, etc. Other kinds of AI are represented through images and interfaces (i.e. IBM Watson, Emotion API, Microsoft Cognitive Services, Amazon Lex, etc.). Being they tangible or intangible, through AI artefacts we try to resemble the human-like intelligence, assign particular roles and duties, or generally scripts to the technologies.
Artificial entities with AI «embody trade-offs and compromises […] they embody social, political, psychological, economic, and professional commitments, skills, prejudices, possibilities, and constraints» (Bijker & Law, 1992).
The authors are interested to examine AI through the humanistic lens, and phenomenological dimension concerning the interaction and experiential rituals.
The massive spreading of AI-based systems is indeed drawing a big attention on the experiential stance and design-oriented approaches and methods, with a purpose to improve the interaction between the human and AI, and to understand all the limitations and possibilities offered by AI technology (Wong & Flow, 2018).
Since the AI systems are «being perceived as autonomous agents and team-mates, an important focus of research and development is understanding the ethical impact of these systems» (Dignum, 2018).
The authors want to understand how it is possible to trigger critical thinking related to the ethical and societal implications of technological artefacts containing AI and as a consequence improve the human-technology relations.

The artefacts embed prescriptions and values, as Latour (1992) explains: «We have been able to delegate to nonhumans not only force as we have known it for centuries but also values, duties, and ethics» (Verbeek, 2006).
The more AI systems gain the responsibility for their actions, also different risks, and the demand for designing consciously technological artefacts increases.
The authors suggest the use of critical design practices and theories, such as design fiction, for designing more consciously the technological artefacts with AI. The meaning of design fiction and critical thinking, their methods and approaches and their potentialities when designing with AI in a conscious way will be presented and discussed.

Design fiction: design consciously through critical thinking

The pervasive development of AI is posing several reflections to the design communities such as deliver consciously designed artefacts, answering some essential concepts and criteria related to societal and ethical issues (Simon, 1995; Wong, 2018). Designing consciously means to analyse the products on several levels: its physical properties (i.e. sustainability), how the product as an artificial entity influences our relationship to the world and to the product itself. Feenberg (1999), in his critique on technology proposes to examine the technological systems at several levels: «A primary level at which natural objects and people are decontextualized to identify affordances, complemented by a secondary level of recontextualization in natural, technical and social environments.»
Recently, we are testimony of the new forms of (critical) design such as design fiction. Design fiction principles like diegetic prototypes and What if? scenarios, are considered powerful tools to trigger critical thinking when it comes to design of technological artefacts. Design fiction as a future-oriented practice permits us to use the future space as a «medium to aid imaginative thought-to speculate with […] about today as well, and this is where they become critique» (Dunne & Raby, 2013).
Design fiction discipline coined by Bruce Sterling, uses a typical tool of Science Fiction (SCI-FI) such as diegetic prototype with a purpose to suspend disbelief about the change (Tanenbaum, 2014; Lindley, 2015). Diegetic prototypes are performative artefacts representing the not-yet-existing technologies in SCI-FI films, but they inspire also real-life innovations. One of the most remarkable examples and the most cited in design fiction literature is "Minority Report" directed by Steven Spielberg in 1999, rich in technological proposals for the future such as biometric recognition, personalized ads, gestural interaction modalities, smart wearables, driverless cars, and other. These objects are narrating the social, political and economic structures of the fictional worlds (Kirby, 2010). The combination of storytelling and prototyping is the basic rule on which is to build the design fiction (Bleeker, 2010).
Through What if? scenarios designer imagines an alternative world and creates and contextualize the diegetic prototype as a protagonist of that word. Diegetic prototype builds the relationships between the human and the technology, human and society. These are the «artefacts brought back from those worlds to be examined, studied

over» (Bleeker, 2010). All these elements help designer encourage the new ideas and envision, raise questions that concern wider publics and actors, but also reflect on the real world as a space for possible action.
The authors suggest the use of design fiction principles to explore the field of AI on different levels through the possible applications, forms, and interactions. We believe that design fiction can help designers analyse from the critical point of view the technologies but also open a new space for discussion.

Design fiction for AI: insights and reflections

There is an increased interest in critical design practices and speculative proposals for AI. The interest in introducing more humanistic approaches is evident as the AI becomes more autonomous: «Responsible Artificial Intelligence is about human responsibility for the development of intelligent systems along with fundamental human principles and values, to ensure human flourishing and wellbeing in a sustainable world» (Dignum, 2018).
The authors bring some insights and reflections about how design fiction can help design practitioners and researchers deal with AI through critical thinking to design the interactions and experiences considering the ethical and social implications and values. Developing the future oriented What if? scenarios and diegetic prototypes can be a strategy for approaching the design of technological artefacts with AI, but also identifying new applications for this technology. Indeed, the construction of the What if? scenarios as representations of the fictional world has to be done on the conscious level in order to enable the critical thinking. In SCI-FI films we can recognize the historical and political structures, founded on social and ethical values. These elements are expressed through the storytelling and diegetic prototypes. With design fiction, we narrate the world and its complex structure through the What if? scenarios, and we produce the diegetic prototypes that prove their existence in a world, to help us bond the fiction to the present. Through the design fiction principles, we use the future as a space for critical inquiry and contextualize the elements of this future in the present to explore the fields of possible actions.
There is a necessity to operationalize the design fiction to have a more control over the design process and use the future not only for the creative exploration.
Based on this ground and exploiting the literature in this regard, the authors set a protocol for exploring the new approaches when designing technological artefacts encompassing AI: it can help designers in construction of the future world where we can question the AI, in order to explore its new interactions, experiences, aesthetics and applications.
The authors connect the societal challenges (i.e. environmental sustainability, health and wellbeing, safety of citizens), agents (individual, collective and moral), and the role of technology in regard. Through societal challenges we can explore design opportunities. Artefacts are the mediators between the human and the environment, and these influence the society both directly and indirectly technological artefacts, as material objects designed by humans, impact the environment (directly), but also, these shape human actions, and in this way the impact results from human behaviour (indirectly). To define the agency means to analyse the human, collective actions, impacts and influences, moral judgments, but also conflicts that prevent us act in one way or another. Defining the role of technology -in this case AI-means to analyse the impact of technology on different levels, through its affordances, natural, social and technical environments (Feenberg, 1999).
The protocol is then framed into four main blocks: 1) analyse a societal issue; 2) define di agency; 3) understand the best strategy to trigger critical thinking; 4) design the near future scenario by describing the role of technology.
The different factions within the protocol are supported by three main tools: (1) Technology Inspiration Cards (TICs) an envisioning tool developed by the authors that use the SCI-FI genre to show how the technologies and society influence one another; (2) Design with Intent Tool (DwI), strategies for designing intentionally the products and services able to tackle ethical and conscious behaviours (Lockton, 2010); (3) Functional Triad (Fogg, 2003), to describing the role of technology on three levels, technology as mediator, tool, and social actor.
Authors are developing fit on purpose Tech inspiration cards (TICs) as a collection of SCI-FI films, showing the diegetic prototypes representing the not-yet-existing applications and use of AI. For the moment it counts 30 cards, with the plot and a list of the fictional technologies as so their references in the real world. With TICs we can explore how in the SCI-FI films are contextualizing the technologies respect to the social and political historical structures, but also the public opinion about the future.

Discussion and further development

Designing with and for technologies requires particular attention when it comes to ethical and societal questions. The role of a designer in collective social and technological experiments is becoming more relevant. Designers, through their thinking and acting, can create and visualize the possible futures. Critical design practices, such as design fiction and speculative design can help in dealing more easily with the new design challenges and technologies, as Tanenbaum (2014) explains: «Positioning an imagined technology within a narrative world requires a designer to think beyond the immediate implications of that technology and consider it within a broader social and cultural ecosystem.»
Starting from the critical design practices and in-depth description of design fiction and its principles, the authors observe the current development, applications and concerns related to the AI technologies and, suggest how can we practically use design fiction (What if? scenarios and diegetic prototypes) to design the technological artefacts with AI.
There is a need to provide more human-centred AI, that take care when it comes to interaction and experience, and to design the trustworthy AI artefacts able to take care of their users there is a need to approach critically as also recommended by the Euro-

pean Commission that developed “Ethic guidelines for trustworthy AI”. According to these guidelines indeed, we need to «develop, deploy and use AI systems in a way that adheres to the ethical principles of respect for human autonomy, prevention of harm, fairness and explicability.»

Since very often we are guided by a disbelief about the future of AI and its impact on humanity and society, as scholars and practitioners in the design field, we can acknowledge the use of design fiction to suspend this disbelief and instead analyse critically what the impacts of technology could be and understand how this can be managed through conscious/ethic/trustworthy design of technological artefacts AI-based.

The authors propose the use of the protocol that can help us build the future worlds and at the same time help us relate the fiction to the reality.

The further development of our inquiry will focus on testing this kind of approach in design sessions with practitioners and researchers and testing of diegetic prototypes with the potential end users to understand the impact of the technological artefacts designed in this way on the users’ perception related to the interaction rituals and experiences.

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Designer Pollinator: a case study

Being aware of direct aftereffects of human activities on the entire ecosystem is one of the main phenomena characterising modern times. Research is looking for methodologies and frameworks that, in parallel with many other themes, could enable industrial companies towards a radical shift in current production systems assets and resources management techniques. However, industrial companies usually show huge recalcitrance in adopting innovations, preferring already known procedures. Designers, instead, are intrinsically familiar with iterative way of working and they naturally look for promoting innovation, taking inspiration by emerging of different kind of novelties. Therefore, designer could represent a key-figure in the transitional process towards new economies adoption. In this article, authors propose a case study where, through design typical tools, the workflow of an existing industrial company has been mapped in order to promoting new working assets. Material selection process has been the reference activity for the entire analysis: being a key decisional process in product design, it allowed researchers to enlighten possible interferences between several departments. The interconnection and overlapping of several processes into the company defines a very intricate environment in which a single variation in the workflow can have consequences over the whole system. It follows that it is fundamental to identify specific moment to introduce novelties without compromising the industrial system equilibrium. Authors here propose a vision where the designer, thanks to the adductive way of thinking, competencies as facilitator and the ability of synthesising complex systems into visual outputs, can be receptor and promoter of potentially radical innovations at a systemic level into industrial companies.

[case study, designer pollinator,
transition management, sustainable development]

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Introduction

The birth of design as a discipline is usually located in industrial revolution age (Vitta, 2001). In early '900, the concept of "design" was generally associated with "design of everyday objects" (Pevsner, 1936); between first and second post-war period, design was defined as "synthesis" of scientific and technological progresses into real products. Nowadays, instead, design has not an unique definition: it is a discipline showing several shades of meaning, so that in last years design methodologies have been integrated in decisional and innovation management processes.

Today it is difficult to uniquely define design, probably because of the changeability with whom, the discipline itself evolves in parallel with its cultural context. In a recent article, professor Kees Dorst (2019) enlightens how design evolved from artisanal practice to academic discipline, by continuously reinventing itself. This phenomenon is easily seen in the birth of several sub-disciplines very different in object of interest (from product to communication, from services to UX experiences, from management to systems (Koskinen & Dorst, 2015)), but all contributing to the making of design discipline.

Constantly contemporary nature of design makes its "definition" elusive and difficult to express in a unique way: "trapping" design in a well established axiom could affect directly the design changeability dimension.

Being expression and synthesis not only of technological advancement but of most important cultural changes of each epoch, design is constantly evolving, so to preview possible future evolution of this discipline it is important to analyse the current context in which design is operating.

Context: the Anthropocene

What actually characterises our contemporaneity is the concept of the Anthropocene (Crutzen & Stoermer, 2000). Being aware on how human activity has significantly altered the planetary equilibrium is bringing attention upon a profound reflection on the human positioning in the whole Natural ecosystem.

It follows, that a review of current reasoning paths is nowadays mandatory to promote new ways of thinking and acting, in order to change human behaviour in radical way. This theme guided several contemporary sociologists, anthropologists and philosophers towards the debate on how to overcome the "white-man-western-centric" reasoning (Morton,2016; Braidotti, 2013; Latour, 2017).

From a socio-economical point of view, several economical models have been theorized to guide production processes towards new, sustainable practices: neglecting the pure run for richness, those new economic approaches focus on creating autopoietic systems endeavors. This is the case of economic models such as the "Green Economy", "Blue Economy (Pauli, 2010) and the most recent "Circular Economy" model (Ellen MacArthur Foundation, 2015).

Those models all adopt a systemic vision, with (at least on theory) missions oriented towards a sustainable future for both humans and Earth in its totality.

It follows that also design and the role of the designer in this context needs to be reviewed. Looking at the histroy of design for enviromental sustainability (Ceschin & Gaziulusoy, 2016) we can notice that initially this discipline was pretty much focused on the product, while nowadays its dimension is comparable to systemic and managerial disciplines and the designer himself is seen as a true innovator in both industrial and social contexts (Valtonen, 2005).
This concept is also adopted by most recent design disciplines, as Design for Transition (Irwin, 2015; Irwin, Kossoff, Tonkinwise, & Scupelli, 2015), where the designer is seen as promoter of radical changes, maintaining a holistic and systemic perspective.

Designer's role

Based on previous preface, it is easy to imagine the future of designer as a professional assuming complex and tangled roles, where a creative approach is essential. Thanks to his own training, affected by iterative mode of working, contemporary designer is able to reason in divergent, flexible ways (Minder & Heidemann Lassen, 2018).
Into academic contexts, it is well shared the opinion that younger designers feel the necessity to cooperate with experts from very different disciplines, asking for multidisciplinary, cooperative environment (Bowen, Durrant, Nissen, Bowers, & Wright, 2016; Camere & Karana, 2018).
In industrial companies environment, where multidisciplinary and complex relationships are typical, designer could play a key role for being catalyst and promoter of new working models, being a key figure for managing information between company's departments.
The creative approach to problem definition and solution finding, if transferred from ideation process to a logistical one, could enable substantial changes at organizational working level that can be easily understood from every member of the same company.
The designer could be the perfect manager for radical changes, thanks to the creative approach to problem solving activities; adductive reasoning (Kolko, 2010); problem-framing ability (Dorst, 2011) and ability to share information that can also be used by users with different backgrounds (eg maps, graphic visualizations) (Jones & Bowes, 2017).

Case study

To verify if designer, towards the use of their own methods and practices could promote radical changes at a systemic level in industrial contexts and ease the transition towards more sustainable production processes, authors will describe an experience carried on into an existing company.
The main objective of the presented work was to understand if typical designer tools could ease the transition towards new product development processes, and if those tools could implement cooperation between professionals with different background. For doing this, material selection process has been chosen as the main topic of observation.
At the beginning, material selection was pretty much managed by technicians because materials were strictly linked with "function" (Cornish, 1987), but during the years materials assumed a central role in product design process. Several attributes have been conferred to materials (Ashby & Johnson, 2007): from communication interface with the user (Del Curto, Fiorani, & Passaro, 2010) to core elements in contributing at aesthetic (Wilkes *et al*., 2014), sensorial (Karana, Hekkert, & Kandachar, 2009), intangible (Van Kesteren, Stappers, & de Bruijn, 2007) and ethical (Bahrudin, Aurisicchio, & Baxter, 2017) characterization of the final product.
In an organic and systemic context as the industrial one, the material selection task, as well as other tasks (O' Connor, 2001; Prendeville, O'Connor, & Palmer, 2014) is affected by specific product requirements but also by organizational and managerial needs. Therefore, even a process as the one of material selection becomes a multidisciplinary task, involving several professional figures. In this case study authors propose a methodology for identifying a scenario where material selection is no more a single-person-referring task but it becomes a cooperative one, thanks to design proper tools.
In the proposed work, authors also analyzed the figure of designer as central role in transitional processes towards production processes more oriented to sustainable development objectives.

Methodology

Through the collaboration with Faber S.p.A. company, authors have enlightened information flux concerning material selection task, across the whole ideation and production process of a new product. To define a clear picture of how material selection is currently approached by the company, a mixed method approach has been applied to the research.

Phenomenological research: Observations and Non-Structured interviews

In order to identify precise workflow and how material selection task is embedded in it, was necessary to start an in-depth analysis of the industrial context.
A qualitative analysis of the research partner company Faber S.p.A has been prepared in the form of observations and non-structured interviews, to figure out how material selection is currently managed by the employees.
Being physically into the company allowed researchers to collect information through observations and unstructured interviews. People asked to describe the material selection process into the company were experts in different domains (marketing, R&D, industrialization and supply chain), selected among others for their strategic role into the company in order to investigate the net of relationships between departments.

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Quantitative research: surveys

To give a precise quantity to what emerged by the observations, a survey with precise questions has been submitted to the company. In this case, data collected by qualitative research have been quantified, systematized and synthesized also at quantitative level. With 30 responses by employees with minimum 5 years experience into the company it has been possible to identify who actually is in charge to research and promote the introduction of new materials into the production process, why and how often this activity is carried on. With this methodology, it has been possible to verify not only that material selection is actually a multidisciplinary task but also to measure some levels of recalcitrance to innovation in complex systems as companies (Berna-Martinez & Macia-Perez, 2012).

Data triangulation

Data triangulation is a methodological approach (Given, 2008) that helps in correlating data collected with different methodologies (e.g. qualitative and quantitative data). From data collected as previously mentioned, triangulation enlightened three main research topics:

- In referring industrial context it is necessary to understand better how the material selection should be managed by different departments;
- It is necessary to understand how information of different nature should be shared into multidisciplinary workflow;
- It could be necessary to intervene with new data collection and new modalities for sharing information between departments.

Participatory action research

"Participatory action research is […] a methodology that attempts to break down power relationships between the researcher and the researched by letting the stakeholders define the problem and work toward solutions (Given, 2008)".

The focus of this methodology is to conduct esearch by, for and with the people who will take benefits for the research output itself (Bilandzic & Venable, 2011; Jones, 2018). It is a methodology flexible uniquely suited to researching and supporting change (Given, 2008).

In this perspective, a workshop into the referring company has been planned and researchers have been able to depict properly the internal workflow in collaboration with employees. The activity aim was to identify specific moments in the workflow where, through direct collaboration between departments, professionals were enabled to empower their communication and information transfer. In the same way, it has been possible to find specific moments in which the research on innovative materials could be introduced in the working routine.

To manage those activities in a strict time span (one day workshop) it has been fundamental to deploy proper design tools such as:

- extensive maps;
- Data visualizations;
- User data-sheet;
- Online material libraries;
- Sharing platforms.

Those tools were essential to carry the workshop and to promote co-operation through colleagues and are very flexible to an easy updating activity, indulging company's needs.

Results

As mentioned previously, designer is a professional figure strongly dependent from its context of operation continuously evolving. The multifaceted nature of designers is extremely receptive and allows professionals to bring new values in several contexts, promoting new collaborative activities even between different experts thanks to its own tools (Bowen *et al*., 2016).

Moreover, operating in contexts always more complex and interconnected, to be strongly influenced by contemporaneity allows designer to visualize entangled problems even at a systemic level (Jones, 2014).

In the same way of pollinators, designers can take nourishment from the environment and, through several methodologies and tools, bring them into professional context in a sharable language. In this way, designers are able to promote collaborative activities oriented to adopting innovations at different levels, becoming pioneer of innovative changes even for work methodologies.

To confirm this hypothesis, thanks to the experience in the industrial company, depending on the modalities and timing presented in this paper, authors can affirm that:

- visualization tools properly designed can stimulate discussion and debate through several professionals, generating healthy comparison moments and enabling exchange of information between different departments, focusing on employees needs and their work-modality;
- through mapping and cooperative tasks, it is possible to enlighten neural points in the workflow in which innovative practices could be slowly integrated, as a starting point for change even in recalcitrant environments;
- collective moments are highly receptive to implement research activities in the workflow: to plan cooperative activities finalized to promote research and to reflect upon integration of innovative materials as well as working modalities, could ease the transitional process to a more sustainable production.

In this context, the designer contribution is essential due to:

- the ability of synthesizing and visualizing information through graphical artworks allows all the employees to have a common ground as starting point for a change;
- the natural mutability of design practice implicitly influences designers in their "need to be constantly updated", so innovation promoted by designers will always be up-to-dated;

- designer's attitude to be a facilitator in multidisciplinary contexts is a plus for easing transitional processes towards new work modalities.

The presented methodology is the result of a year-long research and new counter-proofs are needed for its validation. Authors suppose that through cyclical investigations and mapping activities it could be possible to monitor and to identify neural points of intervention for promoting or integrating new practices in the workflow, looking for a transition towards fast-refreshing work modalities. The hypothesis is that, even for complex and entangled contexts, designer could promote an agile adaptation to incoming necessities, as the current one that is demanding a fast conversion of industries towards more sustainable production. In this process, designer could play a central role.

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Design Practice for Transformation

In the context of ongoing technological, economic and social evolution, digital transformation is an increasingly necessary phenomenon in today's business landscape. This phenomenon has undergone further spread following the outbreak of the Coronavirus pandemic.
Far from a vision of digital transformation as the mere implementation of digital and new technologies in business, it is assumed that this represents a company's ability to modify its structure to design transformation. In the light of these reflections, what role does design play in this context? How can design practice drive this transformation?
The paper aims to contribute to current thinking on the role of design in the evolution of processes that can become human-driven, starting from our experience of collaboration with companies.
To do this, the first part of the article aims to define the role and integration of disciplines, such as Design and Management, in the development of the design-oriented digital and cultural transformation of a company.
The second part is dedicated to a description of two case studies in which design-driven processes (co-design and open innovation) have been used to drive innovation at the leadership and the business levels, and an educational experience relating to the topic of integrating new skills and profiles as the emerging needs expressed by companies.
The main goal of this paper is to define how the design practice represents an essential asset in the development of digital and cultural transformation within companies, and the skills of this new type of consultant, whom we will call the "designer for transformation".

[digital transformation, design practice, design for transformation, design attitude, design leadership]

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Introduction

Digital transformation, one of the more prominent phenomena in the business landscape, has undergone a further push towards implementation following the spread of the Coronavirus pandemic, an event that has accelerated companies' need to choose and standardise their tools and procedures for supporting remote work.
During the lockdown, at the beginning of April, a provocative illustration was published on "businessillustrator.com": «Who led the digital transformation of your company?» The image gives the readers three possible answers: Chief Executive Officer (CEO), Chief Technology Officer (CTO) and COVID-19. This sharply ironic image is able to synthesize some of the main actors of digital transformation processes, focusing on the relationship between the CEO, CTO and exogenous factors (such as COVID-19). The illustration highlights a key concept: it is important to start from the company's needs when talking about transformation. This is a process that requires the identification of the expectations of the people who are part of the organization, an analysis of the market and the subsequent alignment of these factors with the strategic aims of the company, without forgetting its vision and values.
According to this argument, the need for a receptive figure inside the company emerges. This person should be capable of understanding the "tension towards change", and able: 1) to promote, design and initiate a transformative process in response to one or more needs emerging during the listening phase; and 2) to predict the final result, communicating and explaining the need for transformation to those who are part of the company structure.
Under this scenario, digital transformation is no longer simply the implementation of digital and new technologies within business realities, but represents the company's ability to change its structure in designing the transformation. This is the most important characteristic of the new sponsor of transformation, and it is connected to the capability of the manager and their team to share a systemic vision. In the light of these premises, what role does design play in this context? How can design practice drive transformation?

Design to support transformation

Historically, digital transformation has been considered an issue related to the technological development of an organization (Capgemini Consulting, 2011), and as such, delegated to the person in charge of technology management: the head of Information Technology (IT), today known as the CTO. Although acceptable in the past, this has often created situations in which digital transformation has been the same as the introduction of a new enabling technology.
This procedure has an obvious limit: top-down implementation of technology has often negative consequences on those that will have to use it. If we do not begin by listening to human needs, including non-technological needs (Bloomberg, 2018; Rogers, 2016), and we do not take an approach involving participatory adoption (e.g.

through co-design processes), the risk is that the technology itself will be misused, negating the investment in time, money and human capital.
For this reason, we have developed a method and a set of tools ("ST.EX Chart", "ID. PO Chart" and "DS Matrix") based on a needs analysis using a design approach: 1) the need for a renewed identity; 2) the need for a new position; 3) the need for a new offer; and 4) the need to structure a new organization (Ronchi & Ciancia, 2019).
This method can be used to prepare for a process of organic change in a social organization, and it is designed to ensure the fluidity and interoperability of business functions. Moreover, it avoids the idea that the individual sponsor, through their individual budget, can push the transformation without the systemic vision necessary for an effective and efficient result in line with the corporate culture. A systemic vision combined with a human-driven approach and a business results orientation indicates design as the preferred discipline for those in charge of designing transformation. Since the early 1970s, design has been identified as a problem-solving discipline (Eames, 1972) with a technical approach. However, it is design research that entrusts design with strategic and programmatic action (Brown, 2009; Martin, 2009; Verganti, 2009; Zurlo, 2010) and the creation of meaning (Manzini, 2015). In light of this evolution, people have begun to recognise the key role of design research in decision-making processes, such as business and management. The relationship between supply and demand, favoured by the bottom-up diffusion of digitalisation in the Business-to-Consumer (B2C) market, has changed, and design is able to combine the aforementioned capabilities with: 1) digital listening to market trends, and the active audiences' needs and their relationships with brands; 2) the orientation of multidisciplinary teams in the translation of needs into insights useful for company transformation. Therefore, design is becoming a differentiating element for organizations seeking change processes consistent with their public, rather than enterprises that are looking for cohesion with their foundation factors. This scenario supports the hypothesis that the processes of re-organization within companies are reinforced by a renewed connection with the market.
The situation described above is supported by a report from the Design Thinking for Business Observatory (2019). In Italian companies, four of the internal sponsors of Design Thinking based consulting cover more than 50% of company revenue: 21,2% from Management, 13,6% from Marketing, 10,3% from Information Technology (IT) and 10,2% from Business Development. In addition, the analysis of the sectors addressed shows that four main areas of expertise cover more than 60% of the 2018 revenues obtained through a consulting project based on Design Thinking: strategy (21,2%), services (16,6%), products (15,3%) and process/organization (10,2%). According to John Kolko (2018), design has the ability to understand meaning and shapes and enriches cultures, despite his criticism of the methodology of Design Thinking itself (Kolko, 2016). Among these cultures, we identify the corporate culture, which plays a fundamental role in the evolution of the current capitalist model, and whose renewal represents one of the most interesting topics for those in the leadership field.

In understanding how transformation can be enabled and guided by design, it is useful to identify the functions that are driving digital transformation today. The Enterprise Mobility Exchange (2018) released the extremely interesting "Annual Survey Report", stating that the IT function is responsible for 34,8% of requests for digital transformation resulting in the adoption of technologies by companies, such as:
- Artificial Intelligence (AI)/Machine learning, Mobility and the Internet of Things, which have a strong impact on the relationship with the target and different intermediaries in the supply chain, both in terms of behavioural information and user experience;
- data analytics, a key asset for the development of new business models;
- the cloud, an exclusively technological asset.
These data depict the widespread scenario in which the IT function is the sponsor of digital transformation and the owner of its development. The question is whether the relationship with an audience can be digitalised starting from a technology-driven function that is not able to provide a final result and/or properly react to feedback coming from the market, as can marketing or communication.
Turning to other sponsors of transformation, only 12,5% of the functions responsible for Human Resources (HR) or sales and operations are promoters of digital transformation in their companies. This means that the functions with the closest contact with the market are also the least proactive in promoting change. Moving forward, we are convinced that when digital transformation is activated beginning with the accurate identification of the needs of the company functions directly connected with the market, the process is "solution-driven": a response to a complex need by a business asset of the company, such as sales, logistics or human capital.
Finally, the report shows that management and the managers of business lines are promoters of 52,7% of digital transformation requests. More than half of the companies surveyed have sponsors whose business functions are to ensure the survival and growth of the company as a whole, and whose main characteristic is the translation of the vision:
- in redefining the business model and go-to-market strategy, *conditio sine qua non* for a digital transformation consistent with market needs;
- in the renewal of the relationship between supply and demand with its audience, or with its prospects;
- in identifying new methods (design thinking) or new approaches to transformation (co-design, open innovation).
Therefore, digital transformation processes that arise under the umbrella of management are characterised by a value-driven approach. The result of such transformation is intended to be an overall outcome, not a single success obtained by one function over the others: this is the kind of result potentially able to break down company *silos* and the real sharing of knowledge, objectives, methods and tools. Therefore, if the digital transformation of a company must involve all stakeholders in a synergistic way, each function should promote its needs to a figure with an organic vision, clear decision-making powers, a strong ability to ensure translation and a predisposition to negotiate with the individual business functions.

The result is that the manager assumes the role of a practitioner capable of innovating through new ways of transformation, among which design emerges as a discipline able to manage the complexity of change: from the spreading of design thinking as a toolkit for supporting managers, to the introduction of the designer as a consultant able to support the manager in the processes of transformation. This change rewards the transition from the imperative of doing, to the need to transform in the medium- to long-term.
Our aim is to support the evolution of this new type of consultant and its authority. Thanks to our continuous experience with companies we have obtained results that represent a concrete starting point for the identification of this figure: the so-called "designer for transformation".

At the origins of design for transformation

As we carried out research activities applied to the market, it became increasingly clear how an organic transformation is a fundamental factor for successful change. This has allowed us to recognise the designer's key role in guiding transformation through the analysis of processes, rather than the application of technology to unhinge them. This approach commences with the assumption that a company is the sum of the human factors within it, an understanding which should underlie the transformation itself.
The research method we have developed is derived from field experiences that were useful in validating our initial ideas. An educational experience at the School of Design (Politecnico di Milano) followed in 2019–2020, where we investigated the skills needed by the designer for transformation.
From a methodological point of view, all the experiences were conducted using the Research through Design (RtD) approach (Freyling, 1993), in which the designer actively participates in the creation of knowledge through practice. The projects described below highlight how designers can contribute to the evolution of companies through co-design methods (Björgvinsson *et al*., 2012; Sanders & Stappers, 2008) and open innovation (Chesbrough & Bogers, 2014).
The first project was the Innovation Bootcamp, a co-design operation in the field of digital transformation that has seen ABB – the world leader at the forefront of digital industries – collaborate with the School of Design (Politecnico di Milano) (2018–2019) and various other partners in order to identify new business models and redesign their internal processes. Beginning with listening to the needs of the Electrification Business Unit and its customers, a co-design activity was developed that saw the active involvement of students and the selection of four start-ups. This experience showed how it is possible to integrate new skills and processes by breaking down company *silos* and creating opportunities for interoperability with the outside world.
The second project was with Leroy Merlin, a global retail player. The challenge was to maximise investments in Corporate Social Responsibility (CSR) and HR, enhancing the company's commitment to people, strengthening the relationship with its customers, attracting young talent and increasing staff commitment. We involved more than 90 design students in several activities related to the creation of employer branding strategies, the redefinition of HR processes in a digital way, and through their participation in the Career Design module in the Master of Digital Strategy (POLIdesign).
In both projects, the students used the tools mentioned above: the "ST.EX Chart" for analysis and strategic framing, the "ID.PO Chart" for the definition of identity and positioning and the "DS Matrix" for the development of digital campaigns (Ronchi & Ciancia, 2019).
These experiences have allowed us to identify processes, people and skills as the three main constituents of a company in which a designer is a natural enabler of transformation, capable of offering strategic skills for formalising tools, resources and procedures to be taken to the market. Accordingly, we have launched the Working Through Digital Transformation educational experience, which aims to define the capabilities required by a designer for transformation and give students the tools and skills that contribute to a design attitude through a learning-by-doing approach.
As part of the first phase, we listened to, and conducted an analysis of, the needs of future professionals and companies. We assigned this task to students, integrating design skills with marketing and communication competences, and experimenting with the use of digital marketing as a tool for engaging with, listening to, and broadening audiences. We ran two surveys, collecting responses from around 300 graduates from the design, communication and marketing sectors, as well as over 60 Italian companies. The data show that according to 75% of recent graduates, their job title is not aligned with the job offers on the market, and 60% of companies find it difficult to attract professionals able to design for digital transformation. These data make the need for CEOs and managers, employees and recent graduates to renew their orientations to transform change into opportunity abundantly clear.

Conclusion

The experience gained with the RtD approach has allowed us to identify a new design paradigm within a context characterised by the absence of definite objectives and the presence of multiple truths as the real challenge for the professions of tomorrow (Bruttini, 2007): design intended as a discipline to guide cultural and organizational changes (Burns *et al*., 2006).
According to cultural assumptions, design offers a unique ability. If digital transformation is enabled primarily through people, processes and skills, technology and the most advanced forms of automation should be intended as tools available for a broader cultural response in supporting a vision.
Starting as a strategic asset for the development and application of lateral thinking (design thinking), design today explores new frontiers and becomes an attitude to change (design attitude), promoting a cultural mindset that integrates design, *techne*, leadership and emotional intelligence. This creates an approach able to overcome the rigid infrastructure that has characterised the company organization, which has

historically demanded figures without a human-centred perspective.
Therefore, we recognise five competencies needed by a designer for transformation:
- systemic vision, fundamental to operating beyond contingencies, and connection with those who represent the natural owner of each transformation (management);
- active listening, useful to frame the context and identify the preliminary insights needed for change;
- linguistic and cultural mediation, a *conditio sine qua non* to translate the needs of individual the functions and negotiate their management with the various stakeholders;
- symbolisation, necessary to represent the context (how the world in which we are operating
is changing), to tell about ourselves (who we are in this world and what we do, with whom) and to make the transformation meaningful for the stakeholders involved;
- emotional agility, necessary to face the change with a positive approach (David, 2016).

This new mix of skills makes the designer for transformation the consultant capable of driving and naming change, neutralising the fear of the unknown and helping to develop the transformative courage that is needed today, giving a renewed meaning to terms such as Human-centred and People First.

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Design and different ways of "doing" technologies

The undermining of this era is the emergency. On the one hand, it is immediately interrelated with the impact of human activities as well as directly or reciprocally with scientific discoveries. While, on the other, it opens up new perspectives, consistent with the different hypotheses of socio-economic commitment. The discontinuity of the occurrence of events introduces a new concept of time: the difference between the untimeliness of lived time reflects the conception of linear time, while timeliness, produces singular events that determine significant discontinuities in linear dynamics, creating a concentration and connotation of absolute time. In short: an emergency. This phenomenon produces widespread attention to all activities, prefiguring a basis to be rebuilt, based on the responsibility and solidarity of the individual that tries to recover a globally collective sense.
Remote cooperation cancels space and establishes the ordinariness of time that itself becomes an event, whose singularity lies in the approach to collaboration aimed at developing collaborative methods to cope with global emergencies. The identifying figure of the global does not end in the encounter, but rather reacts in a creative-productive way and through technical collaboration plays the role of forerunner for other organizational and production systems. A model for the production of goods and services that, in addition to responding immediately to emergencies, forces us to rethink the absence of coordination and adherence to the principles of circular economy as well as the resilience of the systems. The change of pace requires considering the nature and application of innovation, the ability to integrate humanistic knowledge into technology that introduces, in the man-machine relationship, the collaboration that flows into the collaborative industry. There is no real dependence on technology: we discover, in times of emergency, a renewed collaboration between man and machines; the man-machine-relationship today finds in the machine the necessary comfort to face the unpredictable.

[outdated, untimely, manufacturing technology, collaborative industry, man-machine co-evolution]

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The project, immediate response to the emergency

Different eras are outlined by different connotations, as are the ways of discussing the development of human space and its influence on ecosystems. Never as in this era has a connotation applied to everything, with it being that of an emergency. On the one hand, it is immediately interrelated with the impact of human activities as well as directly or reciprocally with scientific discoveries. While, on the other, it opens up new perspectives, congruent with the various hypotheses of commitments which have emerged, since change required new approaches: to the social or rather to sociability; to the evident and necessary evolution in the forms of work; to a renewed political commitment parallel to the impulse of scientific research.

The forecasts favor the responsibility and solidarity of the individual who makes an effort to recover a globally collective sense. There is also the issue of how the right distance between people can be guaranteed in order to allow the necessary intensity and diversity of exchanges.

Where it is necessary to establish implementation ways, spaces and times of planning-production systems, of tangible and intangible goods, that are also circular and sustainable, scenarios have been outlined on the emergence of new ways of cooperating at a distance. If technology plays the role of anticipator, the other organizational systems of society, along with the production of goods and services, demonstrate all the limits of the lack of coordination and adherence to the principles of the circular economy and resilience of the systems (Khanna & Khanna, 2012).

Production processes developed locally have a proven impact on ecosystems, triggering irreversible processes, the effects of which propagate elsewhere, putting the global balance at risk. The change of pace requires considering the nature and application of innovation, on the ability to integrate humanistic knowledge into the technology that introduces, in the man-machine relationship, a collaboration that flows into the collaborative industry.

There is no real dependence on technology. When considering the new condition of contemporary man, we discover, in times of emergency, a renewed collaboration between man and machines. The man-machine-relationship today finds in the machine the necessary comfort to face the unpredictable (De Biase, 2016).

We find ourselves having to rethink the forms of collaborative work: firstly, the man-man relationship in reference to social distancing requires forms of work in teams that are managed and organized remotely; the man-machine relationship, from a dependent relationship, will translate into a real collaborative partnership, potentially evolving into a predictive action by machines towards humans (Frey & Osborne, 2015). The first step, already underway, regards the machine that will resemble humans, exploring the operational capabilities, speed, efficiency, productivity, skills such as creativity, knowledge and critical conscience, to create the collaborative industry.

It is therefore no coincidence that the recent industrial revolution called Industry 5.0, is based on the concept of empowering people. Prophetic are the words used by Esben H. Østergaard – founder and technical director of *Universal Robots* – during

the 2017 Hannover fair, in which the main theme was Industry 4.0. He discussed the importance of the so-called "human touch" within manufacturing processes. The promises of the new industrial paradigm, based on collaboration between the human workforce and artificial intelligence, strengthen the scope of a circular economy, capable of renewing itself through the themes of collaboration and diversity. If the collaboration between man and machine takes place, it is essential to formulate a framework of diversity, based on artificial intelligence when it meets human intelligence of which it is necessary to modulate its aspects in order to include all the diversity of which it is capable.
Design formulates a sort of hermeneutics of the relationship between absence and appearance, its consistency in quantitative and qualitative terms, taking the discussion far beyond its own disciplinary boundaries.
The emergency has led to celebrate limitations, to do without the framework that induces billions of people around the world to act in the same way, with the same tools whose approved behaviors keep complex systems in place and whose fragility has been unmasked, with a return to differentiated systems of life now being necessary.
The limitations are the background to two different hypotheses for managing emergencies: «The first is between totalitarian surveillance and the empowerment of citizens. The second is between nationalist isolation and global solidarity» (Harari, 2018).
Solidarity can be within the reach of machines, intervening directly on the human-machine relationship and, since these are technologies recognized and used globally, it will be the latter that will realize, first of all, global solidarity, and subsequently will substantiate the challenge of differentiated productions without waste that reformulates the hypotheses of a circular economy in a global agreement.

The online community

The metaphor of the "intelligent swarm" is based on the ability of living organisms, in this case biological, to live their own life and time of implementation that fall back into factual reality (Iori, 2010): they autonomously arrange their activities, transform their living environment, make resources profitable, change their rhythms to face the *inconnu* in a community, while also sharing. On the other hand, man is able to live a life designed on his own, moving further and further away from the natural basis that generated him: a life so exclusive, reaching out to the dynamics of self-evolution that makes it, like a natural evolution, a unique work (Bejan, 2020).
Without rivals, the man takes on the idea of "creator of evolution" before the surrounding environment, to glorify deeds and feats close to those of the gods, and then gradually take on their appearance. Harari leads to the origin of the lost alliance, in which man proceeds in the direction of self-evolution (2018): referable to the dominance over other species through domestication; the construction of "imaginary orders" of a socio-political and technical-scientific nature in order to connect single human beings; to self-glorification, through the ability to give meaning to actions whose results are already somehow prefigured; the actuality of overcoming human limits to aspire to immortality, happiness and to defeat evil, wherever it is hidden; to the pursuit of ethics subordinated to contingent value systems; to the landing of the superman who has always resided in the collective imagination that challenges the foundations of life itself; to the consciousness of the self-endowed with supernatural abilities, a gift of technology that is also self-ordered.
A new meaning to life devoted to integration and sharing, that resides in the heterogeneous network that unravels between different knowledge, between universities and companies, whose beating heart remains the community of global makers (Rheingold, 1993). The global maker network not only allows for an exponential implementation of the design and production capacity, but it also favors a more careful, collaborative and continuous phase of verification and development of the project that allows to arrive at the realization of a product with an optimized design, with the use of materials along with the coexistence of innovation and advanced utility (Rheingold, 1994).
In line with what has just been discussed, there have been various national and international experiences that have used digital manufacturing technologies in order to face the COVID emergency. In Italy, a territory that is in part still resistant and not fully aware of the technological advancement and of the most advanced production realities, there are many centres and, in particular, universities making devices and equipment for the healthcare sector. The latter brings out skills and tools far from the common imagination which triggers a revolution both from a design and production point of view, as well as from an ideological point of view, with respect to the profession of the designer and, more particularly, of the maker.
From north to south, the most significant data that emerges and unites the Italian universities involved in the COVID emergency is the presence of the network, which at this moment allows to bring together as many forces as possible, academic and non-academic makers, to increase production capacity as a response to the needs expressed by hospitals. For example, the University of Roma Tre accepted the request of the company Isinnova and launched the solidarity call "Easy Covid-19", for the printing (at home, at the office, or university) of "Charlotte valves", that are used for sub-intensive therapy in which took part other Italian Universities, such as the University of Camerino. The University of Messina developed, in collaboration with the Department of Engineering and other innovative companies and spin-offs "AirFactorie.org", a non-profit digital platform, defined as a "widespread factory", designed to facilitate the relationship between makers, citizens, startups, researchers and companies, but also to become a tool for design and production.
In an effort to cope with the emergency, there has been a worldwide increase of the spread of three-dimensional (3D) printing methods for various types of Personal Protective Equipment (PPE), including masks, face-shields and ventilator parts (Clifton *et al.*, 2020) that allow the relatively simple and rapid production of polymer structures (also) based on open-source data. At the same time, the role of design has demonstrated its strategic dimension due to the ability to arrive at solutions, including preventive ones, in response to the different needs manifested following the emergency.

The design was, therefore, able to internalize the specificities of the context whose fragility has, more than ever, triggered the convergence between the creative capacity of the designer, his prototype tools and methodological rigor, in an attempt to identify a design and production process that can be adapted to the rigid protocols and quality standards of the healthcare sector.

Case History: Officina Vanvitelli

The case study deals with the role of the designer in relation to the response to emergencies, focusing, in particular, on the relationship that establishes with more contemporary production techniques, such as those relating to advanced manufacturing. During the manufacturing of PPE at Officina Vanvitelli (a hub founded within the development and research activities of the Department of Architecture and Industrial Design-DADI of the University of Campania "Luigi Vanvitelli"), advanced manufacturing represented the tool for the instant verification and rapid production of design projects which, thanks to the interaction with other disciplinary fields, such as medicine and biomedical engineering, gave life to solutions which evaluated the feasibility and compliance with the identified needs.

Over the last decade, the evolution of 3D printing, and, in particular, its application to medicine, has followed both creative and problem-solving design paths (Flanagan & Ballard, 2020). For this reason, but also due to the limited ability to produce or procure PPE with more conventional means, 3D printing has proven to be the most suitable choice for the realization of devices which can be quickly manufactured and made available, representing an opportunity to solve their absence and limitation (Salmi *et al.*, 2020).

It was therefore decided to adapt the equipment of Officina Vanvitelli (OV), converted on this occasion for the rapid production of equipment, accessory instruments and useful devices to cope with the epidemic emergency.

Thanks to the analysis of current scientific literature and the state of the art, it was possible to analyse different types of products: mainly taking into account that not all 3D printed objects are suitable for use in the healthcare sector (unless formally approved by a regulator institution), and it is not certain that they can provide a sufficient degree of protection for healthcare professionals and/or be safe for patients – consider, for example, valves and ventilators.

The initial research carried out, highlighted how 60% of 3D printing projects, in response to the epidemic emergency, consist of personal protective equipment, of which the two main products are face shields and masks, which respectively cover 62 and 20% of the previously reported total (Novak & Loy, 2020). After examining the practicality and clinical suitability of some possible devices, and in consideration of the two different additive manufacturing technologies, Polyjet and Fused Disposition Modeling (FDM), both available at OV, the choice fell on face shields. Already widespread and used in the medical field (Erickson *et al.*, 2020), it is the primary shielding device in intensive care units that protects the operator wearing it, even before the mask; the face shields were printed using FDM technology. This was decided due to the greater printing capacity of FDM technology, whose production and post-production time can be reduced (Wesermann *et al.*, 2020) if the support structures are reduced, or completely eliminated, where the shape allows it.

The project, the machine, the doing

Having identified the type of device, it was then necessary to study its characteristics, evaluating the weight and printing time of a single object, as well as the tools necessary for its assembly. The model chosen, selected due to it being available on the internet for free –and approved by the emergency services, 118– was analysed and compared with some alternatives. The analysis identified several possible improvements to the original design, including the correction of the terminals – hich allow the user to further fix the face shield by adding a simple and common elastic band– and increasing the distance between the frame of the visor (forehead band) and the face shield. Thanks to these changes was created a product that aligns with the parameters identified by Wesermann *et al.* for the evaluation of the effectiveness of the different models of face shields made with 3D printing (2020). The identified parameters are the following:

1. adaptation of the frame to the head (forehead band);
2. comfort during use, in particular, the reduction of pressure on the head or the slipping of the device;
3. sufficient space for additional protective equipment like goggles and face-mask;
4. protection of all areas of the face;
5. overall assessment.

The result obtained, at the end of this first design phase dedicated to the redesign/correction of the open-source file, was a protocol for a product that can be produced through 3D printing in a relatively short time, highly performing, without any critical issues in terms of wearability and use, more ergonomic and functional.

Given a choice to proceed with realizing of the face shields using FDM technology, the materials were then analysed. Were used thermoplastic polymers which, thanks to overheating, can be extruded to take the desired shape. Each material has specific characteristics, strengths and weaknesses that require the designer to carefully analyse them, especially when considering that the object is designed to remain in contact with the skin for several hours. The forehead band, or the frame that forms the part of the shield that rests on the forehead, is made of PLA, the polymer of polylactic acid, a biodegradable thermoplastic material that melts at 180 ° C, derived from renewable resources such as corn starch and among whose characteristics it is worth mentioning that it can be used to make external biomedical devices/products. To speed up the assembly process and shorten the production chain, the face shield was made of an A4-size transparent PVC sheet, easily available and perforated using a common A4 sheet punch, which constituted the guideline for positioning the individual hooks on the frame.

From a technical point of view, before starting a larger production of the face shields, it was necessary to determine the parameters for printing, which allow to obtain an optimal result (Amin *et al.*, 2020). Only thanks to continuous experimentation was it possible to identify suitable settings that optimize the total weight of the frame and the printing time, as well as the height of the layer set at 0,3 mm, and the density of the filling at 100%. These settings, developed and designed specifically to make the structure of the forehand band more resistant and safe during the use are based on an in-depth study of the technology used as well as the geometry to be printed. The result achieved is that of an optimal design in the mechanical, technical and functional specifications, in in the printing times and quantity of the material used, and, finally, in the obtaining of a reduced printing time than that initially estimated and, therefore, resulting in an above-average daily production capacity (Mazlish, 1993).

Adaptation and coevolution

The case study describes the use of 3D printers to make personal protective equipment, highlighting how, thanks to the project, it is possible to produce effective and suitable products in response to emergencies.

When considering the potential of additive production technologies, linked to advanced manufacturing, and more generally to the global maker network, the commitment in terms of technical skills and experimentation for the development of innovative products confirms the alternative and immediate hypothesis of a way (among many) of contemporary manufacturing (Larrañeta *et al.*, 2020).

The case study described has shown how the convergence between different skills and the use of such technologies leads, without hesitation, to the creation, in much shorter times, of the most performing products for individual protection and, above all, without any waste.

The team, made up not only of technicians in the sector but also academics, Ph.D. students, students, researchers, freelance professionals, in collaboration with the Regional Makers Group, has become a group that was created spontaneously, a virtuous example of how collaboration, in a moment like the current one, can provide the strategic tool on a productive, human and psychological level.

From the adaptation of the machine to the project, a characteristic is highlighted that refers to an evolutionary constant that represents the re-creation of the machine itself. It is no longer just a case of machine learning, but it is a self-evolving machine. Prototypers do not conclude their evolutionary capacity in the finished product, they learn from contexts, leading them to a form of co-evolution. The co-evolution aspect is based on the man-project-machine triad, determining elements in the coming decades; the mechanism of the project that inspires the machine is, in turn, inspired by the man who drives the project.

The man-project-machine relationship is played out on completely renewed levels: on the level of sharing on the network, problems are dealt with, like in a collective problem-solving; on the level of solidarity, is relied upon the community of makers, therefore global solidarity; on the level of new forms of work, the community listens, distributes, manages, therefore we are in the sphere of new collaborative-work; in terms of the choices to be implemented for greater functionality of the machines, the role of the community is established on the evolution of the machines, therefore of self-evolution machines; on the level of community and collaboration and, above all, in full sharing between context and machines, here the real challenge is the co-evolution man-machine. The power relations are cancelled due to a conscious evolution of the man-machine relationship, the machine comes to the aid of man, indicates the choice of the solution to be adopted and evolves according to any problematic context; the project collects the requests; the categories of manufacturing are received and implemented.

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The paragraphs: The project as an immediate response to the emergency, The online community, Adaptation and co-evolution - are written by Maria Antonietta Sbordone.
The paragraphs: Case History: Officina Vanvitelli, The project, the machine, the doing, Adaptation and co-evolution - are written by Gabriele Pontillo.

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Apple Design Studio, Cupertino, California, USA. From the movie "Designed by Apple in California" Chronicles 20 Years of Apple Design.

Focus gallery

Design 2030: Spaces, Factories, Labs

«We worked very hard to create a single studio where it was possible to design all the tools and experiment with the new processes necessary to obtain the finished products that you see» Jonathan Ive, Chief Design Officer at Apple, with these words highlights one of the least discussed topics in the practice of design: the workspace. Factories, studios, ateliers, laboratories: over the years the place where the designers gave life to their products has undergone profound transformations. The introduction of new technologies and new practices has forced designers to think about the workspace exactly as if it were a product. The large factories of the assembly line, designed for mass production, are opposed to the small realities of the ateliers or labs, support of an increasingly collaborative and "online" design. The need to reduce the time of production has translated into a centralization of space: many laboratories and studios have equipped themselves to develop each phase of the production cycle within a single environment. Even the ideation process itself transforms, and if the tools necessary for the designer change, also the workspace acquires a completely different aspect, as in the case of bio-design or generative and computational design. If we look to the future, with the robotics sector constantly growing, the workspace is represented more as an instrument of machines and artificial intelligence than of the designer himself. But is it really necessary for the work area to be tangible to make design? The introduction of innovative technologies such as augmented or virtual reality has made possible to overcome the space-time dimension. Platforms or apps that allow to easily share ideas, images or drawings inside a virtual room are increasingly popular. The designer's space is therefore an ever-changing element that oscillates between large and small, open and closed, physical and immaterial. The purpose of this gallery is to highlight its different configurations. Through Focus we will therefore try to answer a question that is not often asked: where does the practice of design take place?

Paride Duello

[the resized space, the collaborative space, the open space, the merged space, the imagined space]

01

The resized space
>
Eight thousand square meters against fourteen. From the large Olivetti factory to the small studios and ateliers: how the designer's space changes in its physical dimension.

02

03

01 Olivetti factory, Ivrea, Luigi Figini, Gino Pollini, 1955-58. Retrieved 16/05/2020 https://archeologiaindustriale.net/4156_archivio-storico-olivetti-di-ivrea/.
02 Portrait of Ettore Sottsass in his studio, 1979. Photo: Silvia Lelli, Lelli e Masotti Archivio.
03 04 Spazio R3, R3Architetti, Turin, 2015. Photo: R3Architetti.

04

01

The collaborative space
>
The designer's workspace is no longer individual but becomes of "many". A theatrical work in which the designers, engineers and architects are the actors and the walls are the screens that represent the show.

02

03

04

01 One of the stages of Co-design: use of post-it to facilitate the collaborative design process. Retrieved 2/06/2020 https://uxdesign.cc/figma-makes-note-taking-in-remote-usability-testing-easy-6d85511db7c2;
02 Designer Lorenzo Fernandez leads a multidisciplinary team of engineers and designers at Zalando. Retrieved 18/06/2020 https://lorenzo-fernandez.com/.
03 04 Made Again: Creating the Biggest Fab City Prototype to Date, Space10, Barcelona, 2016. Photo: Space10.

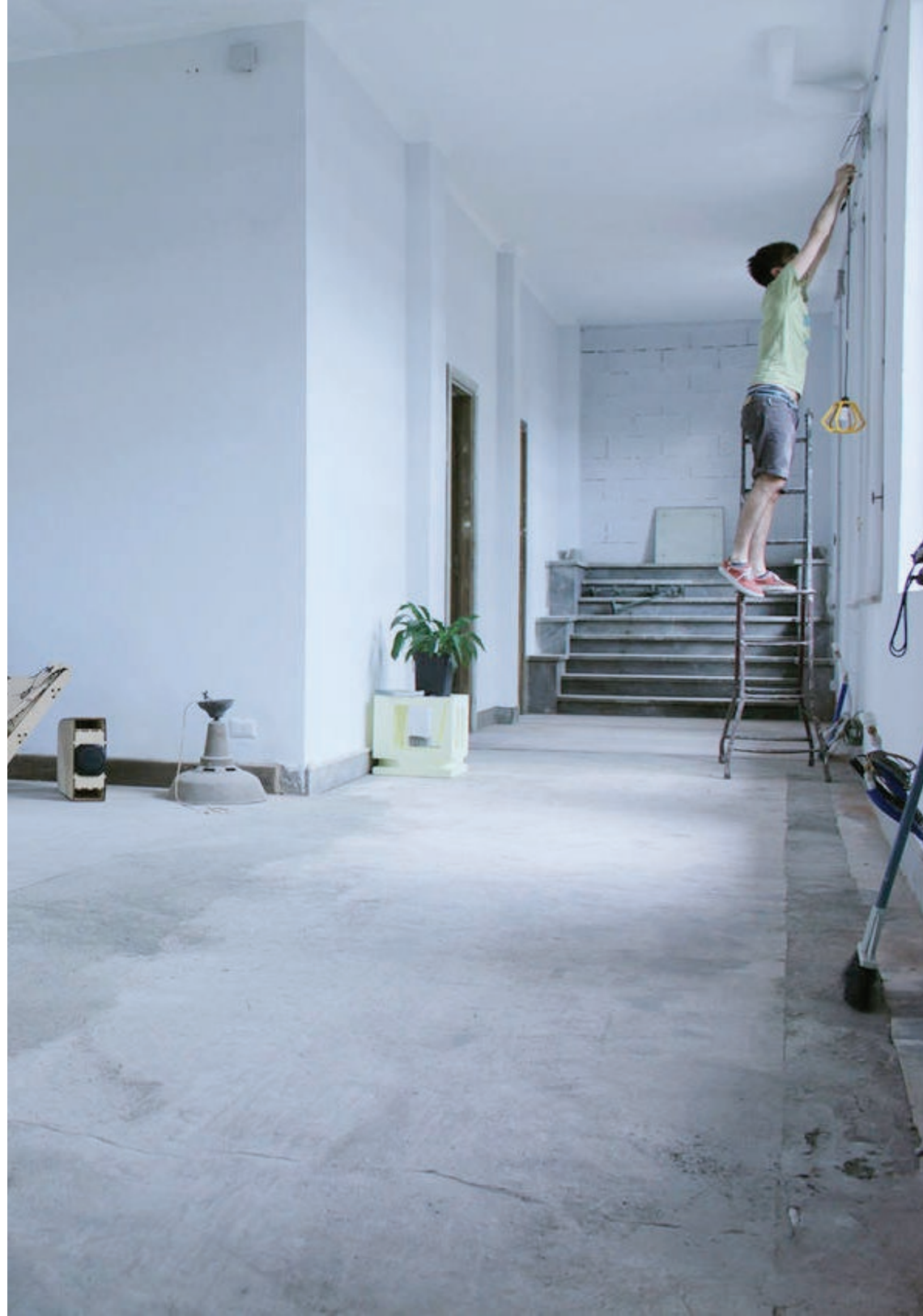
01

The open space
>
The Open Design space is ubiquitous, changeable and shared. Its physical dimension is relative and takes shape only in small local realities such as the FabLabs.

02

03

01 ICI thecamp fablab, thecamp, Marseilles. Retrieved 26/05/2020 https://thecamp.fr/en/fablab-thecamp-idea-prototype.
02 Workshop organized in 2016 by the Cucula organization for West African refugees, using the project "Proposta per un' autoprogettazione" by Enzo Mari, 1974. Photo: Verena Brüning.
03 Bruce Sterling and OpenDesk co-founder Nick Ierodiaconou inside Casa Jasmina, Turin. Retrieved 7/07/2020 https://www.opendesk.cc/blog/torino-maker-faire.
04 Casa Jasmina, Turin, 2015. Curated by Arduino in collaboration with the science fiction writer Bruce Sterling, the house occupies part of the Toolbox Coworking complex. Retrieved 18/06/2020. https://www.ambientecucinaweb.it/la-casa-futuribile-e-a-torino/.



04

01

The merged space
>
Where did the drawing sheets, pencils and compasses go? Today the space of the designer merges with other tools through new ideation processes.

02

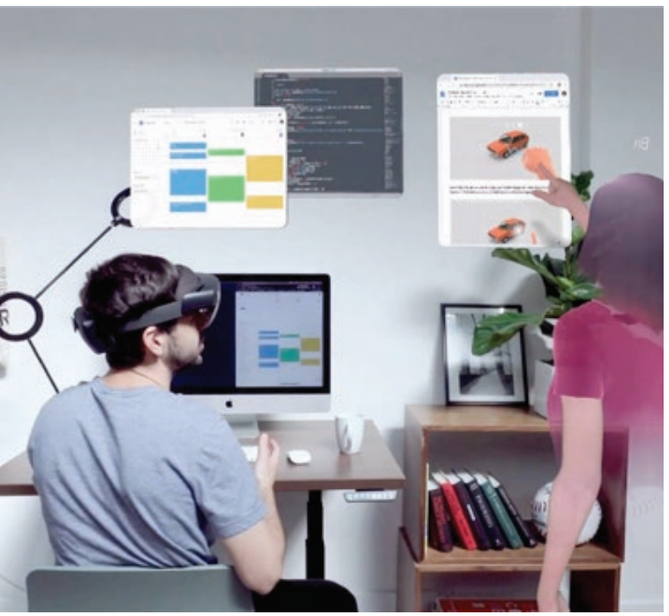
03

01 Adam N. Smith (Autodesk) and Dhiraj Madura (SRAM) discuss how generative design can be used for bicycle component development at Atuodesk's generative design lab in Chicago. Retrieved 7/07/2020 https://adsknews.autodesk.com/news/why-were-opening-a-generative-design-field-lab-in-chicago
02 Elbo Chair, Autodesk, 2016. Generated in Project Dreamcatcher and developed through Fusion 360. Collaborators: Brittany Presten, John Hutchinson, Carl Bass. Retrieved 7/07/2020 https://virtute.io/elbo-chair-design-generatif-autodesk/
03 04 Algae Lab Luma, Studio Klarenbeek & Dros and Atelier Luma, 2017. Photo: Antoine Raab.

04

01

The imagined space
>
Unreal, virtual, intelligent spaces. The places of the future transcend space-time and serve only the imagination of the designer.



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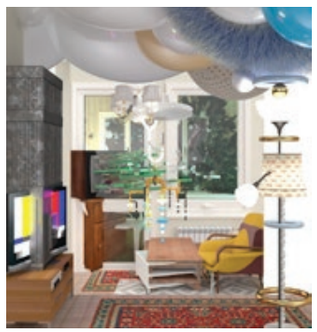

03

01 Shawn Maximo, Going Green, 2016. Photo: Shawn Maximo.
02 Spatial, 2020. Spatial is a startup that allows people to meet through augmented or virtual reality. Photo: Spatial.
03 The Venn Room, Space Popular, Tallinn, 2019. Photo: SpacePopular.
04 The Venn Room, Space Popular, Tallinn, 2019. Photo: Fredrik Hellberg.

04

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