

Exploring Tomás Maldonado

EDITED BY

Pierfrancesco Califano



Fondazione
Giangiacomo
Feltrinelli

Scenari 45

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POLITECNICO
MILANO 1863

SCUOLA DEL DESIGN



DOTTORATO
DI RICERCA
IN DESIGN

POLITECNICO DI MILANO
DIPARTIMENTO DI DESIGN

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Introductory Note

The idea for this book originated from the inter-doctoral course “The Legacy of Tomás Maldonado”, promoted by the Doctorate in Design and the School of Design of Politecnico di Milano, with the support of the Feltrinelli Foundation. The course, curated by Luca Guerrini and Raimonda Riccini, involved approximately 60 doctoral students and 11 doctoral programmes.¹

From February to April 2021, through the reading of texts and meetings with experts, the doctoral students were confronted with the thought and work of Tomás Maldonado on six themes: the training of designers, the role that artistic practice has in the design process, the

¹ The course involved the following PhD programmes: “Architecture and Design Cultures”, University of Bologna Alma Mater Studiorum; “Architecture, Design, Planning”, University of Camerino; “Environment, Design and Innovation”, University of Campania Luigi Vanvitelli; “Architecture and Urban planning”, University of Ferrara; “Sustainability and Innovation for the Design of Built Environment and System Product”, University of Florence; “Architecture and Design” and “Scienze e Tecnologie del Mare”, University of Genoa; “Design”, Politecnico di Milano; “Architecture”, University of Naples Federico II; “Planning, Design and Architecture Technology”, Sapienza University of Rome; “Management, Production and Design”, Politecnico di Torino; “Architecture, City and Design”, Iuav University of Venice.

environmental issue, the attention to the body and to interaction, the relation between design and technology, the contribution that semiotics and the philosophy of language can make to design. Out of this comparison emerged the essays by the doctoral students that make up this volume.

Before these, the essays by Paola Bertola, Luca Guerrini, and Raimonda Riccini reflect respectively on the perspectives of research in design, the doctoral learning experience gained in this seminar, and the influence that - directly and indirectly - Maldonado has had on the history of teaching design in Italy.

The section of doctoral students' essays opens with an essay by Pierfrancesco Califano that reconstructs how the six themes discussed in the seminar developed in Tomás Maldonado's thought and activity.

Reading Tomás Maldonado: back to Design Research Future

Paola Bertola

Design Research Pathway of Legitimation

In January 2020 the Politecnico di Milano celebrated the thirtieth anniversary since the establishment of its Doctoral Program in Design, the first internationally to be entirely focused on design, of which Tomás Maldonado was the coordinator since 1990. It was born at Politecnico even before the Bachelor Program in Design emancipated from the School of Architecture (1993), and the School of Design and the Department of Design were then formally institutionalized. It anticipated many other experiences that followed at national and international level, feeding the legitimation of design as a research discipline, able to express a specific cognitive attitude, a unique way of “knowing the world” and producing new knowledge.

Today we find ourselves in a highly transformed context both for research practice as a whole and for design itself as a discipline and research field.

On the one hand at European level, starting from the Salzburg document of 2005 (AA.VV., 2005), we have been witnessing a growing

attention to third level education. It is seen as a relevant lever not only to train academics, but to seed new entrepreneurial capacities, promoting research and innovation driven initiatives able to impact on local and territorial development, as other international models have been showing, especially the north American context (Etzkowitz, 2003a; 2003b). The pandemic crisis has layered to this an increased awareness on the importance of constantly developing research capabilities for which PhD education represents the founding pillar and this is giving an additional impulse to investments in it. This is clearly shown also at Italian level with the measures that the government is taking within the PNRR framework (MEF, 2021) to support doctoral education.

On the other hand, design in its statute of academic discipline has been highly transforming in the last thirty years. After the seminal Bauhaus experience, the goal to “scientisize” design emerged with urgency in the middle of last century, in a context increasingly populated by “designed artefacts”, and moved from the recognition of the implicit nature of design practice towards the establishment of the discipline as an independent field of inquiry (Buckminster Fuller, 1957; Bradbury, et al., 2018). The theoretical debate that flourished in the 60s and 70s, especially in the Anglo-Saxon contexts, brought to diversified attempts to formalize a theoretical corpus for design. The need to codify “the” design process led to the appropriation of methodological approaches developed in other scientific fields, such as information sciences, mechanical engineering, mathematics and statistics, as well as social sciences (Collina, 2005), unveiling the undeniable multidisciplinary nature of design discipline (Gregory, 1966; Simon, 1969; Archer, 1979). However, it soon became clear that the elaboration of a comprehensive theory of design based on a set of methodologies able to guide its research approaches and codifying its practices was inconsistent with the nature of design itself. This acknowledgement rose with the epistemological study of several applied disciplines (i.e. medicine, architecture) showing the interweaving of theories and experimental practices in the process of advancing their disciplinary

knowledge (Rosselli, 1973; Schön, 1983; Friedman, 1997; Cross, 2001). Within the Italian context, the focus on “practice” as a specific ontological system of design has always had great relevance. When in 1990 Politecnico was the first University in Italy to institutionalize design research education, it could count on several experiences and expertise both inside and outside the academy. They were all the results of the same reflexive attitude transcending the material dimension of artefacts, an attitude which Emilio Ambasz highlighted in the exhibition “Italy. The New Domestic Landscape” he curated at MoMa-New York in 1972 (Ambasz, 1972). He eloquently titled his introduction to the catalogue *Transcending functions. In the world of Italian design simple shapes mask complex thoughts*, giving a formal recognition to an original body of contributions where design practices and design theories were strictly interwoven. Such contributions stemmed from a large community of “reflexive practitioners”, among which many graduates and professors of Politecnico di Milano (Munari, 1966; Rosselli, 1973; Bonsiepe, 1975; Ciribini, 1984; Branzi 1999, 2008). Across the last thirty years of reflection, theoretical elaborations and design research practices, several advancements have been made reinforcing an interdisciplinary vision of design, blending theories and applied methodologies and building a rich, diverse and connected research community (Bertola, et al., 2020).

Design Research to Critically Question Future Trajectories of Change

After thirty years from the establishment of the first PhD program in design, thanks to several seminal contributions among which the one by Tomás Maldonado remains crucial, there is a general acknowledgment that design research training is a fundamental component for our cultural and scientific progress. And more specifically that it contributes to develop those speculative, critical and planning skills necessary to face the challenges that increasingly characterize our horizon.

More in detail I would like to focus on one specific theme, that of digital transformation, which certainly represents a topic he addressed beforehand with an anticipatory vision.

The context that characterizes our contemporaneity has profoundly changed, also in light of the experience we have lived in the last two years. Some dynamics of transformation, already underway, have been accelerated by the pandemic and today place us even more clearly in the face of challenges that require new categories of thought, new tools and the ability to promote a radical change of paradigm. In particular, along these two years one dimension of transformation has been influencing our daily lives more than others, that of digitization, towards which Tomás Maldonado had arisen many concerns with respect to its implications and potential impacts (Maldonado, 1997).

Indeed, during the pandemic several of the foreseen impacts he had drawn have shown their effects in an unprecedented way, making our reality a mirror of the three dimensions of the digital he had questioned in his book *Critica della Ragione Informatica* [Critique of the Informatic Reason]. Hence, the essay is organized in three main chapters.

The first one is titled *Cyberspace, a democratic space?*, questioning if the digital space generated by new media and networks is really accessible and participative.

The second one is titled *Telematic and the urban scenario*, discussing the dematerialization of our activities and related infrastructures for working and learning, and if they are still able to guarantee the quality of relationships, contents and knowledge.

The third one is titled *Human body and digital knowledge*, focusing on how digital technologies partake in the process of human body “artificialization” started with the technological development.

All these three themes resonate with several topics we have been discussing since the start of the digital revolution and then highly revamped during the pandemic.

First of all, the shift from the “industrial economy” paradigm to the “knowledge economy” one has been opening up a rich debate on the

accessibility of knowledge (Rifkin, 2000). Being intangible and easily transferable it could be potentially shared in a capillar way, especially thorough democratic and distributed web supported by new technologies; but which, in real, has demonstrated to be a factor of politization even worst that the previous ones. All ideologies based on the abstract conception of distributed and participative democracy have been becoming a lever for the growth of Internet colossi, such as Google and Amazon, owning now monopolies within almost completely un-regulated markets of knowledge and information (Sundararajan, 2016). This has become even clearer during the pandemic, where we have been experiencing how much technologies can increase inequalities between the ones that can access them, and the ones excluded, isolating entire urban neighborhoods, villages, regions and areas of the planet.

Also the second chapter seems contemporary indeed. In the last few years, the topic of transforming cities through an extensive technological infrastructure enabling efficient flows, shared services and full connectivity has been guiding the urban planning debate. Smart cities have become symbols for a sustainable transformation of urban environments and for improving citizens' quality of life. This concept of a cyber-physical space has quickly turned into real as a consequence of the pandemic. In a condition of social distancing, digitization has allowed us to carry on with several activities related to tertiary works and professions (a large majority in the first world), to learning and teaching activities (especially developed in western countries), in some cases even increasing our efficiency and working capacity. Looked downside, it turned out to be a factor increasing inequalities towards peripheral areas and activities, and also it has negatively impacted our lives (Sassen, 1991, 2015; Secchi, 2013). It has impoverished our human and social dimension, often distorting our work-life balance. It has demonstrated to be a very powerful tool for teaching and learning, but at the same time not always able to support the development of all students' cognitive capacity. The deprivation of the physical social interaction dimension from learning environments has been heavily

affecting younger generations, growing anxiety, sense of isolation and loneliness.

The third chapter touches perhaps the most sensitive topic within the discourse on technological evolution. In fact, it's never been so evident how implications of technologies which characterize the so-called fourth industrial revolution are unpredictable and unexplored. On the one hand, for the first time in the history of human development, technology is no longer able to simply process data and information faster and in greater quantities, as it happened with the third industrial revolution; but it is able to replicate cognitive processes, that is, to say, to learn and take decisions such as the paradigm of Artificial Intelligence teaches us. On the other hand, a process of convergence between information sciences and biological and cognitive sciences has also been triggered (the so-called Nano Bio Info Cognitive convergence, NBIC) (Dordrecht, Roco, 2016). Especially in the North American context, this process is supported by a strong "technology-driven" vision, in which the prospect of being able to fully exploit this convergence of technologies to enhance and increase human capabilities is highly pursued. This scenario, not anymore so-futuristic, populated by artificial intelligences and augmented humans brings with it undoubtedly unexplored potentials for development, but also urgent ethical questions (Khushf, 2007; Harari, 2017; Russel, 2019).

The critical vision introduced by Maldonado on these topics seems to be quite anticipatory as effects produced by purely technology driven visions of the future are currently questioned from several voices, and especially in Europe a different perspective is emerging. It is based on a broader openness to knowledge development where, together with sciences and technologies, also arts and humanities find their space as necessary components for a sustainable transformation, in order to guide technological development towards applications aimed at improving the quality of life and the environment.

Too many times, approaches to innovation driven by the sole technological lever and blind to long-term impacts, have produced deleterious effects on the environment, on the transformation of work, on

social communities, on culture. This growing awareness is widening a new space for design. The culture of design, both in its speculative and design dimension, of dialogue between arts and sciences, of projection into the future of new and better ways of life, cultural systems, relationship practices, represents an important alternative to a purely technology driven vision.

Several initiatives among which the New European Bauhaus recently launched by the European Community are reinforcing this conception.

It is the sign for a “new humanism”, capable of guiding technological development through a clear design vision. Despite the fact that our common understanding often confuses “humanism” with the conception of an “anthropocentric world”, often iconized by the “Vitruvian man” drawing, it is instead rooted in a holistic vision of the world, which was at the core of the early Renaissance. A comprehensive science, unifying man with the world under the same system of governing principles, going from the mathematical reading of the world by Leonardo Fibonacci, passing through Leonardo da Vinci’s exploration of scientific principles through the arts, up to Giordano Bruno’s cosmology (Montecucco, 2001). It was in that cultural milieu that the masters of the Renaissance, embedding in themselves artistic practice, philosophical thinking and scientific research, were using arts and design to create meaningful visions of the world, designing desirable futures, such as in the fiction-book *Utopia* by Tommaso Moro, or in the painting *La città ideale* (The Ideal City) by Leon Battista Alberti.

Along this vein, contemporary design research practice can become an important guiding compass in critically discussing future innovation trajectories. By defining new relationships among societal trends, cultural directions and technological potentials, it can fully express its powerful capacity of “materializing” possible and desirable futures, making them tangible through design thinking.

A Living Legacy

There are several reasons why reading today Tomás Maldonado's corpus of thought can be so relevant and impactful.

First of all, the essays included in this book represent important steps to redraw some identity red threads within the design culture that still characterizes Italian schools and their contribution to design discipline in general.

Additionally, they embody a consistent way to update some of Tomás Maldonado's core themes through the exercise of a critical vision, itself an integral part of the legacy he left us.

Moreover, re-reading his essays through the filter of contemporaneity is one of the way to nourish the awareness about the strategic relevance of design research. This can contribute to reinforce the pathway of legitimation of design discipline that Tomás Maldonado himself gave a great contribution to.

Finally, given the ongoing contemporary dramatic transformations and the challenges we are confronting, it is particularly important that the contributions included in this book are developed by young PhD researchers in design. Indeed, doctoral research embeds by its nature that exploratory and curiosity driven attitude which is becoming so important for building a future more socially equitable, culturally inclusive and environmentally sustainable.

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An Experiment in PhD Online Teaching: The legacy of Tomás Maldonado

Luca Guerrini

“The legacy of Tomás Maldonado” is an unprecedented training experiment in Italian PhD programmes on Design. For the first time about 60 doctoral students throughout Italy attended a course designed entirely for online teaching, lasting 12 weeks, during which they collaborated not only sharing their own ideas but also bringing into the learning process the disciplinary culture, the methodology, and the research topics of each doctoral school, building a fertile terrain for exchange.¹

From the very beginning, we planned to involve the largest possible audience of doctoral students. We are therefore grateful to the PhD programme and the School of Design of Politecnico di Milano for support, and to all the colleagues of the Italian PhD programmes linked to the discipline of design who have joined with enthusiasm, allowing us to put this experiment into place.

¹ See the *Introductory Note* in this book for the complete list of the PhD programmes involved.

This essay retraces the learning path leading to the final seminar of which this volume collects the outcomes. We outline the course structure, the pedagogy and the practices adopted, so that other colleagues might replicate this experience. Effective choices and weaknesses are critically revised, not only from the teachers' perspective, but also by commenting on the outcomes of a self-administered questionnaire we distributed at the end of the course.

Premises and Past Experience

From a methodological perspective, the course rests on a previous teaching experience conducted in the Design Doctorate of Milan, which Ezio Manzini and I entitled "Organising scientific seminars". That course – in fact – aimed to organise an annual public seminar identifying key concepts of the design debate that emerged from the research work of doctoral students. Therefore, it was a training course that finalized theoretical reflection to concrete action (Guerrini, 2020).

The course pedagogy adopted a revised version of *action learning*, a method developed by Reginald Revans around 1980, which is aimed at concrete action and based on teamwork and collaborative practice among peers (Revans, 1982; Revans, 2011). Revans's model was particularly suitable for a community of doctoral students, that is, young researchers who already possess specialist skills that were thus recognized. Furthermore, the model attributed to the teacher the task of bringing out the skills and knowledge from group work instead of transmitting them – Revans himself defines the teacher as a "coach" or an "accoucheur". It was, therefore, a sort of "flipped classroom", before Eric Mazur (1997).

Indeed, the class became a sort of cabinet where ideas, decisions and actions were debated and deliberated, amplifying the power of dialogic conversation. This strategy proved to be particularly effective both in overcoming the roughness usually arising in teamwork and in achieving a shared goal. Reflecting on collaborative practices, Richard Sennett underlines the strong link between dialogic conversation and

the empathic experience (Sennett, 2012). Empathy is the ability to recognize the other as such, on the basis of common humanity, allowing us to cooperate with the stranger and with the foreigner (Devecchi, Guerrini, 2019). This experience is increasingly common today, also among doctoral students.

If, on the one hand, Tomás Maldonado would certainly have appreciated a learning path based on conversation,² on the other he would have harshly criticised a course entitled to his “legacy” relying on the action of doing. Everyone knows, actually, how sceptical Maldonado was about the application of the pragmatist educational approach – popularized as “learning by doing” – especially in higher education. Reflecting upon Bauhaus pedagogy he stated: “We know now that theory must be impregnated with practice, practices with theory. It is impossible today to act without knowledge, or to know without doing” (Maldonado, 1993, p. 299). Therefore, from his perspective, any learning experience in higher education should focus on the development of critical thinking, even when conveyed by practice, since designing is primarily a moral commitment. “Conscience is, by its nature, restless, its task is to disturb, not to preserve quietness, namely, its task is to ask tirelessly questions, to advance doubts and to require for clarifications. Conscience, therefore, is always critical” (Maldonado, 2001, p. 195. Translated by the author).

However, we believe we have made it clear that the action we pursue – the *organization* of the seminar – is instrumental to critical elaboration. The whole process focuses on understanding and critically revising what ideas should be discussed in the seminar and how. In this respect, we may see a link to design pedagogy. The course as “a revised version of the design studio, aimed at handling an intellectual construct – the seminar – instead of a product. Similarly, we can con-

2 Talking about Maldonado’s teaching style, Giovanni Anceschi says: “An informal teacher, that is, a conversationalist who has made conversation, that is the ability to listen as well as to say, one of the liberal arts” (Translated by the author), Anceschi, 2001, p. 162.

sider the mapping of knowledge as content and the final seminar as form of the design process” (Guerrini, 2020, p. 165).

The Process of Adaptation

The first challenge we faced designing “The legacy of Tomás Maldonado” was to adapt the bottom-up approach of the model to the new content and goals. Although the exploration of the complex and multifaced scientific production of the master was the assignment, we rejected from the beginning any subjection or – worse – flattery. Doctoral students were young enough to cast fresh light on his intellectual endeavour. Most of them had never met him personally nor studied deeply on his books before. Therefore, they could interpret the term “legacy” in a personal, original and unbiased way.

Maldonadian corpus, however, is so vast, his scientific biography of theoretician, educator and professional so complex that we, as instructors, had to provide the students with a compass. Among many choices we finally selected six topics as potential fields for further investigation: the role of art practice, design pedagogy, environmental design, the relationship between design and technology, the body and the notion of interaction, the connection between design, linguistics, and semiotics. Each topic was introduced by a brief, carefully selected list of references that could help students quickly finding their favourite field of investigation. This strategy mediates between full freedom of choice and assigned task, allowing to form groups sharing common motivations and goals.

The second challenge we faced was indeed a tough one and consisted in rearranging the course in a remote modality. We were aware that the design and management of the course as well as teaching practices required adaptation to online teaching (Boling, et al., 2012). Distance learning gave us a unique opportunity “to include geographically dispersed audiences via online” (Keengwe, Kidd, 2010, p. 538), thus laying the foundation for further doctoral courses, even if the new medium seemed testing hard any pedagogical approach based on

dialogic conversation and empathy. The philosopher Carlo Sini delves into the distance learning experience from a phenomenological perspective distinguishing between competence and knowledge. We can successfully acquire the first via online, resting on the efficiency of tailored technological tools. Much harder – or even impossible according to Sini – is to achieve the second for it can only spring from the encounter with the other “in flesh and bones”.³

This attitude towards distance learning was common thinking among many Italian academics before the pandemic. Unlike foreign universities, especially in the US, which massively tested the potential of both synchronous and asynchronous distance learning (Keengwe, Kidd, 2010; Baran, et al., 2013; Kebritchi, et al., 2017), limited experimentations had been put in place in previous years in the country. Therefore, this learning modality was regarded with vague suspicion, which only the pandemic emergency forced to reconsider.⁴

Compared to past foreign experiences, however, our model showed promising features. Our pedagogy is characterized by an active learning student-centred approach as many online learning environments (Browne, 2005). Collaborative components are fundamental for the development of learning practices (Olofsson, 2007). The teacher/learner interaction in our course share with successful online activities a strong dialogic approach (Baker, Watson, 2014). Finally, the teachers already act as tutors or facilitators (Anderson, et al., 2001; Baran, et al., 2011). The shift to distance learning was therefore reasonably feasible.

Moreover, both the doctoral students and the teachers were already skilled to handle the tools. The course was designed between November 2020 and January 2021 after everyone experienced the dramatic move into the web of the whole education system in spring 2020

3 Carlo Sini, *Education and telematic tools* [in Italian], <https://www.youtube.com/watch?v=kA9pxBvXud0>. See also Edmund Husserl, *Phenomenological Psychology. Lectures, Summer Semester, 1925*, edited and translated by John Scanlon, Martinus Nijhoff, The Hague 1977, p. 11.

4 The debate involving Carlo Olmo, Ferruccio Resta, Gabriele Pasqui and Francesca Tosi on *Il giornale dell'Architettura* immediately after the beginning of the pandemic is particularly meaningful in this respect, <https://inchieste.ilgiornaledellarchitettura.com/a-distanza-da-chi-2/>.

(Crawford, et al., 2020). That trial and – sometimes – error process we went through was crucial for shaping the course appropriately, and – especially for the teachers – for reconsidering their role in the learning process at large.⁵ Since we had never practiced distance education before the pandemic, our effort was to translate the experience we gained from emergency remote teaching into a better formalized online learning proposal (Hodges, et al., 2020).

Designing the Course

Both in past experience and in the new course, doctoral students were meant to play a central constructive role. Elaborating on “The legacy of Tomás Maldonado” they could rely on robust critical, methodological and technical tools they acquired before joining the class. They knew how to analyse and critically review texts, how to find further references and map them, how to extrapolate meaningful questions from the outcomes of their research. Therefore, they could focus on the chosen topic mastering most of the tasks required.

Teachers instead had to carefully adjust their posture to fit the virtual learning environment. The online teacher roles identified in the literature, likewise in the traditional face-to-face context, “comprise pedagogical, facilitator, instructional designer, social, managerial, and technical roles” (Baran, et al., 2011, p. 427). These roles, however, are differently prioritised (Bawane, Spector, 2009). Expert teachers in a face-to-face contest can always adapt the learning path in real time according to the reaction of the students. In online teaching the quick real time response may be ineffective. Therefore, instructional design, that is planning, organizing, and structuring the course components became crucial (Anderson, et al., 2001, p. 4-6; Hodges, et al., 2020, p. 4).

5 Affective factors, which apparently have no room in virtual classrooms (Keengwe, Kidd, 2010; Baran, et al., 2013; Kebritchi, et al., 2017) were crucial in this respect: “The negative connotations of risk-taking and making mistakes while learning to teach online seem to have been mitigated by a combination of affective factors such as humility, empathy, and even optimism” (Maile Cutri, et al., 2020, p. 523). See also Stafford, 2020.

Between November 2020 and January 2021, we carefully evaluated available teaching tools, drafted the programme, collected instructional materials such as texts, videos, introductory lessons, planned the course activities, shared basic information with the colleagues in charge of the doctoral programmes, arranged the communication material,⁶ and finally chose the appropriate technology to deliver our course.

To promote collaborative practice and to stimulate conversation among the students as well as between the students and the teachers the course approach mostly relied on synchronous online teaching. The medium adopted was web videoconferencing for it provided us with the most classroom-like virtual environment,⁷ as we experienced and tested during the pandemic emergency. Therefore, we not only organised a common virtual room open to the whole class according to the course schedule, but also set six smaller rooms by topic where groups could meet at any time.⁸

The effectiveness of web videoconferencing in education was placed under scrutiny by Maldonado in his extensive effort to understand the upcoming digital world (Maldonado, 1992; 1997; 2005). His investigation led him to claim – not surprisingly – that this practice would play a crucial role in future education even though videoconferencing was in its infancy at the time of his studies (Maldonado, 1997, pp. 82-83, pp. 127-135). In this respect, especially in recent years, we made considerable steps forward.

In web videoconferencing we share our digital self in a digital space. We interact with others striving to imitate the gestures and the rituals

6 Thanks to the graphic designer Lorenzo Bigatti/www.lorenzobigatti.xyz.

7 In the early years of online teaching practice, the similarity between videoconferencing and classrooms was analysed (Bernard, et al., 2004). More recent studies confirm that web videoconferencing “appears to provide a more promising learning environment for students to freely collaborate and communicate effectively through different interaction channels” (Al-Samarraie, 2019, p. 132).

8 The effectiveness of the – so called – “breakout room” is underlined by Yanhong Wei and Huili Tang: “Online learning provides a proper framework for collaboration, allowing learners to be split into breakout rooms and assigned teamwork to make decisions and prepare for the virtual plenary presentation” (Wei, Tang, 2022, p. 4). See also Chandler, 2016.

of face-to-face social interaction. The effectiveness of this behavioural strategy seems supported by evidence accumulated in literature.⁹ Much work, however, is still required to understand the overall rules of digital interpersonal communication.

Besides the main medium, we set up parallel communication tools, such as e-mail, instant messaging, and a storage system to provide doctoral students with a continuous flow of information and data. Compare to face-to-face, online teaching particularly requires this kind of facility, not only for smoothing the working process, but also for reinforcing the students' community building and the perception of the teachers' "presence" (Anderson, et al., 2001, p. 6; Martin, Bolliger, 2018, p. 218; Cundell, Sheepy, 2018, p. 98). Managing this information network increases teaching workload heavily. Therefore, it usually involves a dedicated instructor. This role is crucial for an effective course management, and requires scrutiny and sensitivity. The teacher doesn't merely share files and instructions, rather s/he acts as coach, facilitator and conflict manager.¹⁰

The introduction of an instructor mainly devoted to communication is not the only novelty in the teaching staff compared to our previous teaching model. The contributions of external experts in a distance modality only last the time of the webinar, no travel time or staying are required, therefore a talk to students fits much easier in a scholar's busy agenda. To broaden the perspective on Maldonado's work, we decided to act accordingly. Design critics and historians belonging to the younger generation could bring novel interpretations about the topics under scrutiny. University colleagues could discuss the effectiveness, the topicality – and even the legitimacy – of our investigation. Maldonado's pupils could testify to his talent as a teacher, his rigour as scholar, his multifaceted personality. Therefore, we got in touch with several scholars to check for their availability and finally

⁹ See note 7.

¹⁰ We thank Pierfrancesco Califano who played this decisive role in the course.

scheduled a series of webinars in which they generously shared their ideas with our doctoral students.¹¹

Throughout his life Maldonado delved into technology with vigilant attention carefully weighing both social opportunities and risks of any new development. Technology plays a crucial role in online teaching. In fact, the whole education process is filtered by digital tools, which scholars deeply analysed often achieving conflicting results. Commenting on this considerable scientific production needs more elaboration than this short essay allows. Especially because in the context we operated technology was a given. Therefore, we integrated the electronic tools we were provided with according to their function, performance, and potential, without any favour or suspect. The full list comprises the following items:

- a) a videoconferencing application with which we implemented a virtual classroom for delivering introductory lessons, plenary sessions of the ongoing work of groups, meetings with guest experts and finally for giving the seminar. The same application was also used to set up “breakout rooms” open to doctoral students at any time for teamworking;
- b) a digital repository to archive our library consisting of selected reading from Maldonado’s scientific production, essays on Maldonado written by guest experts and other scholars, work instructions, shared working papers, video-recordings of collective discussions, in-course presentations and research material, as well as files about the course organisation and scheduling, and information about the participants;
- c) email and instant messaging applications, the first for sharing structured information and communication, the latter for quick feedback and Q&A sessions out of the scheduled class days;

¹¹ For their participation in the course we sincerely thank: Giovanni Anceschi, Larry Busbea, Medardo Chiapponi, Federico Deambrosis, Stefano Maffei, Ezio Manzini, Emanuele Quinz.

- d) collaborative whiteboards, especially used by the students for teamwork and for discussing with the teachers their elaboration on the chosen topic step by step;
- e) presentation software for sharing intermediate developments, and final outcomes.

The Course Scheduling

Relying on these premises the course scheduling outlined a path in four steps: a preliminary phase anticipating the course start; a research development phase which constitutes the core-activity of the course; a third phase aiming at organising the seminar, and finally the presentation and the discussion of the research outcomes within the seminar itself.

The preliminary phase represents the main novelty with respect to previous experiences. A call for participants was sent to colleagues in charge of the doctoral programmes on November 2nd, 2020. 59 students enrolled from 12 programmes of 11 universities. The class, therefore, showed promising numbers right from the start. On the one hand, considering that the staff consisted of 3 teachers, the student-instructor ratio was 20 to 1, which is rated more than optimal in literature (Means, et al., 2014), on the other the average number of students per programme was close to the one of the envisioned topics, so that the development of almost all the topics could involve representatives of each programme.

Transforming promising numbers into cohesive working teams, however, proved to be a tough task, since most of the students had never worked together before. The mediating role of the instructor was crucial in this respect. In mid-January 2021 we began sharing information with the students about the course programme, the methodology, the scheduling and the expected outcomes. Especially we focused on the six lines of research on which the doctoral students were expected to work, asking them to indicate preferences that could help us setting up the teams. Working on the preferred topic, in fact, would

have certainly stimulated an active and fruitful collaboration among the participants in each team.

To introduce Maldonado to the doctoral students we suggested them to read *Arte e artefatti*, which summarises his work in the form of an interview-balance, and is also his last published book. Furthermore, we gradually uploaded texts by and about Maldonado to the online repository. This material had the dual purpose of guiding doctoral students in choosing their topic, and forming a solid basis for the subsequent research work. At the end of the preliminary phase 6 research teams fairly representing the doctoral programmes and the students' expectations were ready to start.

On February 19th 2021, the course began. The three teachers gave introductory lessons, which outlined Maldonado's profile, his early years as militant artist in Argentina, and the overall course programme and aims.¹² Maldonado himself actually contributed to the opening session. We were lucky enough as to discover an unpublished video-interview of 2012 in the Politecnico di Milano archive, which was projected at the end of the first day.¹³

The course, then, took place on a weekly basis. The meetings involved the class alternatively in checking research development and in debating with guest experts. Most of the research work consisted in reading and critically understanding the chosen topic as it emerged from Maldonado's bibliography and from his commenters. Students had to find out key issues that might cross their own doctoral research, thus providing a personal interpretation of the legacy of Maldonado. In this process they acquired valuable knowledge for the setting and development of their research, especially they familiarised with Maldonado's distinctive approach to critical thinking, which is one of his fundamental legacies.

12 These lessons were given by Raimonda Riccini, Pierfrancesco Califano and myself respectively.

13 The video-interview consists of one hour of rough material recorded by ImagisLab of Politecnico di Milano under the direction of Marisa Galbiati and Elisa Bertolotti. We thank the authors for sharing.

Meetings were usually organised by topic, especially because after a few weeks the overall group of 10-12 students had split into 2-3 smaller teams each one delving into a defined sub-topic. Teams elaborated on the chosen sub-topic independently, and brought the outcomes of their work to the attention of the teachers, usually sharing their whiteboard on the screen, which plastically displayed the ongoing process or adopting more formal Power Point presentations. The teachers basically focused on listening and understanding the issues at stake facilitating discourse and encouraging students to probe their assumptions (Anderson, et al., 2001, p. 6; Baran, et al., 2011, p. 426). The teachers could also recommend meaningful examples, additional resources, and effective research tools. They rarely questioned the whole process, rather, they intervened mainly to clarify the meaning of sources and to prevent misunderstanding.

Plenary sessions addressed class issues such as methodological and organisational ones and also served to verify the effective development of the elaboration process. In the distance learning mode these sessions played a crucial role for community building. Therefore, their scheduling concentrated in the initial and final part of the course and included intermediate monthly meetings as well. In fact, most of the final seminar organisation was set up in plenary sessions. For the rest of the course, they hosted meetings with guest experts.

As we anticipated, to stimulate and enrich the debate, we made use of the contribution of several guests who generously shared their ideas on the work and legacy of Tomás Maldonado. Their considerations affected, explicitly or implicitly, the proceeding and final outcomes of the course. To link effectively the talks of guests to the work of students, we asked each speaker to reflect on a given keyword which addressed the disciplinary debate in general and Maldonado's studies in particular.¹⁴ Moreover, we accurately set up these meetings. Texts by the authors were uploaded to the repository in advance and we

¹⁴ The six keywords, tailored on the role of each guest in the course development were: "utopia" (F. Deambrosis), "object" (E. Quinz), "environment" (L. Busbea), "method" (S. Maffei), "knowledge" (M. Chiapponi and G. Anceschi), "design" (E. Manzini).

recommended that the students prepare pertinent questions not only to encourage lively debate but also to provide them with meaningful indications on how to develop both the course tasks and their doctoral research.

On March 26th, after six weeks, the course was halfway through. Teams had sufficiently delved into the topics and framed the corresponding sub-topics so that they could sketch an overall picture of the final seminar. In previous years this task would involve many issues dealing with the physical world, such as logistics, accommodation of guests, printing matters, and catering. The distance mode scratched most of them out. The few remaining decisions concerned the organisation and scheduling of the day, the role and sequence of the speakers, the choice of the discussants. Nevertheless, organising the online final seminar proved to be a challenging assignment.

The students first attempted to redefine the seminar as a whole evaluating different sequencing of the speakers, suggesting alternative patterns of interactions between speakers, discussants and the audience, and extending the duration of the seminar over more days to expand on the course outcomes. All of these proposals proved to be unrealistic not only because they required careful testing but also because online interaction, as far as we have experienced, calls for precision and conciseness.

Students then focused on the choice of discussants which required long careful scrutiny, especially matching the appropriate profile to the issues raising from the research outcomes. Once we fixed the actors, the content and the schedule of the seminar, additional time was spent checking the efficacy of communication. The class had a fortnight in rehearsal, carefully verifying the layout and the correctness of Power Point presentations, the fluency of the speeches as well as their appropriate sequence and timing.

Throughout this process the role of the teachers slowly shifted from counseling to supervising. The urgency of decision-making prevailed over pedagogical premises as sometimes happened also in our previ-

ous face-to-face teaching experiences. Choices, however, were always shared and deeply discussed in the class before taking any resolution.

Finally, on May 14th, the class gave the seminar witnessed by this book, or we may say that the book is an unpredicted additional workload suggested by the success of the seminar itself, although many students had asked for publishing a book even before the course ended.

The index of the publication conforms to the content and sequencing of the presentations. The titles of the six main research topics were carefully redefined and broadened into 16 key issues¹⁵ to put the legacy of Tomás Maldonado into the new perspective the class was eager to share with the audience.

The webinar was opened by the dean of the School of Design and by the director of the PhD programme in Design of Politecnico di Milano¹⁶ which virtually hosted this initiative. Then teachers appeared on the screen to outline the motivation and the expected outcomes of the final seminar. After the presentations, both in the morning and in the afternoon session, acknowledged scholars contributed to a lively round table not only by providing the class with insightful and constructive comments but also by filling the screen with their appealing bookshelves.¹⁷

The pandemic emergency was undoubtedly crucial in the choice of switching to distance learning. Comparing our experience to similar ones in the same period, however, is difficult. Most of them outline the rapid adaptation to the new condition of typical content-based learning focusing on issues such as keeping students focused on the task or assessing knowledge acquisition. Also, many scholars underline the relevance of teacher-student interaction, especially the dialogue be-

15 There were 17 presentations in the seminar, unfortunately one group resigned from writing in this book.

16 We sincerely thank Luisa Collina and Paola Bertola for introducing to the audience the School and the PhD programme respectively.

17 For their contribution to the seminar we sincerely thank: Rocco Antonucci, Pier Luigi Capucci, Cristina Chiappini, Riccardo Falcinelli, Davide Fornari, Carla Langella, Tatiana Mazali, Alessandro Tartaglia, Salvatore Zingale.

tween the two. Among the many, we may find similarities with the extensive/intensive online learning approach. This approach adopts “compulsory pre-session student-led group discussions which are documented and [shared with] the lecturer” (Bryson, Andres, 2020, p. 619), and it has proved effective for classes comparable in size to ours. “Extensive online learning experiences involve the curation of resources to support self-guided learning and [the subsequent] intensive learning experiences” (Bryson, Andres, 2020, p. 616), which “revolve around online engagement with the academic(s) and other students in real-time as part of the co-creation of experiential learning experiences” (Bryson, Andres, 2020, p. 618). Some scholars describe massive online seminars, which do not involve doctoral students (Chia-En Teng, et al., 2012). Not many others seem to share the path we followed.

The Questionnaire Outcomes

As common practice at the end of a course, we drafted a survey aimed at checking whether the learning experience fulfilled students’ expectations. The short questionnaire (see Appendix) was developed on the basis of the “students’ opinion survey” usually distributed to the students of Politecnico di Milano. The original 20 items were reduced to 11 and modified to fit the setting of the course. Questions aimed at testing the effectiveness of preparatory materials, online teaching, teamworking, guests’ contribution, and the overall satisfaction of the participants. The students were asked to rate items using a 5-point scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Three open questions were added to find out students’ opinion especially on the course management, the quality of interaction, and to seek for suggestions to improve the learning experience.

A few days before the seminar took place, we sent the whole class the survey by email. Only 7 students replied on that occasion, very likely because respondents to an email were identifiable. Therefore,

we sent the survey again one month later using Google Form, which let the students answer anonymously, and we collected 25 responses.¹⁸

The total number of respondents to the two questionnaires was 32, that is almost 60% of the whole class, a significant rate for the analysis. In both cases, most of the students were extremely supportive so much so that the average score for each item was 4. Such a successful result requires deep scrutiny, and decimals may help, in this respect. The preliminary work was rated the highest (4,64)¹⁹ confirming the efficacy of our effort. The overall satisfaction about the course was high as well (4,08), so we can reasonably think this experience can become a model for further educational initiatives. The effectiveness of the teacher/student interaction was acknowledged by everyone (4,24), even if our contribution was mostly perceived as prescriptive (4,04). Some critical issues were raised about teamworking (3,84), therefore the goal of effective distance interaction requires additional work. Similarly, the distance learning modality, which scored the – relatively – lowest rate (3,76), requires careful scrutiny. We made all our effort to overcome the prevailing opinion that online “a sense of being connected to a learning community is weak” (Kuong, 2014, p. 1004). The nostalgia for face-to-face learning, however, seems persisting.

Among the many positive – or extremely positive – responses, there is only one doctoral student expressing deep dissatisfaction, substantially about the unbalance between workload and final outcome: “We worked three months – s/he claims – for speaking individually 3 minutes, in the final seminar!”. Workload was undoubtedly heavy, as many others underlined without complaining. The statement, however, shows the commitment and expectations of a typically self-centred personality, which teachers should have considered. In the seminar, teams presented the outcomes of a collaborative work in a collaborative manner – like a choir. Each topic was given about 20 minutes, an amount of time totally effective and suitable to the seminar’s goals.

¹⁸ 55 students of the 59 enrolled effectively completed the course and took part in the seminar with a drop-out rate of 9%.

¹⁹ Reported rates come from the anonymous respondents.

Still the student thinks this choice doesn't provide her/him with any personal contentment.

Open questions provided us with more clues to assess the whole experience. They focused on four issues: information, management, teamwork, and interaction. Many students asked for a comprehensive, syllabus-like programme carefully detailing expected outcomes, scheduling, and workload. Such a programme should have been provided before enrolment so that students could evaluate whether joining the course or not. They also suggested the adoption of precise instructions specifying contents and formats (template, layout etc.) both for intermediate delivery and the final seminar which, from our perspective, is indeed a cultural shift, rather than the suggestion of a good teaching practice. In fact, providing the students with so strict prescriptions would reduce their capability not only to design but also to think.

With respect to the course management students suggested to expand the introductory part not only for sharing more information about Maldonado, and the six research topics – that is about the course content in general – but also for getting acquainted and facilitating team building. Increasing team-reviews in this initial part would also serve to check teachers' expectations. Typically, all these suggestions involve online interaction, therefore they should be carefully scrutinised. Students also complained about workload, which they estimated considerably heavy and only partially compensated by the value of research and the relevance of the seminar.

Teamwork was indeed a crucial topic crossing the issues of both workload and interaction. Students suggested smaller groups of 5/6 people, which are much easier to manage, and an increase of synchronous learning with respect to asynchronous one, that is concentrating teamwork in the virtual classroom rather than at home. They also criticised the process of splitting groups by topic into smaller ones by sub-topic, especially because they were asked to join together again for the final seminar, which required additional work.

Interactions involved student to student, teacher to student and guest to student relationship. Peer-to-peer learning was strongly recommended by the students although they admitted that the virtual environment exacerbated group dynamics. Peer review should involve the whole class and more time should be spent in this practice rather than in conventional teacher to students review. Partially contradicting their colleagues claiming precise instructions some students also requested more time for independent work and speculation out of the teachers' guidance. Guest speeches were rated highly valuable therefore many students focused on this experience recommending more accuracy in providing the class with information about the guest and instructions on how managing the debate. Someone also suggested leaving the guests free in the choice of topics to explore.

Significantly, some students complained that they were not formally thanked by the teachers for their efforts in organising the final seminar. The thing is that by the end of the course we were as exhausted as the students. This essay, however, is a good opportunity to correct this impoliteness. We believe everyone performed excellently at every stage of the learning process. Furthermore, their dissatisfaction clearly demonstrates that the course was fully successful in recreating the expectations, the rituals, and the social conventions of a face-to-face learning environment. Like any experimental training experience, however this too can be improved and we will move in this direction.

Appendix

The result of survey: anonymous respondents (25)

Category	Items	Responses					Average rating	Overall rating
		SD	D	N	A	SA		
		1	2	3	4	5		
Preparatory work	Was the preparatory material beneficial?			1	7	17	4,64	4,27
	Was the preliminary work (team building, programme, etc.) effective?	1	2	4	7	11	4,00	
	Was the reading of the book <i>Arte e artefatti</i> helpful?		1	4	10	10	4,16	
Course development	Was the distance learning course set up satisfactorily?	1	1	6	8	3	3,88	3,82
	Would you replicate the same format in other courses?	1	4	3	9	8	3,76	
Teamwork	Was the teamwork carried out satisfactorily?	1	2	5	9	8	3,84	3,95
	Did teams work independently?	1	1	3	13	7	3,96	
	or Did teams work under the guidance of the teachers?		1	4	13	7	4,04	
Teachers' contribution	Were the teachers' crits helpful?	1	1	4	4	15		4,24
Experts' contribution	Were the conversations with			6	12	7		4,04
Overall satisfaction	What is your overall satisfaction level?	1	1	2	12	9		4,08

The result of survey: identified respondents (7)

Category	Items	Responses					Average rating	Overall rating
		SD	D	N	A	SA		
		1	2	3	4	5		
Preparatory work	Was the preparatory material beneficial?			1	3	3	4,29	4,53
	Was the preliminary work (team building, programme, etc.) effective?				4	3	4,43	
	Was the reading of the book <i>Arte e artefatti</i> helpful?				1	6	4,86	
Course development	Was the distance learning course set up satisfactorily?				3	4	4,57	4,43
	Would you replicate the same format in other courses?			1	3	3	4,29	
Teamwork	Was the teamwork carried out satisfactorily?			2	1	4	4,29	4,11
	Did teams work independently?			1	4	1	4,00	
	or Did teams work under the guidance of the teachers?		2		3	2	4,04	
Teachers contribution	Were the teachers' crits helpful?				1	6		4,86
Experts contribution	Were the conversations with experts helpful?			2	1	4		4,29
Overall satisfaction	What is your overall satisfaction level?				3	4		4,57

SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

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Maldonado, Design *and* Research

Raimonda Riccini

In the long and controversial history of teaching design at Italian universities, Tomás Maldonado was a central figure. He played this role “indirectly” through the wide-ranging influence of the Hochschule für Gestaltung Ulm (Ulm School of Design), but he also played a direct and active role through his part in developing new proposals for the teaching of design. These include his work at DAMS (School of Art, Music and Performing Arts) in Bologna; his contribution to specific projects, such as for the Department of Environmental Studies at the University of Bologna (1976, not realised); and his introduction of the first doctorate research programme in industrial design (1990) and of the first bachelor’s course in industrial design at a public university (1993-94). These two channels of Maldonado’s influence – direct and indirect – may seem distinct, but they are closely tied – as I aim to show in the following pages.

In the thirty years after the Second World War, design faculties were established everywhere in Europe and beyond, taking their inspiration from the Bauhaus and, after its closure in 1968, the Ulm School of

Design. The Italian education system, however, was uninterested in – if not positively hostile to – the idea of a nationwide method of teaching design based on the Humboldtian concept of the university as a place for teaching and research. In Italy, a different concept was used. It was referred to by Giuseppe Furlanis as the “Italian way of teaching design” – a bumpy, experimental approach driven initially by the vivacity of private design schools and the personal enthusiasm of the people involved. This was particularly true of the Centre for the Study of Industry and Art in Novara, founded in 1954 by Nino Di Salvatore. These private initiatives arose alongside public ones such as those of the ISIA (Higher Institute for Artistic Industries) and of the Advanced Course in Industrial Design in Venice (1960-72). In his *Introduzione al disegno industriale*, Gillo Dorfles complained that, despite boasting industrial design of the highest level in certain sectors, Italy suffered “an almost complete lack of teaching methodology, so much so that most of our designers are either self-taught or are architects who have applied the notions they absorbed during their architectural studies to the design of objects” (1967, p. 89).

Unlike the rest of the world (UNESCO-ICSID, 1967), Italy had not laid out any recognisable educational programmes at a national level consistent with the advanced state of its industry and the quality of its industrial design. The demand for professional training in the field was met with initiatives that either arose from the requirements of local specificities or were developed within individual faculties of architecture. While these events have already been recounted extensively (Pansera, 2016; Bulegato, Pastore, 2018; Furlanis, 2019) the deeper reasons for this situation are only now beginning to be investigated (Riccini). I do not wish to dwell on these here so, rather than rewrite the history of these institutions, I will focus on the fact that, in Italy, alongside this disorderly process there was a lively debate. There are two points at which this public discussion peaked: one in the 1950s and the other in the 1980s.

During the First International Congress of Industrial Design held at the Milan Triennale from 28 to 30 October 1954,¹ Giulio Carlo Argan spoke of the urgent need to define a design teaching programme, reminding his audience of the need for a “profound reform... of the educational systems as a whole”. Another well-noted catalyst were the numerous documents and opinions on the subject published in “Stile Industria”, the magazine founded and directed for twelve years by Alberto Rosselli.² In particular, the magazine focused on the conference held by Tomás Maldonado at the Universal Exposition in Brussels titled Higher Education and the Education Crisis – a cornerstone of the culture of design and the profession.

A second and decisive moment came in the 1980s, when the importance of the profession was already well established and the new areas of design knowledge concerning architecture students were becoming clearer. An example of this, at the end of the decade, is the cycle of seminars promoted by Nicola Sinopoli (1990) and hosted by the Istituto Universitario di Architettura di Venezia (now Università Iuav di Venezia).. Representatives of design education, from both public and private sectors, were called to the discussion, in particular those involved in the Industrial Design and Furniture degree course at Politecnico di Milano, “the only course held in Italy that structurally coordinates the various disciplines relating to design at university level” (Sinopoli, 1990, p. 53).

The path I have briefly outlined began with a new awareness of the urgent need to establish an academic method of teaching design. This was the starting point of the process that led to the acceptance of de-

1 In addition to a young Tomás Maldonado who had recently arrived in Germany, personalities such as Luciano Anceschi, Giulio Carlo Argan, Max Bill, Gillo Dorfles, Lucio Fontana, Asger Jorn, Enzo Paci, Ernesto Nathan Rogers, Alberto Rosselli, Walter Dorwin Teague, Jacques Viénot, Vittoriano Viganò, Konrad Wachsmann, and Marco Zanuso participated. The proceedings of the three days were published on the initiative of Augusto Morello (1928-2002) with the title *La memoria e il futuro* (Memory and Future), 2001.

2 Numbers 18 and 19, 1958 that focused on the subject of teaching abroad and in Italy, and Number 21, 1959 dedicated to the Ulm School of Design, its methods and its protagonists.

sign as a subject for study at university level. The Venice seminars subsequently sparked debate on a number of topical issues, the first being the design environment – to which Maldonado had made a significant contribution, such as in his essay *La speranza progettuale* (1970; new edition 2022). Another environmental factor was the emergence of the computer as a design tool, which Maldonado had already explored during his years at the Ulm School. There, cybernetics and computer science were considered essential, and the potential for computers to create new ways of using graphics was explored.

Two major questions were introduced during the debate: the relevance of technology to the design process, and the intrinsic presence of technology in both products and services. Both themes necessarily implied the increasing involvement of disciplines hitherto ignored in design circles.

These disruptive issues were addressed in precise terms, and it may have been exactly this that led to research taking on a decisive role. Acknowledgment of the importance of research in the field of design was vital for its acceptance as a subject suitable for study at university, an institution – we should bear in mind – whose primary activities are teaching and research. The opportunities for research in the field of design clearly facilitated its entry into academia.

The importance of research was central to the project Maldonado had devoted himself to since his Ulm years – a project that investigated teaching methods and the integration of new subjects such as semiotics, ergonomics, and cybernetics (the Ulm School of Design being the first to include these in a design course). For this reason, the institution of the first PhD course in Industrial Design at the Politecnico di Milano preceded that of the bachelor's course by a few years. Driven by the need to develop research in a field that included innovative themes such as product configuration and planning, development of materials, and environmental issues, the doctoral programme was introduced during the fifth cycle of the PhD course in 1990, with

the name of Doctorate in industrial design.³ The thematic areas were theoretical, product, communication, environmental, historical-critical. The first coordinator was Raffaella Crespi, while teaching staff included Giovanni Anceschi, Achille Castiglioni, Tomás Maldonado, Ezio Manzini, Attilio Marcolli, Guido Nardi, Gianni Ottolini, Giandomenico Salotti, Francesco Trabucco and Marco Zanuso. A combination of three design areas – design, architectural technology and interior design – was a prelude to the Industrial Design degree course being prepared by the Faculty of Architecture.

The reason for offering the PhD course before the bachelor's course was not only the academic-political procedure necessary for setting up the latter but also Maldonado's belief that research is "a sort of permanent reference for design" in an increasingly important "operational convergence between design and research".⁴ The predominance of research, therefore, makes it a starting point for each successive educational project – a basic element for any branch of knowledge that needs structure in order to be taught. Moreover, research is also fundamental to the development of design as a professional activity.

The dual nature of design – theoretical vs. practical, speculative vs. applied – has conditioned the academic development of the discipline while at the same time being a source of ambiguity for research. It is no accident that Maldonado, too, dwelt on this duality in his text. On the one hand, there is research into design theory configured as a "thorough investigation into the nature of the tasks that industrial design

3 Independent doctoral courses at various Italian universities were formed later, including the doctoral design course in Venice (2007). Currently, research centres in Design, with dedicated grants or curriculum within courses with other denominations, are active in numerous locations: Bologna, Florence, Camerino, Rome, Naples. The PhD in Industrial design at the Politecnico di Milano was one of the first at international level. On the PhD in the international debate, Durling, Friedman (2000); Friedman, Ox (2017).

4 This citation, like many of those to follow, is from the opening lecture that Maldonado gave at the international conference *Design Plus Research*, organised by the Politecnico di Milano in May 2001, in which he was able to make a succinct but comprehensive presentation of his ideas regarding doctoral research. Maldonado's critique and the title of the convention provided the formula for the title of my text.

is called to perform”. Maldonado sees this occurring in the context of transformations resulting from the development of technologies and the social, cultural, and environmental challenges of our time. On the other hand, he writes, there is “practical research [...] with the aim of offering the innovative design of products or of systems of products and services”.

According to Maldonado, both types of research require a “framework for action” based on an accurate, rigorous, and non-dogmatic definition of design and compatible with the dual nature of the discipline. And, I would add, this definition must work as an identifying element shared among researchers.

In 1961, Maldonado had put forward the definition that would be officially adopted by the International Council of Societies of Industrial Design (ICSID, now WDO, World Design Organisation). His return to the question of definition was doubtless dictated by the need for a conceptual framework. But it also implied commentary on the use and lexical abuse of the term design. His overt aversion to the “digressions on design” promulgated by the media is known, but he also disapproved of the indeterminacy the word had taken on, its gradual stripping of meaning, its vagueness, its indiscriminate use by architects, engineers, fashion designers, scientists, philosophers, managers, politicians... in a sort of “terminological Babel”.

Far from being a mere question of semantics, adopting clear specifications for the context in which a discipline operates is essential to allow the basic elements of any research work – theories, methods, areas of application and tools – to come into play. (And, of course, play means interplay, even to the extent of shifting the boundaries of the definition we started out with.) This is particularly true in the case of the hybrid discipline of design. According to Maldonado’s definition, it is “heteronomous”, with a low level of independence: “In fact, more than any other, design is subordinate to the methods and results it borrows from other disciplines”.

For design, this occurs in basic, theoretical, and applied research, in areas closest to natural science and technology and those more typi-

cal of social sciences. For a design researcher, the task of identifying specific research tools in this context may appear complex. Maldonado, however, found a number of fixed reference points common to all fields of research. Leaving aside the differences that exist, for example, between research in chemistry, molecular biology or astronomy and research in design, the latter should “be able to meet the basic criteria of ‘scientific acceptability’. If this were not the case, the notion of design research would become too loose, too fluid and elusive, and jeopardise the possibility of being recognized as genuine research”.

I think it is pertinent, at this point, to ask whether current research in design, even at a doctoral level, concerns itself with a fleeting and nuanced idea or whether it resides in a structured environment, endowed with both the minimum prerogatives of “scientific acceptability” and its own tools and methods adapted to the transformations of today’s world. Current changes in socioeconomic and technological developments clearly have profound repercussions for the profession – and therefore also a significant impact on the nature of the research that the university must promote, especially at doctoral level. This question of research is crucial – and perhaps even alarming – because despite being able to adapt to the radical changes taking place at a global level, the discipline of design lacks sufficient critical and orientational skills. For instance, digital technologies are guiding all the restructuring processes of our contemporary material culture, but barely encounter critical opposition.

Seen from this point of view – beyond its shiny public image – design has never appeared so fragile and uncertain as it does today.

Here is just one example of the current situation. Many professions now make use of methods that nod at those used in design, such as design thinking or co-design. Both these methods are specific to design but have been adopted by other disciplines, such as marketing or sociology. Business teams are taught to develop creative thinking modelled on that used by designers, along with problem-solving inspired by the scientific approach used in research. Participatory techniques are used to make decision-making processes faster and more fluid.

Furthermore, these disciplines, in using the operational and creative methods of design, adopt what I would call the “standard model”, that is, the one developed since the middle of the last century. Design, on the other hand, has rediscovered these “novel” working methods, and has begun to apply them to its own research!

It is worth going back to the years in which the basic methodologies of the discipline were established – above all, those relating to the scientific approach to design. Significant historical references include the foundational work conducted at the Hochschule für Gestaltung, Ulm; the 1963 Conference on *Design Methods*, organised by John Christopher Jones and D. G. Thornley in Great Britain; the 1964 publication of *Systematic Methods for Designers* by Bruce Archer, director of the Design Research Unit at the Royal College of Art; the formation of the Design Methods Group at the University of California, Berkeley in 1967; the *Design Methods in Architecture* Symposium, organised in Portsmouth, UK, by Geoffrey Broadbent and Anthony Ward in 1967; and the publication in 1968 of the book *The Sciences of the Artificial* by Herbert Simon and in 1970 of the book *Design Methods* by John Christopher Jones. Since the 1980s, the theme of methodology has lost its centrality, but it has continued to be the backdrop to the rich debate on the discipline of design. Leading figures in the debate include R. Buchanan, C. T. Mitchell, V. Margolin, K. Friedman, N. Cross, T. Love, A. Findeli and others, including a number of designers (though not as often as might have been expected). For a more detailed assessment, see Bayazit, 2004.

Most of their contributions were aimed at identifying the placement of design among other project-based disciplines and at establishing appropriate methods for its academic development, both in its operational and experimental versions – hence the controversy in the use of the term “design research”. The discourse on design as an academic discipline and on the profession of designer found no correspondence in a similar specific discourse about research, at least until more recent years. Perhaps the reason is that – as mentioned earlier – design

has, for a long time, been perceived as a project-based discipline, not a fully-fledged academic discipline.

While research in design in terms of working methods has continued to focus on the problems and areas in which the research can be applied, it has often borrowed from other disciplines, adopting methods typical of semiotics, economics, marketing, psychology, ergonomics, history of art, and architecture, etc. This step is completely normal during the formation of any academic discipline. In the 1950s and 60s, methods attributable to engineering, systematic research, mathematics, and scientific fields were reworked and rethought in terms of their potential as a foundation for the new discipline. This is exemplified by the inclusion of exercises on symmetry, topology, and the psychology of perception in the foundation course at Ulm, and by the development of the project as a procedural and flexible phenomenon, etc.

Today, instead, there seems to be a certain passivity in this regard. In a doctorate research programme, when we speak, for example, of “user-centred” research, “ethnographic research”, or “qualitative research”, how does the design approach differ from that of the disciplines the research types were borrowed from? What original contribution, in terms of theories or tools, did design bring to those methods in terms of modifying and updating them?

Obviously, in recent years, a considerable amount of research has been carried out, much of it at doctoral level (Vial, 2015). International conferences were promoted by design associations (such as those organised by the Design Society or the Design History Society) and by university institutions such as the *Design Plus Research* already mentioned conference at the Politecnico di Milano in May 2000 (the first conference to be held in Italy that resembled its international counterparts, which would give rise to a rich and consolidated tradition). These “global” opportunities expanded the community of scholars and researchers, opened up a wide variety of research themes from different contexts and were willing to adopt non-“Anglocentric” approaches. Nonetheless, there is a real risk of these international events becoming repetitive and self-celebratory (for example, the set of keywords that

researchers are constantly asked to refer to consists of the same words but presented in a different order). This makes it difficult to extract useful elements or to present meaningful and shareable proposals. It is as if “promulgation” (or rather, the myth of promulgation that circulates in international research formats) is in itself enough to ensure that ideas will not only circulate but also produce results. In this sense, doctoral research should be wary of uncritical adherence to an agenda of themes and problems dictated by others. Consider the prescriptive guidelines for research funded by European agencies, the excessive power of technologies and the economic system that promotes them, and the constraints of evaluation systems, etc. Furthermore, doctoral research should focus on research aimed at producing new knowledge in the field of design. Only through research and its practices, design can establish its own assumptions, its field of endeavour and, indeed, its own work practices.

Leaving behind the “acrobatics” that have characterised some recent phases of academic research in design, doctoral research should now return to talking about methods. In the plural. By this, I do not mean that we should establish a rigid set of didactic models, but rather that we should identify the methods most suited to addressing today’s problems, which are characterised by an inherent systemic complexity. We should also explore ways of conducting research in a variety of contexts and identify the diverse aspects expressed by our discipline today. Ours is a rigorous and coherent discipline but at the same time one that is flexible and open to the transformations of a world so different from that of the mid-20th century.

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ESSAYS

Six Topics in Tomás Maldonado's Thought

Pierfrancesco Califano

Among the many topics that Maldonado dealt with in his long intellectual itinerary, the six ones that Luca Guerrini and Raimonda Riccini brought to the attention of PhD students in the seminar *The Legacy of Tomás Maldonado* are undoubtedly those that can still provide stimuli for the contemporary debate on the design culture. This is demonstrated by the essays that make up this volume. The training of designers, the role that artistic practice must (or must not) play in the design process, the environmental issue, the attention to the body and to interaction, the vigilant observation of digital artefacts, the contribution that semiotics and the philosophy of language can make to design are the topics from which the authors have started to develop their considerations. In some cases, Maldonado's thought has been useful in tackling contemporary issues; in others, it has proved inadequate to provide answers to society's current problems and the authors have taken up positions opposed to his. Nothing better. After all, a legacy is a bequest, which we are not obliged to use slavishly. Furthermore, it is Maldonado himself who suggests that the only way to fight compla-

gency in design education is to always put one's own ideas under the magnifying glass, without fear of changing them:

In the near future we will have to revise our position, not only our position, however, but our methods too: that is, we must develop our specific working methods adjusting them to the specific types of problems that we shall have to solve (Maldonado, 1966, p. 20).

In order to highlight the contiguity and distance between the authors' reflections and Maldonado's, it seems useful to introduce how the topics of the seminar have emerged in Maldonado's thought. It must be said, however, that the division by topics is purely didactic. Throughout his life, Maldonado's activity and thought have changed radically in form and in subject matter. In this continuous critical scrutiny and revision of his ideas, Maldonado did not simply overtake his practical-theoretical achievements but forced them to react to each other, to enrich and sometimes to merge. Although it has therefore been decided to order the essays in this volume according to the thematic division through which the seminar was organised, the reader will notice the trajectories that transversely link essays of different topics. This is why I prefer to speak of "problematic horizons" rather than topics.

Maldonado's efforts in the field of education could be summed up in his own words: "The impossibility of opening a new way for design education without a revision of its academic structure" (Maldonado, 1966, p. 14). Maldonado was a great reviewer of academic structures. We can cite his work in the organisation and coordination of the didactic activity of the Hochschule für Gestaltung in Ulm, but also his contribution to the birth of design universities based on the ulmian model in Argentina, Brazil, Japan and India. Finally, in Italy, in the 1970s, he was an active and propositive protagonist of the new degree course in "Discipline dell'Arte, della Musica e dello Spettacolo" (DAMS) in Bologna and was personally involved in the debate on university reform. In the mid-1980s he arrived at the Politecnico di Milano, where in 1990 he founded the first research doctorate in Industrial Design in Italy

and chaired the working group that led, in 1993, to the launch of the first degree course in Industrial Design in an Italian public university.

Institutional activism responds to the need to give academic legitimacy to industrial design. Since the moment he arrived in Ulm in 1954, Maldonado aimed to scientifically found the discipline, first of all by revising the *Grundlehre* (Basic Course). The Ulm School *Grundlehre* was based on a timid renewal of the various didactic proposals of the Bauhaus Vorkurs; that is, it recovered the educational model of “learning by doing”, which consisted of collective work and teaching in workshops. In one of the first collegiate reunions he attended at the HfG in Ulm, Maldonado criticised this pedagogical activism, considering it unsuitable for higher education. For him, using ‘play’ as an educational method meant simply falling back on purely formal matters, which would lead to uncontrolled self-expression and the superficial use of scientific knowledge (Maldonado, 1954). In short, Maldonado rails against those who argue for a conflicting relationship between theory and practice, between knowing and doing. He considered this position untenable in relation to the changes that had taken place in science and technology between the Bauhaus and HfG experiences: “We know now that theory must be impregnated with practice, practice with theory. It is impossible today to act without knowledge, or to know without doing” (Maldonado, 1958, p. 39). Following these ideas, he first of all renewed the approach of the Basic Course and introduced in the discipline he taught – *Visuelle Einführung* (visual introduction) – rigorous scientific instruments for a rational control of the formal creation processes: theory of perception, symmetry, visual topology, among others.

The continuity of method and aesthetic sources between the exercises of visual introduction and concrete art – to which Maldonado had dedicated himself until his arrival in Ulm – could lead one to believe that a sort of artistic residue remains in the design practice he proposes. This is not the case. It is true that there is a certain formal continuity between concrete art and Ulm’s exercises; it is also true that the visual introduction exercises are abstract, not oriented

towards practical application and their focus is on the configuration principles. However, in their didactic use, these principles are not used with an aesthetic function but to train the student's critical capacities. The same can be said of all those branches of mathematics and geometry that are used in concrete art as in visual introduction: for the first they are sources of formal inspiration, for the second they serve to elaborate a rigorous methodology for the study and design of the configuration of technical objects.

As early as 1949, it was clear to Maldonado that there is a difference between artistic and technical forms. It is not a value difference but a functional difference (Maldonado, 1949). A distinction that he reiterated in a lecture in 1964:

Industrial design, even though it is an important and essential task, must never be considered man's sole occupation. [...] In order to develop further [...] the consciousness needs the continuous challenge of its capacity to represent and its capacity for experience. Continuous renewal both in the field of the verbal, and in the fields of the visual and acoustic world of symbols. In the past this important task was always the purpose of literature, painting and music and will remain their purpose, even though in modified form (Maldonado, 1964, pp. 75-76).

It is for this reason that if in artistic practice the use of rational and scientific instruments appears to be an aesthetic-political choice, this is not the case for industrial design: in HfG's study plan "generic modernity and generic creativity are not to be found, but the accent is placed on the moral content of creation" (Maldonado, 1955, p. 6. Translated by the author).

It is not by accident, therefore, that in the same issue of "ulm" where he takes a peremptory position on the art-design dialectic, the famous article *Science and Design* appears, as well as the responses of Josef Albers, Walter Gropius, Gillo Dorfles and Reyner Banham to his article *Is the Bauhaus Relevant Today?* It is in the answer to this question that the notion of industrial design as an artisanal or artistic practice is

surpassed, as well as the possibility of giving the discipline a scientific foundation. In accepting this possibility, however, Maldonado looks not so much to the Bauhaus but to another technical-artistic institute, namely the Vkhutemas-Vkhutein. This is Riccini's (2013) agreeable thesis, who defines the Soviet school's didactic curriculum as the first serious attempt to base "artistic education on a scientific basis in order to reach a high professional level" (p. 42. Translated by the author).

This paradigm shift's essence is the new cultural references that gradually emerge in Maldonado's writings.¹ It is a widening of the problematic horizons to which Maldonado submits industrial design, in the conviction that this discipline has the task and the capacity to absorb and translate stimuli from different fields of knowledge. This conviction found expression in the Wednesday Seminars, a veritable intellectual laboratory coordinated by Maldonado, through which young disciplines such as cybernetics, information theory, systems theory, operations research, semiotics and ergonomics came to Ulm hill. Many of these were not passing infatuations but became part of the school's curriculum (Krampen, 1984), allowing the HfG to surpass the original form-function dualism to renew industrial design as a social and professional practice aimed at assuming responsibility for the human environment.

We should not underestimate the role that this intellectual vitality played in making the HfG one of the first design institutes in which the problems of the deterioration of the human environment were discussed. It should be made clear that Ulm's reflection on *Umweltgestaltung* or *Umweltplanung* is not comparable to that one on environmental morphology or total design, expressed with famous statement "from the spoon to the city". Rather than slogans from the past, HfG's

1 Maldonado's reply to A. Morello, who asked him for references for a new industrial design concept, is emblematic in this sense: A. Moles, *La notion de quantité en cybernétique*; G.G. Granger, *Pensée formelle et sciences de l'homme*; G. Simondon, *Du mode d'existence des objets techniques*. Cfr. Giangiacomo Feltrinelli Foundation, Milan, Tomás Maldonado Archive. Tomás Maldonado to Augusto Morello, December 12, 1961.

teachers looked to the United States of America, where the debate on environmental design had been raging since the 1960s. It was precisely these overseas contacts that gave Maldonado the ideological hook to develop the systemic notion of the environment that would allow him to consider the socio-cultural conditions of humans and the environment they inhabit (and contribute to creating) as a single problematic horizon. Therefore, at least in Maldonado's case, "environment" should be understood as the "human environment", not nature.

It was in Italy, however, that he developed and tested his idea of environmental design. On a theoretical level, Maldonado is committed to clarifying the key points of the environmental question, placing it in relation to the system of needs and, therefore, to the system of objects and services (Maldonado, 1972; 1987; 1990, 2022 [1970]). It denounces the danger of an ecological critique without a critical ecology. There is a double danger: on the one hand, a lack of planning and, on the other, the adoption of overly simplistic solutions. Two attitudes that Maldonado considers inadequate to provide answers in the context of the highly complex problems that modern societies have to face. This is a consideration that drives his constant dialogue with disciplines of complexity, such as cybernetics, systems theory, operations research and decision theory: because, Maldonado explains, designing is deciding, and deciding cannot be understood as a purely speculative activity (Maldonado, 1974 [1966]).

Precisely for this reason, he does not renounce moving from the theoretical to the operational level, first of all through the introduction of environmental design in the Italian university system, more precisely at DAMS in Bologna (1970s). As Chiapponi (1989) pointed out, when the academic context was not completely devoted to design issues – as in the case of the DAMS – environmental design "was configured as a metaprojectual discipline", where the focus was on "the study of the epistemological and methodological foundations of the various design

disciplines” that converge in this field of research (p. 47. Translated by the author).²

However, environmental design does not abandon its design dimension, above all by following two directions: “one aimed at the conservation of the environment, i.e. the problems related to the protection of the heritage of natural and socio-cultural assets; the other aimed at environmental innovation” (p. 48. Translated by the author). It is in these two areas that Maldonado’s professional activity in Italy fits. It is enough to recall the study on the tourist-cultural development strategy of the Province of Salerno (1992-1993) or the coordination of the working group that planned (but did not carry out) the redevelopment of the Florentine district of Castello.

What seems to me to be the truly original trait of Maldonado’s contribution to the environmental question is that it is linked to other questions of a philosophical, social, methodological, economic and geopolitical nature. This is why on more than one occasion Maldonado refers to V.I. Vernadsky, W. Ogburn, J.H. Milsum and G.F. Chil’mi, intellectuals who, although from different perspectives, had proposed the impossibility of considering the system of nature (biosphere and geosphere) in isolation from the system of society (sociosphere) and the system of technical objects (technosphere). It is therefore entirely consistent that in *La speranza progettuale*, while he analyses refined design methodologies, he decides to devote the 15th chapter to semiotic issues, examining the case of Las Vegas.

Maldonado’s “semiotic passion” really began in the 1940s, when as a young exponent of the avant-garde he devoted himself to concrete art, a movement based on the conviction that “expression, understood as communication through symbols and signs, is absolutely extraneous to art” (Maldonado, 1945, p. 10. Translated by the author).

Semiotics became a real scientific interest only after he moved to Ulm, where he introduced and taught the discipline in 1957. As An-

² At the Faculty of Humanities in Bologna, Maldonado also proposed the foundation of the Institute of Environmental Disciplines.

anceschi (2007) has reconstructed, Maldonado's theoretical contribution to the semiotic debate begins with two recognitions: the short essay introducing his 1957 seminar, *Communication and Semiotics*, and the small semiotic vocabulary *Beitrag zur Terminologie der Semiotik* (1961). In order to "resist the danger of a theoretical isolation of semiotics" (Anceschi, 2007, p. 141), Maldonado immediately chose dialogue with other fields of knowledge: this is the case of his interest in visual rhetoric, which culminated in the experimental seminar of 1962-63 dedicated to A. Sjöberg's film *Fröken Julie*.³ It is evident that it was in the attempt to give cognitive legitimacy to visual rhetoric that Maldonado arrived at the question of iconicity, which would engage him for many years in the famous dispute with Umberto Eco. The question of semiotics is also one of the topics that drive his radical critique of postmodernism: we need only mention the famous lecture *Is Architecture a Text?* (1989). Finally, it can be said that the "trilogy" dedicated to information and communication technologies is also interwoven with semiotics.

The vast temporal extension of Maldonado's semiotic reflection has rightly led Anceschi to say that Maldonado has "always been a semiotician". This seems to me to be an agreeable proposal. But I think it is legitimate to ask why a mind as curious and receptive to multiple stimuli as Maldonado's engaged in such reflection for almost all his life. In my opinion, the answer, though it may seem banal, is to be found in the self-evident incipit of *Communication and Semiotics*: "Human communication takes place through the medium of [verbal and visual] signs" (Maldonado, 1959, p. 69). If it is possible to sanction the crisis of such communication (Maldonado, 1953), if the process of semantic banalisation can be an instrument of social control (Maldona-

3 The aim of this empirical-experimental investigation was to reveal the types of rhetorical figures featured in films. The results of this investigation, which Maldonado has kept in his archive, clearly show the scientific-experimental degree of the operation: the film is dissected at each change of frame and information about the image, the word and the sound is noted for each clip. This amount of information was then translated into graphical terms, in order to conduct a critical-comparative examination of the elements of traditional (verbal) rhetoric with the aim of demonstrating or not their usability in terms of visual rhetoric.

do, 1961), if among modern cities there are examples of environmental communicative consumerism (Maldonado, 2022 [1970]) and if, finally, new digital technologies are able to undermine age-old communicative processes (Maldonado, 2005), then we cannot refuse to question ourselves on the nature of the sign and the conditions through which it acts in society. The necessity of this investigation is clear from the relationship (almost syllogistic) that Maldonado establishes between communication, hope and design: “When we hope for something we also have something to tell ourselves; just as the design becomes superfluous when we have nothing to hope for, nor anything to tell ourselves” (Maldonado, 2022 [1970], pp. 46-47. Translated by the author).

Semiotics is, in my opinion, one of the disciplines that, once introduced into the HfG's study plan, radically changed the practice (and teaching) of industrial design. Another discipline that had the same importance was ergonomics. Because, Maldonado reminds us, humans communicate with each other but also with the technical environment around them. When Maldonado first writes about this, the connection between the two disciplines is immediately clear to him:

The processes of communication within man-machine systems are, with the aid of meaning structures, composed of signs and purely physical signals. [...] In the coming years [these ‘mixed’ structures] will play a decisive role in our technical civilization (Maldonado, 1959, p. 74).

As Anceschi (2007) wrote, this gesture “that associates ergonomics with communication and semiotics is the sign of a profound passion for the exploration of marginal spheres (in this case, of a strongly applicational branch of psychology)” (p. 139). If today it seems at least “unusual” to speak of ergonomics in terms of an exclusively psychological discipline, it is also due to its academic repositioning, which has made it increasingly in dialogue with the design disciplines. But it should not be forgotten that it was born as a discipline belonging to the psychology faculty, which was taught for the first time in a design university in Ulm. Although Maldonado was one of the proponents

of this repositioning, in *Science and Design* he harshly criticises the tendency of some ergonomists to consider the human body only in metric terms: “The human body is not only a measure [...]. Movement transcends the measure, and movement is culture” (Maldonado, Bonsiepe, 1964, p. 25). Referring to M. Mauss’s “techniques of the body” and to G.W. Hewes’s “archaeology of bodily habits”, Maldonado and Bonsiepe thus highlight the importance – especially for a design that claims to be “scientific” – of considering socio-cultural factors.

The relationship between design and socio-cultural factors is also proposed with a certain urgency in relation to the environmental issue, more specifically in the discourse relative to the “quality of life”. In the essay *L’idea di comfort*, Maldonado underlines how it is unthinkable to discuss livability without taking into account the particular context in which this discussion takes place; in short, without taking into account the material conditions and the horizon of expectations of the user of that particular context. This is, after all, his old (but still current) belief in the heteronomy of industrial design. But while on the one hand Maldonado points out that there can be no design that does not take into account the context in which it operates, on the other hand he points out that the opposite is also true: there can be no context that does not take design into account because objects are part of those “control mechanisms that aid in structuring and, in the final analysis, stabilising daily life in capitalist society” (Maldonado, 1991 [1987], p. 38).

Lastly, I have decided to deal with Maldonado’s thoughts on what in the seminar organisation have been called “digital artefacts”. This is not only because chronologically this reflection takes place in the last part of his intellectual itinerary, when “getting older, [he] became ‘philosophical’”⁴ but also because, in different ways, all the problematic horizons previously addressed have required a drastic revision after the advent of digital information and communication technologies.

4 Giangiaco Feltrinelli Foundation, Milan, Tomás Maldonado Archive. Tomás Maldonado to Kenneth Frampton, September 6, 2006.

This is Maldonado's conviction, who in that "sort of trilogy" – formed by *Reale e virtuale* (1992), *Critica della ragione informatica* (1997), *Memoria e conoscenza* (2005) – sets out to investigate "the social, political and cultural impact that [they] may have in the future" (Maldonado, 2005, p. 9. Translated by the author).

It is enough to consider in order the topics of the various essays that make up the trilogy to realise how it is a true revision of his previous thinking, although Maldonado does not renounce introducing strong new elements. The trilogy opens with a purely semiotic question, namely the gnoseological status of digitally produced images; it continues by investigating the pedagogical and design implications of the incipient technologies; it then deals with the socio-political and institutional risks of introducing certain telecommunications technologies into the democratic dialectic; finally, the investigation into the "future of knowledge in the digital scenario" offers the opportunity for a broad and stratified analysis of the changes in certain human activities (above all reading, writing, remembering, learning).

The emancipator capacities and critical aspects of all these topics are analysed. Maldonado's position in this regard is very clear: he does not accept senseless luddism or uncritical (and self-interested) trust in technologies. Moreover, Maldonado has never hidden the great importance of technology in his emancipator plans. As a young artist, when he developed a poetics based on instruments of formal control; in Ulm, when he showed himself to be extremely receptive to automation and miniaturisation, practices that were harbingers of a radical renewal of the technical system. But if Maldonado refuses to accept either of these positions, it is because both are based on technological determinism, that is, on the conviction that the system of technical objects is uncontrollable and that technology is an exogenous factor in society. One has to go to the close of the trilogy, analysing the essay *Gli occhiali presi sul serio*, to clarify his position. Here, through a brilliant analysis of the birth and development of eyeglasses, Maldonado demonstrates the impossibility of speaking of technology and society in dichotomous terms: between these two spheres of the human en-

vironment there is a relationship of “circular causality” that forces us, today we know better than yesterday, speaking of a “socio-technical” sphere.

Given the significant number of fields of knowledge that these six problematic horizons presuppose, one might wonder why the seminar whose results are presented in this volume has been offered exclusively to PhD students in design sciences. First of all, this can be explained by Maldonado’s academic activities, which have always matured under the institutional aegis of the design disciplines. In my opinion, however, this is also explained by what I consider Maldonado’s legacy. That is to say: all knowledge, all practice, all method, only makes sense if it manages to flow into a design action. If we look at them carefully, in fact, the problematic horizons just presented appear as different lines of attack on a single problem: the improvement of the conditions of man’s life and his environment. This is the difficult task to which Maldonado calls the designers. A task that implies taking responsibility for the destiny of man and the environment he inhabits. In Maldonado’s words, a common task because responsibility is common.

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Burning Thoughts about a Critical and Positive Design Pedagogy

Marco D'Urzo, Moritz Elbert, Valeria Piras, Jing Ruan

The End of History, the End of Design?

Few disciplines can identify so profoundly with the 20th century as design can: while at the same time recognising the need to constantly redefine its task, its field of action, its social responsibility, its legitimacy, design reflects itself in the transformations and profound upheavals that have taken place throughout the century.

With the fall of the Soviet bloc and the Berlin Wall, we woke up in a world that seemed to have resolved its contrasts and contradictions on a global political level: one belief, one system, one way of thinking. A condition that lowered the threshold of debate, including design: if a different world ceased to be imaginable, the project would act within the borders of the existing world.

However, the challenges we face today as humanity, challenges that concern the very survival of our species, show how wrong was the path guided exclusively by market laws aimed at maximising profit.

This vision has particularly contaminated the discipline of design, whose highly practical and concrete nature lends itself to technical

drifts that have also contaminated the world of research and education in this field.

As designers and researchers, we believe it is essential to start again from the role of education and its various forms in order to offer operational tools to a new generation of designers who should be aware of their role in the environment in which they work.

Criticism, Positivity, Actuality: Starting Again from Maldonado

Maldonado's influence on our work transcends the singular writings and is bound rather to his general attitude: an attitude that is critical but always proactive and attentive to the political value of one's actions and role. As Maldonado says in the introduction to *La speranza progettuale* (Maldonado, 1971, p. 10):

The true exercise of critical consciousness is always inseparable from the willingness to seek a coherent and articulate design alternative to the convulsion of our age.¹

Consistent with his communist beliefs, Maldonado takes a step forward with respect to the design scenario of his time (and beyond). Marx stated that the task of philosophers should go beyond the objective of understanding society, towards transforming it. An inseparable unity between theoretical thought and practical action, between theory and praxis, as Gramsci would later point out (Gramsci, 2014), and as Maldonado would contextualise in the design sphere:

A dissent devoid of projects, an empty-handed dissent, is not particularly dangerous for the forces of consensus. The discourse of non-projecting is an intellectual luxury of consumer society, a prerogative of wealthy peoples, a rhetorical pomposity of peoples saturated with goods and services (Maldonado, 1971, p. 66).

¹ All excerpts from *La speranza progettuale* are taken from the Italian second edition. All translations are by the authors.

A critical and positive approach, always guarded by an attentive and aware spirit, which echoes Marx again: “Criticism is not a passion of the brain, it is the brain of passion, it is not an anatomical knife, it is a weapon” (Marx, 2016. Translated by the authors).

In this sense, design can also be a weapon, but one that can only be practised responsibly through a critical and positive, and therefore conscious, approach. Indeed, design is a non-linear but always methodical process that forces one to observe the design context in its completeness and complexity and in the links it presents with higher order systems. This makes every design action a potential act of holistic vision, in relation to its design context, that consequently leads to build awareness and highlights its political and social value, bringing with it responsibilities that can be accepted or rejected but never ignored.

The rejection of nihilism is therefore intrinsic to the act of design developed with depth and intellectual and ethical honesty. The designer cannot abide from its transformative action: so that we might extend Achille Castiglioni’s famous statement “If you are not curious, change your profession” by adding “If you only want to understand, observe and not act, change your profession anyway”, because the designer’s job is always to make the step from the realm of understanding to that of action.

This process leads the role of design to a constant search for a new terrain of transformation and revolution, and consequently to a constant search for a role for us as designers in this world. A search that must be qualified, however: not the search for a passive role, that forces using some undiscovered market niche, quite the contrary. It is an active, critical and positive search, which leads us to understand what the limits of the system in which we live are and what our roles, postures, methods and practises are. Insofar as designers, we have to contribute to change our world, making it fairer, more just, more sustainable.

In this sense, the synthesis of Maldonado's influence on our work can be found in the answer to Obrist's last question which, not by chance, is entitled in the text *Beyond hope* (Maldonado, Obrist, 2010).²

Maldonado here wants to leave one and only one piece of advice to the designers of the future: to always activate a critical approach to context and projects, but in parallel a positive and never nihilistic attitude.

Maldonado then goes on elaborating on this advice by referring to the educational context, which is our area of interest, saying that:

If one does not want to betray one's role as an educator, one must try to reconcile criticism and positivity. Because criticism without positivity, without concrete outlets, an end in itself, in short, self-referential, is at the antipodes of any pedagogical intention (Maldonado, Obrist, 2010, l. 4218. Translated by the authors).

An attitude that Maldonado held throughout his pedagogical activity, starting from his reform of the Ulm school programme, creating a design pedagogy that prepared for the complexity of society in all its facets, not only productive-industrial but humanistic and social.

The beginning of our explorations were the programmes from three schools of design: the Russian Vkhutemas-Vkhutein (1920-1930), the German Staatliches Bauhaus (1919-1933) and the already mentioned Hochschule für Gestaltung Ulm (HfG - Ulm) (1953-1968).

2 H. U. O.: "(...) What advice can you give a young artist, architect, designer, philosopher or sociologist today?". T. M.: "(...) Most of the time I have preferred to give young people one advice, and only one. (...) I have tried to encourage them, on the one hand, to remain faithful to a critically vigilant attitude towards the world, to always keep alive a healthy and well-considered scepticism regarding the current public discourse on politics, economics, art and culture; on the other hand, not to allow oneself to be easily carried away, although there are plenty of reasons to do so, (...) by an attitude of generalised pessimism which, in my opinion, sooner or later leads to the abdication of any form of action or intervention in reality or, even worse, to sterile defeatism or cynical opportunism. In both cases: to capitulation" (Maldonado, Obrist, 2010. Translated by the authors).

Those three models are still in a lively dialectic relationship with today's design education, with fragments constantly emerging in the curricula of leading design schools worldwide.

Moreover, those models reflected and reacted to the historical and political contexts in which they existed. Our question is: how the design education context should reflect and react to the contemporary socio-political context?

Starting from this question, we think that Maldonado's critical and positive attitude should be recovered and re-contextualized today in light of the challenges we face as humanity, starting from a critical analysis of the context in which we live, design and learn. It is what we propose to do in this text, feeling that we are being called upon as part of the designers of the future to whom Maldonado was addressing us.

In order to do this, we think it is appropriate to start from a reflection on the roles and characteristics of contemporary designers and on those of the educational systems that have formed them.

The Designer as Product: a Critique of the Neo-Liberal Educational System

Over the years, the figure of the designer has evolved, becoming involved in issues characterised by greater breadth and complexity, and opening up to elements from an increasing number of sciences and disciplines.

Maldonado already stated that the relationship between producers and consumers in different economic phases would not be constant, and therefore, the role of designers would change with it (Maldonado, 1958, p. 34). The first phase of the industry's development saw eclectic and diverse personalities acting as designers, inventors and entrepreneurs, such as Henry Ford and William Morris. The role of the designer as such is consolidated in the subsequent second stage, focusing on the product. In the third stage, Maldonado defines the product designer as a coordinator, responsible for the maximum productivity of the

working group and the maximum material and cultural satisfaction of the consumer (Maldonado, 1958).

Nowadays, faced with increasingly complex social issues (Buchanan, 1992; Jones, 2014), the boundaries of design are constantly expanding, with a very diverse development trend. Designers have moved from “making a thing” to “making things happen” (Manzini, 2014), and from designing single artefacts to designing strategies for planning and coordinating complex systems.

In order to approach increasing complexity it is therefore appropriate to expand the didactic areas of design education, but not only: it is also necessary to work on a more personal, cultural, social and individual side other than the technical one, with the aim to gain critical consciousness of what one is designing and to be conscious of the complexity the design artefact will be inserted in.

As Danah Abdulla said in a recent lecture (Abdulla, 2021): “(...) If we take off design thinking tools, can the designer just think?”. What is provocatively emphasised in this sentence is that, in the vast majority of cases, design tools are prepared at a technical and methodological level to serve market needs. Mostly, complexity is addressed without giving the instruments to devise systemic changes that involve the problematic foundations of the existing system. Thus, the design tools provided by the market-driven educational system are useful to approach the problems of the existing world, but they are not critical tools to question reality, society and one’s own individuality to imagine a different world. Horst Rittel’s suggestion to “Do not only teach general rules but also rules for the changing of rules!” (Rittel, 1971) has been lost.

Tony Fry argues that it is because the current design education system reproduces the dynamics and structure of the currently dominant economic system: “Current design education (...) is predominantly based on placing graduates in the labour market. (...) Another direction is needed, based on the recognition of contemporary global imperatives” (Fry, 2017, p. 101).

And Ruben Pater adds that: “A design education that wants to produce creative and critical thinkers should start by listening to the needs of people, rather than the needs of industry” (Pater, 2021, p. 363).

It is obvious that a technical and economic approach in design education is a necessity for the professional future of students, but it must be critical and conscious. We live in a complex reality where different kinds of problems, inequalities and oppressions are increasingly heavy and connected, and design educational institutions cannot ignore this.

The student is trained to become himself a product to be marketed, with his expressiveness, personality and cultural background, and not a conscious individual able to separate this individuality from his presence in the market: “School capital, the amount of knowledge acquired at school, is a subset of cultural capital, but it can be argued that art & design school is slightly exceptional because the student explicitly brings his pre-existing cultural capital (interests, passions, readings, etc.) and the school helps transform it into a ‘practice’, which is the activity through which culture is converted into money. The art and design academy transforms cultural consumers into cultural producers” (Lorusso, 2021).

Even during workshops, which are the moments when students learn practically how to deal with different design challenges, the design methodology taught remains mainly based on design thinking and technical tools: there is rarely a reflection on self-prejudice and diversity, even in the case students are working on projects focused on social issues.

Even if we have the best possible intentions, even if we use tools that are defined as neutral and universal, we always put our own culture and prejudices into our design projects and take a personal position, even if we don’t realise it (Fry, 2017; Pater, 2021).

It is therefore necessary to deepen the critical reflection on our way of designing, our tools and, above all, the responsibilities that should be transferred during the educational process that leads to the training of future designers.

Design, Education, Emancipation: a Link between Maldonado and Freire

If design is the discipline of making choices, it is time to accept that every choice is biased. The issue of objectivity is increasingly difficult to sustain in design.

We think it is necessary to acknowledge and make explicit that what is taught can reproduce power dynamics that are not totally inclusive and equal; dynamics and approaches that have demonstrated their limits on the environmental, social and economic levels.

We think it is necessary to accept that every field of human activity carries political responsibilities: the discipline of design does not escape this, and indeed has an extremely insidious relationship with politics.

The new theory, at least as we imagine it, will have to pivot precisely on the problem of the ethical-practical – let's say tout-court political – implications of design (Maldonado, 1971, p. 129).

The expansion of the discipline to include themes such as design and complexity, social processes on a territorial scale, policymaking and so on (Jones, van Patter, 2009), shows a positive evolution that underlines the interconnection between the different levels of action and therefore of responsibility in decision-making processes.

We strongly believe that it is necessary to take a further, explicit step forward in design education. It must once again become a place of emancipation and not only a place of preparation for the neo-liberal economic system, a place where culture is generated that is “organisation, discipline of one's inner self, taking possession of one's personality, conquest of a higher consciousness thanks to which one is able to understand one's historical value, one's function in life, one's rights, one's duties” (Gramsci in Petrocelli, 2019, p. 16. Translated by the authors).

In short, it is necessary to go back to recognising and exercising the difference between instructing and educating, where the first concept

represents a process linked to training, which results in slavish and non-critical imitation, while the second means promoting the exercise of critical sense, personal values and initiative (Frascara, Noel, 2012).

It is also important to educate on the project as a terrain of possible conflict: a project that can “articulate antagonistic positions (and not standardise them) and represent social and political contradictions” (Facchetti, 2012, p. 32. Translated by the authors). A project that is therefore not only a tool for the evolution and innovation of the present world, but for the imagination and, above all, the creation of new worlds, potentially incompatible with the existing one, and rather fighting to replace and overcome it. More specifically, “Design must disengage itself from consumer culture as the primary shaper of its identity, and find a terrain where it can begin to rethink its role in the world. The result of this activity, if successful, will be a new power for the designer to participate in projects for the welfare of humankind, both inside and outside the market economy” (Margolin, 1998, p. 89).

But how can people learn to design in an “ethical” and “responsible” way if they are not made to reflect critically on the political implications of their projects, their beliefs and prejudices?

Working on subjectivity, on the collective of student subjects and on the politics of the project is not meant to be an attempt to tame expressive freedom; on the contrary, it is a way of expanding it by activating a new critical eye on oneself, on society and on design: exactly the critical and positive eye Maldonado talks about.

This need in the current educational context is not new, and it does not belong only to the sphere of design. We think it is interesting in this sense to start from one of the most important theorists of critical education, Paulo Freire, who contemporary to Maldonado’s elaborated an extremely well-defined theory on the importance of revolutionising the pedagogical context, inserting and proposing elements that allow the development of critical sense, destroying the teacher-learner hierarchy and putting the student in the centre as an active person. The aim is to generate a new freedom through critical awareness, intending education as a form of liberation:

Liberating education consists in acts of cognition, not transferrals of information. It is a learning situation in which the cognizable object (far from being the end of the cognitive act) intermediates the cognitive actors-teachers on the one hand and students on the other (Freire, 2000, p. 79).

This concept was also taken up in the context of feminist pedagogy, by authors such as bell hooks (hooks, 1994, p. 12): “Home was the place where I was forced to conform to someone else’s image regarding who and what I should be. School was the place where I could forget that self and, through ideas, reinvent myself”.

The actuality of this type of thinking, which we perceive to be very close to Maldonado’s, is evident and strong.

It is no coincidence that it has been possible to trace some contemporary experiences which, in our opinion, take up the challenge launched by Maldonado in *Arte e Artefatti*, referring precisely to Freire’s theories.

One example is the research group decolonising design (decolonisingdesign.com) which wants to try to carry out a post-colonial reflection on the discipline of design and its educational context. The group consists of researchers and educators who carry out their work individually and as a group, following a precise political approach.³

The group openly refers to Freire’s pedagogy, implementing a dismantling of classroom hierarchies, thus placing the student and his thinking at the centre and activating a dialogue on an equal level with him, so as to activate a teaching process where everyone, including the teacher, participates in the learning process.⁴

3 “This planet, shared and co-inhabited by a plurality of peoples, each inhabiting different worlds, each orienting themselves within and towards their environments in different ways, and with different civilizational histories, is being undermined by a globalised system of power that threatens to flatten and eradicate ontological and epistemological difference, rewriting histories and advancing visions of a future for a privileged few at the expense of their human and nonhuman others” (Decolonising Design, 2016).

4 “In our pedagogical practice, we employ a student-centric approach to disentangle the knotted threads of what design does and what it can do. We eschew solution-oriented approaches in favour of a process of “finding how”, where students seek for

A very similar approach is implemented by two realities that merged in 2021 in a single entity, namely the depatriarchise design project (depatriarchisedesign.com) and the Futuress project (futuress.org). depatriarchise design was founded in 2017 as an association aimed at acting with respect to the apparently (and pretendedly) apolitical set-up of the design discipline. In 2021 it joins *Futuress*,⁵ an open research community that is expressed through a web platform and focuses its research, dissemination and education activities on intersectionality.

This interesting community brings together and maps all those voices working to bring to light the relationships between politics and design.

The way in which *Futuress* refers to the keyword “feminism” is not only in dealing with gender content, but much more broadly in adopting a critical and feminist pedagogy approach to the discipline of design.

What these two emblematic experiences of the panorama of design pedagogy have in common is the intersectional approach, that is, not focusing on a single oppressive issue, but conceiving and addressing the different oppressions afflicting the contemporary world as closely interrelated:

Recognizing that identity politics takes place at the site where categories intersect thus seems more fruitful than challenging the possibility of talking about categories at all. Through an awareness of intersectionality, we can better acknowledge and ground the differences among us and negotiate the means by which these

themselves the best approach to tackle the issues they are interested in. We believe that such a process – inspired by the works of educator Paulo Freire and playwright Augusto Boal – can elicit a much more informed and inclusive perspective on the materiality of design-driven endeavours” (Ansari, Kiem, de O. Martins, 2018).

- 5 “We view design as a social and political practice – one that shapes our lived realities. Design is in the words we speak, in the objects around us, in the things we do, in the systems around us – all of which, too often, are fundamentally flawed. But design can also be a lens to critically look at the world, and unite us toward a common goal. The daunting struggles for social, spatial and environmental justice require us to come together, across our differences, as a learning community” (Futuress, 2021).

differences will find expression in constructing group politics (Crenshaw, 1991, p. 1299).

This approach is typical of Freire's pedagogy and can also be found in Maldonado's thought.

From Criticism to Action: What Should We Keep, What Should We Take Away, What Should We Focus On?

We therefore believe that the pedagogical context of design should start from the challenge launched by Maldonado in *Arte e artefatti*, and that authors such as Freire and bell hooks could be a possible starting point, as is already happening for example in the experiences mentioned earlier. A pedagogical approach that is therefore critical, positive and intersectional, and which educates on awareness, compatibility and equity: awareness of production processes to allow us to understand their real value and environmental and social cost; equity to promote the idea that the more progress is shared, the more it is capable of positively influencing society; compatibility with our environment, with the context, with the community (Mincoelli, 2019, pp. 51–52).

At the same time, it is important to avoid excessive labelling and technicalisation: labels risk limiting possibilities, interests and duties, leading to compartmentalised visions: “only those involved in social design must concern themselves with social aspects”, “only those involved in critical design have a critical approach” and so on. The risk exists because these are not technical labels, defining areas of intervention (editorial design, digital design, web design...), but ideological labels that include elements that should be transversal and not inseparable: politics, society, ecology, etc. There is therefore the risk that they limit the designer's possibilities of learning and action (Camuffo, 2019, pp. 76–77).

These reflections are the starting point for the proposal we are putting forward in this article. A proposal born within the limits of our

experiences and the cultural biases to which we are subjected. An open proposal, organised in four broad directions.

We believe it is appropriate to continue to develop and expand a culture of complexity in design education. It is necessary to continue to develop a design vision that takes into account the profound inter-relationship between all phenomena, environmental, social and economic, and that is able to overcome the anthropocentric conception to consider instead humanity as one of the many different elements that inhabit and influence natural systems.

We believe that a critical and proactive vision of history should be developed, which considers it as a material subject to continuous re-interpretation and contextualisation. A vision that does not use it only as a material for the consolidation and reproduction of current social relations and oppressions, but that can instead become an element for questioning those relations and imagining new models. A history that is active and alive, inclusive and plural.

We believe that design must always respond to a social horizon. The damage that our profession is capable of producing and amplifying when it responds solely to the interests of private profit has been known and emphasised for years (Forty, 1992). The exercise of design allows us to develop a certain capacity for anticipation: it is our responsibility to use this to prevent problems and not to multiply them in the name of a return limited to the immediate. The world we live in is bursting with concrete, real, primary needs, in all parts of the globe: we think that the task of the designer is to identify them and attempt to construct the most shared and sustainable responses to these needs, and not to generate further, secondary ones dictated by perverse pursuit of profit.

Finally, we believe that this social horizon must be developed by pursuing the concepts of ethics, care and intersectionality. The social dimension cannot become yet another market niche. It is necessary to educate by reviewing the fundamental paradigms of our society, returning to an economy for the human being (and for the environment), moving away from the idea of a human being and an environ-

ment to be exploited in the function of market economy (Praetorius, 2015). Giving again dignity to work, and even more to those who work; countering a professional ethic centred on exclusionary and destructive competition, and promoting instead constructive cooperation and competition.

We are aware of the more provocative and reflective rather than analytical nature of the work presented here. However, we would like to point out that it is not the result of a presumptuous impulse, but of a sincere urgency that the seminar on Maldonado we have attended has helped to stimulate and enabled us to make explicit. Profoundly inspired by Maldonado's thought, we have decided to remember him not so much by looking at his production retrospectively, but by considering it as a starting point for constructing our own vision.

So, as a work in progress, there are three questions that we are asking ourselves and that we would like to extend to everybody with the same urgencies, to start a collaborative process: what should we keep, what should we take away, what should we focus on in order to create a designer who can deeply relate and design in this society in a critical, and therefore responsible and aware way?

Please respond to DesignBurningThoughts@disroot.org. Obviously, in a critical and positive way.

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Materiality as a Fundamental Knowledge Tool for a Conscious Use of Digital Education

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Introduction

Pedagogy constitutes one of the fundamental themes in Tomás Maldonado's legacy. From his first experience in 1954, when he was hired by Max Bill at the newly founded School of Ulm, Maldonado has been always involved in pedagogy. This is also confirmed in the interview published in *Arte e artefatti*:

A decisive role in all of this was played by my challenge with pedagogy, the need to measure myself every day with the teaching activity. Suddenly, I discovered a passion that will remain with me throughout my whole life: the passion to be useful in the intellectual (and professional) formation of young pupils (Maldonado, 2010, p. 29. Translated by the authors).

Pedagogy is, by definition, an instrument-based subject aimed at researching and tuning the best tools and paths for learning the most diverse disciplines. Disciplines that in turn, with their content, influence the same pedagogy tools and paths. For this reason, this survey was approached by analyzing several Maldonado's writings in order to identify pedagogical tools and paths used by him; from this analysis, the most significant pedagogy tools have been identified and compa-

red with the current pedagogical tools. From the research, one topic eventually emerged as particularly close with Maldonado's legacy: materiality. Besides being a topic extensively discussed in several Maldonado's works such as *Reale e virtuale*, materiality is also quite relevant and a contemporary topic. This is mainly due to the significant trend towards the digital transition of almost all educational tools. Therefore, by investigating the differences between material and digital tools, a discussion has been carried out on the relationship between Maldonado's pedagogical theories and the contemporary ones.

To summarize, a research question has been formulated: considering the current educational horizon in which practice has become dematerialized, is maintaining attention to materiality and dexterity still a valid perspective? Or is it a romantic vision, nowadays out of the contemporary context in which the designer operates?

The Tools of Education According to Maldonado

As reported in 1959 in *Educazione e filosofia dell'educazione*, Maldonado clearly states that education cannot exist without a philosophy of education since he strongly believed that education cannot be made without a theoretical framework aimed at finalizing the educator's activity. Maldonado refers to a renewed education philosophy, based on the scientific approach to the subject and closely linked to a relative and not absolute model: namely, the intention and the objective of teaching will always be well defined but should never be written in stone or in a definitive way. As a consequence the model proposed can be verified at any time and at the same time can also be corrected and transformed. Therefore, the model will be composed of a receptive periphery and a scientific core that has to be resistant to excessive simplification. To clarify, the model should be heteronomous to the characteristics of reality, but autonomous and resistant to contemporary political, economic and military interests.

Another fundamental education tool for Maldonado is certainly the method. In fact, according to the philosophy of education, Maldonado advocates for a university based on the scientific method. On 5th January 1966, in a lecture held at the School of Architecture of Princeton University (Maldonado, 1966), speaking about the current design crisis he underlined the necessity to change universities by using alternative design methodologies. In contrast with the theory that the sum of good design objects should necessarily result in a good design context, Maldonado proposed an alternative theory and method where not only fixed and constant variables of project materiality should be considered but also changing and dynamic factors related to people and time. Therefore, there was a need to revise the design methodologies from a broader perspective. He believed that in order to meet this future challenge, design schools had to evolve into a university of methods, and he suggested that this change was already underway in some of them. This change was so important that it had implicit repercussions both on those who were teaching the discipline of design and on those who were going to develop specific *modus operandi* tailored on specific issues.

Critical spirit and critical thinking are foundational elements in all of Maldonado's writings, and here are reported two illustrative cases. In *Educazione e cultura politecnica* (2001), Maldonado states that critical spirit is a missing tool in the engineering schools of the time where knowledge is presented as dogma and, consequently, there is no room for critical interpretation. In the same *Lectio Magistralis* he forecasted a possible and fruitful convergence of engineering schools and those ones of industrial design, believing that design schools should propose themselves as creative interpreters of new technologies. Therefore, it is possible to conclude that, in Maldonado's vision, future polytechnic schools must use the critical spirit tool to train designers and teachers as conscious professionals capable of using cutting-edge technologies.

Critical thinking is also present in *La speranza progettuale*. In the first edition, while he describes the dialectic between humans and their environment, Maldonado uses the tool of critical thinking to de-

nounce the pollution created by man and the consequent alteration of the ecosystem. In the postscript of the 1972 English edition – titled *Design, Nature, and Revolution: Toward a Critical Ecology* – Maldonado further critiques the man-nature question. He clarifies that society and nature belong to the same problematic horizon and in particular that there is not a destructive man's attitude towards nature but rather there are society constraints that determine the destruction of the environment. The question of society's scandal, therefore, precedes the question of nature's scandal.

In *La speranza progettuale*, Maldonado illustrates another important education tool: the concrete projection. Introducing the human condition and its relative surroundings as elements of the same process, in continuous evolution and interaction, Maldonado defines the concrete projection tool as one of the deepest needs of human beings: it is useful to confirm the tangibility of what humans are, do, and what they want to do. In a later passage, this need is defined as fundamental in the design field. In fact, the rejection of the concrete projection implies the rejection of design, since one cannot exist without the other. In other words, a designer cannot build models to simulate structures, actions or behaviors without willing to create those structures, actions or behaviors. In conclusion all designers, and their trainers, must possess this concrete projection in order both to become an active part of objective reality and to not compromise the future of humanity.

In both his design practice and teaching activity, Tomás Maldonado has always been an advocate of applied rationality. During his period as educator at the School of Ulm, Maldonado proposed a new type of creativity. This new idea of creativity was against the typical expressive practice of the Bauhaus, and instead promoted creativity as a rational practice as well as planning ability. This position is also confirmed later when he criticizes the Bauhaus didactic conception, mainly based on a vitalistic-expressive attitude that was characterized by the lack of rational instruments to analyze, evaluate and finally react to the bourgeois system (Maldonado, 1978).

In *Reale e virtuale*, while analyzing the virtual models, Maldonado states that virtual models are tools of remarkable importance in both scientific and humanistic education. They enable learners to be involved in the process of transmission, reception and production of knowledge in a participative way. In particular, he believes that virtual models should not be used with a dematerialization perspective, but as amplifying tools to better understand, design and interact with the real world. Quoting his words: “Not a *fuga mundi* but a *creatio mundi*”.

Taking into account the digital perspective, in *Memoria e conoscenza*, Maldonado analyzes the role of speaking, writing, and reading. Beside the debate on how computers and machines influence the way humans act and think, he states that the use of digital technologies, hypertextuality, multimedia and interactivity, can certainly be advantageous to elaborate humanistic and scientific texts. This is mainly due to the fact that these technologies increase the argumentative and descriptive user’s potential, allowing a better interpretation and control of the world’s complexity. Maldonado’s approach to new technologies is therefore characterized by a positive but cautious optimism that avoids any celebratory zeal.

Current Educational Tools Scenario

All the pedagogical tools introduced by Maldonado are still in use today, although the context of educational tools has considerably changed. The “solid” world of the twentieth century has progressively melted becoming more fluid, open and connected, opening up to what Bauman defined as a “liquid” system. This transformation has involved every sector of modern society and pedagogy is for sure not an exception. Pedagogical tools had also to adapt by providing methodologies that are increasingly rapid, collaborative, multidisciplinary but to some extent more superficial and simplified. One example may be the environment that Google has made available to schools and universities. Google Classroom has given the possibility to overcome the physical limits enabling expert participation from any part of the

world. The same features are present in Google Drive, where documents and worksheets can be accessed and edited at the same time by a large number of professors and students. Together with the sharing possibility, there is also the ability to reproduce classes according to the learner's needs. In this way it is possible to increase the variety of educational tools which are no longer limited to the written ones but can be used together with multimedia and interactive material. However, together with the great advantages provided by the new digital tools, it is noteworthy to understand the critical issues entailed by these tools. The well-known health emergency situation due to the Covid-19 global pandemic has clearly shown the potential and the limits of distance learning. While on the one hand distance learning has allowed many students and teachers to continue their school attendance, on the other hand all the physical and social rituals have been erased together with all the characteristic non-verbal components of face-to-face teaching.

Considering the new tools generated by the digital context, a significant case to be analyzed is gamification. According to Sangkyun (2018), gamification is a set of activities and processes to solve problems related to learning and education through the use of a game logic. In today's context, thanks to the digital development of computer graphics and interfaces, it is possible to notice a proliferation of start-ups and new agencies that leverage digital technology to facilitate learning and knowledge transfer. One of the best known examples is Duolingo, an edutech app founded by Luis von Ahn and Severin Hacker that uses an online platform to promote and enable users to learn foreign languages. Another case that is worth mentioning is Learnlight, a company founded in 2007 and specialized in entrepreneurs' education that uses gamification to make learning fun and interactive to the point of creating a sort of addiction to learning. As argued by Putz, et al. (2020) gamification involves benefits not only to the strengthening of memorization but also to enhance practical and social skills, such as problem solving, collaboration and communication. By contrast, other authors highlight some critical issues in this practice: in particular,

Toda, et al. (2018) describe several drawbacks of gamification such as a performance drop after the first times of using, the user's indifference to this tool and their preference for traditional study methods, such as reading or listening, and the loss of interest after the first stages of use due to the undesirable machine's behavior. A specific study on Duolingo's use (Huynh, Zuo, Iida, 2016) has shown how user's engagement is higher for beginners and decreases significantly for advanced users. Considering advantages and disadvantages, it is possible to confirm the high potential of this pedagogical tool to make learning more engaging and effective. In particular, the use of the game metaphor can be useful in the growth stages of the individual, especially to generate some interest in a previously unexplored discipline. On the other hand, however, this type of approach could also have a negative effect in real and complex situations, where a prolonged and not superficial effort is required. In conclusion, this tool is most effective where it is used as a reinforcing aid, or as a complementary method to the traditional one. It is worth considering that the effort of learning through traditional analogical methods, such as reading a text, has the advantage of challenging the learners and giving them a certain awareness of their own intellectual tools. In fact, although learning through play is more engaging, the risk is being more focused on the comprehension of structure and rules rather than on the deep understanding of the topic. In other words, the focus of gaming is more on passing the test or game, and less on assimilating the content.

Finally, considering the digital context and the increasing development of electronics and the internet, it seems appropriate to reflect on the human ability most exposed to this technological change of educational tools: concentration. According to a survey conducted by World Psychiatry (Firth, et al., 2019), spending a lot of time on the internet, although it helps us in our daily routines, also affects our *forma mentis*: in particular, the internet and digital tools would make us more multi-tasking but at the same time they would decrease the human ability to concentrate. On the one hand, people are able to do more things at the same time but, on the other hand, their attention

span is more limited. In 2005, a study conducted by Dr. Glenn Wilson (Wainwright, 2005) at London's Institute of Psychiatry measured the effect of our brain exposure to a continuous and persistent series of interruptions and distractions resulting in a 10-point reduction of IQ.

It is not the intent of this paper to belittle digital tools since they are of significant importance to live in this connected, digital, "liquid" reality. Furthermore they can contribute to creating a controlled virtual reality that can certainly be complementary to the real world. From this point of view, concentration as the ability to focus on a specific task while ignoring irrelevant external events is certainly a tool that must be protected and cultivated.

In this regard, Sans Forgetica¹ can be a significant example, since it is a font scientifically designed to help the reader to learn the information contained in the text. Created by a multidisciplinary team of researchers and academics from the RMIT School of Design in the fields of design and behavioral sciences, Sans Forgetica has the peculiarity of being difficult to read. It is due to the discontinuity in the design of the letters and broken strokes. This feature of the font pushes the brain to a deeper processing of what is being read, stimulating cognitive processes through what is called desirable difficulty. In the end, concentration is perhaps the most important tool in learning, since it not only allows us to reach pre-set goals but it also reinforces the brain, making us autonomous and free in our decisions. Concentration is within a category of tools related to the analog-traditional world which are presented as complementary to digital tools.

Considering what has been explored and researched both in Maldonado's writings and in the current design pedagogy scenario, the aim of this contribution is to investigate materiality in relation to virtuality. This research questioned if materiality is still a valid attitude in relation to the practice of teaching which becomes more and more dematerialized every year. Therefore, here are presented two of the main

1 The font Sans Forgetica is available to download for free on the website of the Royal Melbourne Institute of Technology at <https://sansforgetica.rmit.edu.au/> and as an extension for Google Chrome and Mozilla Firefox.

reflections related to this research: the coexistence of the real and virtual world and the current value of analog tools. The first reflection regards the relation between digital and analog worlds that are not seen in opposition, but rather as two coexisting realities strongly dependent on each other. This research has shown how, from the 1960s to today, technological evolution has marked an important paradigm shift in the tools of education. From the past situation where analog practice was partially assisted by virtual tools, the current situation seems to be the opposite: a teaching context increasingly linked to the digital world and increasingly distant from in-person activities. Even though lessons, assignments, exams and didactic interactions may be virtual, the real practice performed with traditional and analog tools still provides valid experiences to understand and to effectively use intangible tools. Nonetheless, if virtual tools present several useful advantages for many students and professionals, they can mislead the project towards design *cul-de-sacs* from which it becomes laborious to get out.

An example of this evolution can be found in the world of nautical design. In the 1950s, nautical design was a manual process, requiring analog instruments. If some tools are of immediate comprehension, others such as the spar gauge² bring with them complex geometric algorithms aimed at solving manufacturing problems in the most universal way with the use of the least possible material. The introduction of virtual tools, linked to the introduction of computers and their softwares, has gradually replaced traditional tools, reinterpreting their functions in a virtual environment, exploiting the potential of electronic calculators. Considering all the activities related to the nautical design process, it is possible to say that the activities of ship design, technical and technological insights as well as everything related to the construction and shipyard aspects, are those that first resonated in harmony with the advent of this digital innovation (Grande, 2009).

² A spar gauge is a simple device which will mark two lines on the face of each side of a square plank either straight or tapered, enabling the four corners of the plank to be planed down to these lines to produce the required octagonal shape.

This digital transformation, which can also be seen in other design specializations, led to the question about what was the function of dexterity in the contemporary educational context. Maldonado's critical spirit, characterized by skepticism, does not agree with all the overly-optimistic people that see the "perfect" digital world as a possible substitute for the "imperfect" analog world. In fact, while the use of digital tools facilitated repetitive and purely computational operations, on the other hand, the same digital tools have shown difficulties to deal with complex problems such as being aware of the working context: it is in fact the user's task to be aware of the context where he or she is working (Zignego, 2009).

Furthermore, Tomás Maldonado argues that a "dematerialization" can only make sense when the digital tool has a direct and comprehensible link to reality: a tool that expands human knowledge, empowers the user, and provides a better understanding of the real world. In addition, Maldonado also questions the opposite situation: a forced digital transition without any reference to analog tools and any improving knowledge and learner's expression. Practicing in a digital reality without being aware of the real context and knowledge can be considered alienating, dystopian, and it can only make sense for economic or unrealistic situations. The current trend seems to maximize the dematerialization of almost all the teaching and working tools. Certainly, this practice has its advantages: more flexibility, a consistent material cost and design time reduction, multitasking and co-working capabilities. Definitely, the benefits listed above are enough to give an explanation about the widespread diffusion of digital tools in a variety of business and academic sectors. Nevertheless, considering a perspective far from the romantic one, analogical tools still possess some characteristics that make them useful in the current scenario. As stated before, digital tools enable and train the brain for multiple simultaneous activities, but at the same time, they reduce the concentration ability.

Balancing digital and analog tools is certainly a good strategy not only to safeguard the ability to concentrate but also to ensure an al-

ternative learning path for those interested to acquire deeper knowledge. For instance, the experience in a letterpress workshop (Caotorta, 2007) is characterized by a practical approach that can stimulate the minds of the youngest learners (Belluzzi Mus, et al., 2020). The benefit of using this particular pedagogical tool has been widely discussed by Célestin Freinet who introduced the use of movable type printing in elementary school between 1924 and 1966: it is in fact a tool for the dissemination and socialization of thoughts, effective in any condition of time and place. Learners are stimulated by this approach since they are involved step by step in all the processes of letterpress printing: from concept elaboration to design and implementation. This is mainly due to the peculiar nature of letterpress printing that empowers the printer with a total control of the design phase at any level.

Conclusion

In conclusion, it is appropriate to emphasize the most important education tools function: the function to make knowledge universally accessible. In particular, in this contribution, it has been highlighted how in a more and more digital context analog tools are useful to maintain and guarantee alternative access to knowledge and to consolidate an alternative vision to the reality of increasingly digital and intangible pedagogical tools.

Even if the digital tool has the potential to improve everyday life, it is also true that the digital tool loses all its meaning when it is not related to the material reality in which we live. In terms of design education, the digital tool certainly has advantages for the development and presentation of an idea, but this tool always needs evidence and comparison with the real world. In the context of educational tools, materiality needs to maintain a connection between the theory elaborated in the designer's mind and the real context where it is applied. Furthermore, materiality is a necessary tool to understand and meas-

ure if the applied theory model has enhanced or worsened the real context where we live.

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Changing Prospects in Design Education

Rupture and Ties with the Legacy of the Ulm Model

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Focusing on Maldonado's role as an educator, what surprises is the depth of thought that characterises his writings as well as his theoretical competence. Trained as an artist, Maldonado was exceptionally cultivated, endowed with great critical attitude, and passionate for design, not merely as a practice, but as a form of education. To this type of education, since the 1950s, he dedicated a large part of his career and academic endeavours, working on the development of a philosophy of design. The weight that Maldonado's work carries within the history of design education is exemplified by the prestige of what is known as Ulm Model, a benchmark for most schools of design still today.

Understanding the legacy of the Ulm School of Design (Ulm HfG) – whose training approach owes much to Maldonado – in the contemporary landscape of design education became the starting point of our investigation. A critical reading of some of Maldonado's writings on the theory of education helped us trace the connections between the traditional models and the current reform of education in the field of design. In this respect, the end point was the conflicted relationship that the current reform movement shows to have with the old paradigm of design education. While breaking with the past, most of the schools that are leading the change prove to be rooted in the pedagog-

ical tradition of the Ulm HfG. Shedding light on this ambivalence is the aim of our research.

In addition to examining the nature of the ambivalent relationship that some world leading schools of design have with the traditional models of education, this essay gives an overview of how design education as a whole is evolving and what possible course(s) it may take in the near future.

Maldonado and the Foundation of a Pedagogy of Design

With the aim of understanding the weight of Tomás Maldonado's intellectual legacy in the contemporary field of design education, we started from the end, asking ourselves what the state of the art of design education is today. The query initially took us far from the fabulous golden age of design – when Maldonado and other prominent figures paved the way for the foundation of the discipline – into the great uncertainty of our time, where the ripening of the discipline is bringing about a crisis of the established models. Then, from the contemporary, we moved to the past, working on the connections between the two.

In doing so, we observed that the current landscape of design education is closely tied to the tradition, despite the major changes being made. While the field is moving far from the modernist understanding of design and approach to education, a fundamental mark of the latter can be still found today. In this regard, we identified three concepts that structure an essential educational core. This core links today's design education to Maldonado, by way of the influential Ulm School of Design.

The long wave of the Ulm Model: a threefold educational gist

Three key concepts form an educational core that has endured to date, since the foundation of design education: 1) inter-disciplinary character of the curriculum; 2) incorporation of scientific subjects, as

a complement to the technical and artistic training; 3) combination of theoretical (i.e., abstract) teaching and practical assignments (Figure 1).

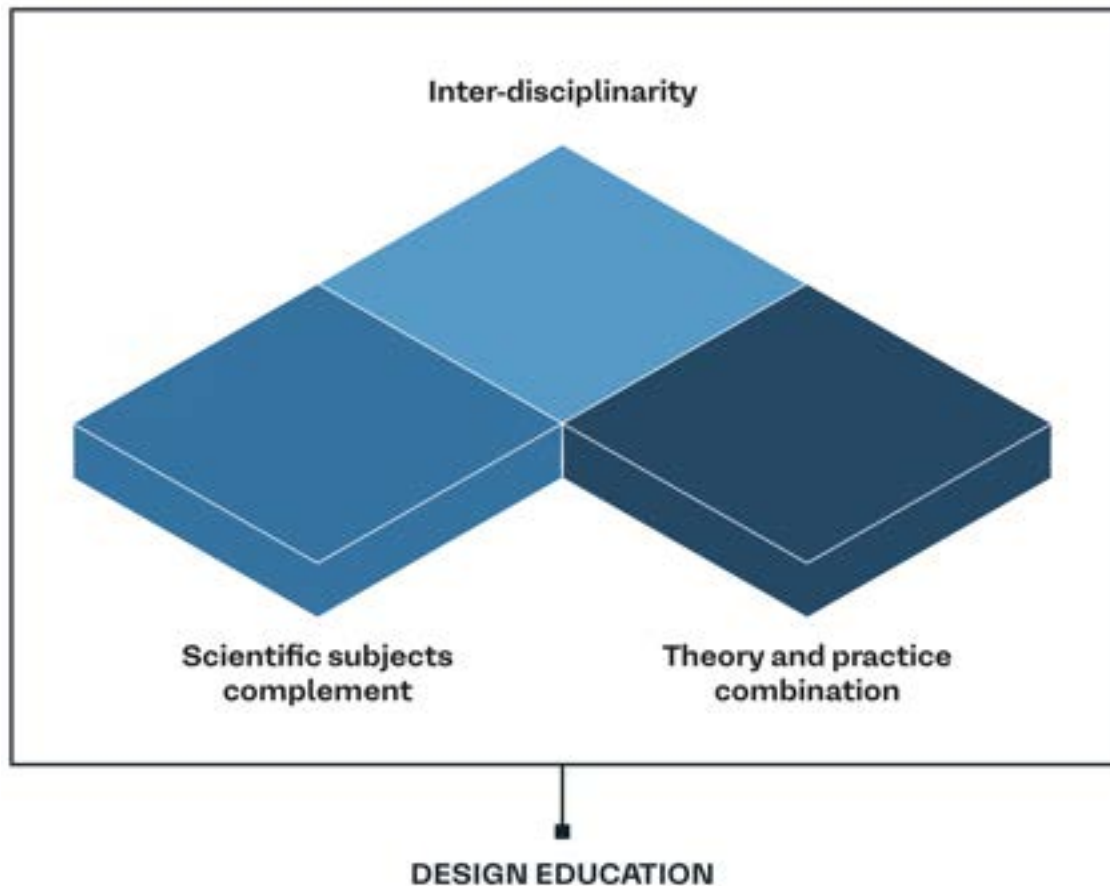


Figure 1. Threefold pedagogical core persisting since the Ulm HfG.

The inception of this educational mark can be traced in Maldonado’s critical writings of the late 1950s, at the time when he took the lead of Ulm HfG, becoming the main instigator of the theoretical foundation of the school (Lindinger, 1988). Since 1958, Maldonado brought about a series of changes in the curriculum prior devised – still based, heavily, on the legacy of Bauhaus – driven by the key educational principles mentioned earlier. The principle that deserves to be explored first is interdisciplinarity, a concept that has been long adopted and recently further developed by most design schools and departments across the world. In a 1959 short essay about the current issues concerning the philosophy of education, Maldonado observed that the sway of the

concept of specialisation in the fields of science and technology was declining, leaving the stage to a pluralistic understanding of disciplines (Maldonado, 1974, p. 91). The interdependence among disciplines, which in Maldonado's view concerns design as much as other fields of study, entails the need for designers to give up the fascination exerted by specialism and be ready to rely on other branches of knowledge for both the attainment of their education and the performance of their role in society.¹ Paradoxically enough, what seems to endure to date – besides interdisciplinarity – is the phenomenon of sub-departmentalisation (i.e., specialisations). On the latter problem, a 1965 writing on the difference between specialization and specialism can be insightful (see Maldonado, 1965, p. 9). Maldonado makes a clear distinction, in this regard, between the necessity of specialisations in the present time and the ethical and cultural astray caused by specialism.

The second concept to be discussed is the need for a science-based design education. This was perhaps the most innovative aspect of the educational program at the Ulm HfG, firmly advocated by Maldonado, who would relentlessly argue against the idea of design as aesthetic and art-driven (Maldonado, 1958, p. 31). Maldonado's determination to disrupt the artistic mark of design education – an almost unquestionable trait at that time, inherited from the Bauhaus – hinged upon the belief that designers ought to gain the “technological and scientific knowledge necessary to work in industry” (“ulm”, 1, 1958, p. 1).

In fact, the breadth of Maldonado's advocacy was much wider than that – a new philosophy of education, informed by science, was at stake. This commitment in favour of a scientific foundation for design is testified by the syllabus of the four-year programme in use since 1958, which included theoretical courses ever seen in a design school.²

1 About the openness to other disciplines, Maldonado once argued that “the designer will, more than ever, have to obey factors unrelated to his own individual fields” (Maldonado, 1958, p. 37). In hindsight, this statement can be regarded as far looking, to the extent that the heteronomous character of design is today considered a matter of fact in the field of design education.

2 Perception theory, Mathematics, Physics, Chemistry, Sociology, Mechanics, Applied physiology, Theory of manufacture, Operational Research, History of Culture, Theory of science (see “ulm”, 1, 1958, pp. 5, 7).

As for the latter subject, one can argue that besides inspiring the training programmes in industrial design worldwide in the following years, the Ulm Model is also at the base of the contemporary development of design as an academic discipline.³

The third fundamental concept is the complementary relationship between practice and theory in design education. At the time when the Ulm HfG was founded, the problem was to incorporate theoretical – and scientific-based – teaching in the basic training, since the latter still matched the practice-driven approach developed at the Bauhaus thirty years before. Maldonado’s commitment, in this regard, was considerable and his critical writing about it extensive. The matter was of pedagogical nature, mainly revolving around the inadequacy of the Deweyan “learning by doing” approach⁴ in light of the rise of a new age of unprecedented progress based on abstract scientific thought. Maldonado observed that the educational theories at the core of the progressivist approach were proving to be no longer suitable for effective learning, at several levels of education (Maldonado, 1974, pp. 87-89). This approach, for Maldonado, was no match for the challenges of modern life that the designer was called upon to address (Maldonado, 1958, pp. 38-40). The moment had come, thus, to restore the importance of theory in design education, equipping design students with theoretical knowledge, besides practical training.⁵

3 Indeed, the current debate over epistemological matters pertaining to design research would be unimaginable, had that historical shift in design education not occurred. And the same applies to the content of the educational programmes in contemporary design schools: irrespective of the specialisation or direction of the school, scientific subjects are a trademark of basic training in design.

4 For a better understanding of the role of Dewey’s thought in the early foundation of design education, see Cross (1983).

5 The aim, however, was not to turn the educational approach so far adopted upside down, making theory the absolute drive of education, but rather to rebalance the relationship between theoretical and practical learning.

Educational Turn in the Discipline of Design

The current reform of design education: new curricula and the evolution of the discipline

In our post-industrial world, characterised by far-reaching transformations on a global scale, design education is undergoing a veritable ontological change – a renewal process that questions the very roots of the discipline, moving away from the classical Ulmian conception of training and research at the service of industry. This process is bringing about significant changes to the way designers are trained, testified by the current overhaul of the curricula across design schools around the world. Of all the changes under way, we believe, three are key to the evolution of the discipline.

First, a new understanding of the *raison d'être* of design – no longer of merely utilitarian character – is taking hold. In this regard, new ways of investigating the relationship between “designed things” and humans are being explored, often outside of industrial production systems. Therefore, design education is expanding its scope of intervention, beyond the context of industry and mass production. Indeed, today designers are trained to work in a wide range of professional areas, from consultancy in the field of service and product strategy to project-management in the context of multi-disciplinary design teams, as well as theoretical research in academia – let alone the vast area of interaction design and HCI (human-computer interaction). The traditional craft-oriented industrial design education, in this regard, is believed by some to be unfit to prepare students for the challenges of our fast-changing and increasingly complex socio-economic system. Educators in the field of design are thus revising the curriculum, including new skillsets and competences, drawing on subject areas traditionally uncharted.⁶

⁶ E.g., philosophy, business, economics, anthropology, behavioural science, climate science, psychology, political science, social theory, robotics, digital fabrication,

Second, as design expands towards a wide range of fields of application, methodological issues about teaching and learning arise. In particular, some educators and academics claim the need to go beyond the concept of tacit knowledge – underpinning the traditional training in design – identifying clear and structured methods to both achieve and assess the knowledge transfer. Such a theoretical standpoint has major implications for the education of the designers of the present and the future – indeed, whether designers are well equipped for the challenges of our contemporary society largely depends on the quality of learning. The landscape of design education, however, is diverse and the above-mentioned instances of reform live alongside traditional programs, in which the concept of tacit knowledge is deep-seated as integral to the artistic side of the education. As a result of this theoretical divergence, some design schools are leaving behind the artistic dimension of the training, hinging upon a scientific approach to education (Meyer, Norman, 2020, p. 37).

Third, as design became a fully-fledged academic discipline (Archer, 1979; Cross, 2018) – approximately in the 1990's – the field of design education started to face the epistemological problems common to all disciplines (Levy, 1990; Findeli, 2001). For the first time in history, theorists and academics in this field dealt with the problem of what kind of knowledge design produces and, above all, to what extent this knowledge can be regarded as trustworthy (Cross, 1982). In other words, the problem of what type of research the field of design carries out – i.e., in what way research is conducted and for what purpose. This coming of age of design as a discipline has entailed a twofold innovation. On the one hand, the development of research departments, where students learn how to perform research, either in industry or in academia. Because becoming researchers requires a new set of skills and competences, specific educational programs – research-oriented – have been recently designed and implemented. On the other hand, the increasing efforts being made by some design schools into linking

post-graduate research to undergraduate training, by means of dedicated (and structured) educational activities.⁷ This link gives students the chance to acquire a speculative and theoretically solid approach to problems and problem-solving – typical of the research-minded – since early in their training course.

The breadth of the changes discussed here shows that the evolution of the discipline of design – and its impact on both education and practice – is driven by a shift in perspective, in the light of an unprecedented cultural and techno-social breakthrough.

Shift in perspective: the sprawling role of design in society

When we talk about design today, we cannot help but specify the professional field to which we are referring, among the many where design finds application. Indeed, doing design can mean many different things, depending on the field of application. While such a manifold character is a hallmark of design since its very foundation, in recent years the range of employment of designers has grown wide, spanning from the traditional sector of manufacturing to the thriving service economy, which includes fields such as healthcare, education, and information technology, just to mention a few. Furthermore, designers can work as researchers, either in public universities or in the research and development departments of private businesses.

As the application of design has branched out into a vast set of fields, the understanding of the role of design in society has become more polysemous than ever. That is to say, we are witnessing a diversification of approaches to doing design. As a consequence, new perspectives on both the discipline of design and design education are emerging. In this regard, the new curricula being developed and adopted by some schools aim to meet the requirements of the current

⁷ MSc in Industrial Design at the Eindhoven University of Technology (NL) and Master of Design at the Carnegie Mellon Institute of Design (USA) are two examples among the many.

socio-economic context, characterised by phenomena that have come to be known as “tertiarization” and “fourth industrial revolution”.⁸

The current reform of design education can thus be described as a process of adaptation to the modern socio-economic system, including the cultural and techno-social changes recently occurred. This one-sided understanding, however, does not suffice to illustrate how and why design education is changing. Another sway, besides the market, drives the renewal of the curricula: the intellectual movement inside schools and departments. While the influence of the market change on design education is inevitably strong, academics are those who ultimately devise the curriculum, choosing how to adapt the latter, based on their interpretation of the changes occurring in society. This interpretation is often developed independently from market interests and economic powers, asserting pedagogical principles besides matters of professional expediency. Critical to this active role in driving education is the ability of the discipline of design to question its own foundations at the time of its full maturity.

⁹What is changing design education as we have known it since the 1960s, in the final analysis, is a twofold sway. “External” one – the pressure of the market as well as the related cultural and socio-technical changes – and “internal” one – the intellectual movement that critically interprets the changes occurred and independently develops a pedagogy of design.

8 The latter phenomenon is opening up new opportunities for the hybridisation of design with the fields of artificial intelligence, robotics and computing technology. This expansion in scope is leading some design schools to incorporate subject areas coming from the field of applied sciences, giving rise, in some instances, to distinct educational paths – this is the case of the master programs in interaction design, HCI (human-computer interaction) design and the like. It is not unusual to find subjects such as robotics, digital fabrication, electronic circuit design, and programming in some of today’s graduate programs in design.

9 The critical-theoretical tools that the discipline has developed to structure itself allow for a re-examination of the role of design, considering the cultural and socio-technical changes earlier mentioned (Ghajargar, Bardzell, 2019).

Tradition and Reform in the Landscape of Design Education

The growing signs of breach with the past suggest that design education is departing from the classical teaching approach developed throughout the former century, following the profound change of the world's economic, social, and cultural processes since then occurred. As earlier mentioned, the paradigm shift reflects a new understanding of both the role played by design in society and the aim of design research in academia.

Despite this shift, a deep connection with the modernist *Weltanschauung* that inspired the foundational models of Bauhaus and Ulm is still present today in most schools and departments of design worldwide, including those that have moved away from such models. The greatest theoretical debt, in this respect, is to what has come to be known as Ulm Model, a cornerstone in the history of design education.

While the rupture with the ontological understanding of design posited at Ulm HfG in the 1960s is sizeable, the educational approach adopted by the schools at the forefront of the current reform hinges upon some of the key concepts developed in the legendary German school. In particular, those that form the threefold educational gist earlier described.

A shared pedagogical core among different programmes across the world

A brief review of the programs currently offered by some of the design schools that are leading the reform can help the reader gain an insight about the extent to which the three-pronged theoretical approach at the heart of the Ulm Model is core to design education still today.

Three cases are taken as examples of an emerging trend in design education, which is currently questioning the traditional models estab-

lished over more than half a century: BXA design program¹⁰ (School of Design, Carnegie Mellon University, USA); Master in Design for Emergent Futures¹¹ (ELISAVA – Design and Engineering Faculty, Universitat Central de Catalunya, ES); Master in Design Studies¹² (School of Design, Harvard University, USA).

The BXA design program at the Carnegie Mellon School of Design (USA) is a good example of a radical reform of design education. As an intercollege degree program, the BXA allows design students to attend courses in the fields of science, technology, and humanities outside of the School of Design. The result is a broad-spectrum education, in either humanities or sciences, with a focus on design. The degree program brings the usual framework of interdisciplinary education in design a step further, allowing for a hybridisation of the curriculum, which relies on an interdepartmental exchange of knowledge and competences among different disciplines. Such a prototype of a new training program is as far from the Ulmian traditional model of industrial design education as rooted in the latter's most essential educational framework. Indeed, a blend of theory and practice, highly interdisciplinary teaching and learning, and scientific education are pivotal for this program.

A similar case is the Master in Design for Emergent Futures offered at ELISAVA, in Barcelona (ES). The main objective of the program is to equip students with practical competencies of digital fabrication, physical prototyping, and communication as well as theoretical knowledge of Artificial Intelligence, machine learning, synthetic biology, applied economics, and research methods. Besides designers, engineers, artists, technologists, urbanists, and computer scientists, the program is open to students with a bachelor's degree in either sociology, or anthropology, or economics. The focus of the course is the use of emerg-

10 <https://www.cmu.edu/interdisciplinary/programs/> (Last consultation February 22, 2022).

11 <https://www.elisava.net/en/master-design-emergent-futures> (Last consultation February 22, 2022).

12 <https://www.gsd.harvard.edu/design-studies/> (Last consultation February 22, 2022).

ing technologies to address wicked problems in the urban context, from both a strategic and practical viewpoint. Students are required to implement and validate their designs as well as critically assess the latter's impact through research. This program too – as the BXA design program at CMD – drives away from the canonical models of design education and yet hinges upon the essential threefold Ulmian pedagogical framework earlier discussed.

The Master in Design Studies at the School of Design, Harvard University (USA), is uniquely untraditional in its own way and perhaps a special case. The two-year master is based merely on coursework – no studio work is included. Students choose one area of expertise among four – Mediums, Ecologies, Publics, Narratives – and structure their own peculiar curriculum, benefitting from the wide range of courses offered across both the graduate school and the other departments of Harvard University. Moreover, throughout the study course, students from all four domains gather to develop open projects where everyone's individual expertise can be applied on specific issues of societal concern. This approach to design education is a novel one in so far as some of the areas of knowledge addressed are unusual for a curriculum in the field of design, making the program a true hybrid of different disciplines. The program, thus, is highly interdisciplinary, understanding design as a combination of science, technology, art, economics, politics. Practice, in this regard, comes as the locus where to apply the theoretical and broad knowledge gained during seminars and coursework. Overall, the distance from the traditional models of design education is great. The match with the Ulmian threefold pedagogical core, however, is just as great.

Far from being a representative sample of how the field is evolving, the set of cases described above is a glimpse into some of the emerging trends in the current landscape of design education. Interestingly, these trends break with the past models of education in design while being rooted in them. In this respect, the legacy of Ulm feeds the present world of design education back, thanks to a deep cultural stratification.

The Evolution of Design Education: a Multifaceted Phenomenon

Over the last twenty years, design education has been questioning its fundamentals, changing the understanding of what design is in the first place, and so giving rise to a reform of both the discipline and the practice. As maintained in this essay, the reform has followed the historic change of social, technical, economic, and cultural nature that has occurred in our world. This change is still under way and so are the repercussions on the world of design.

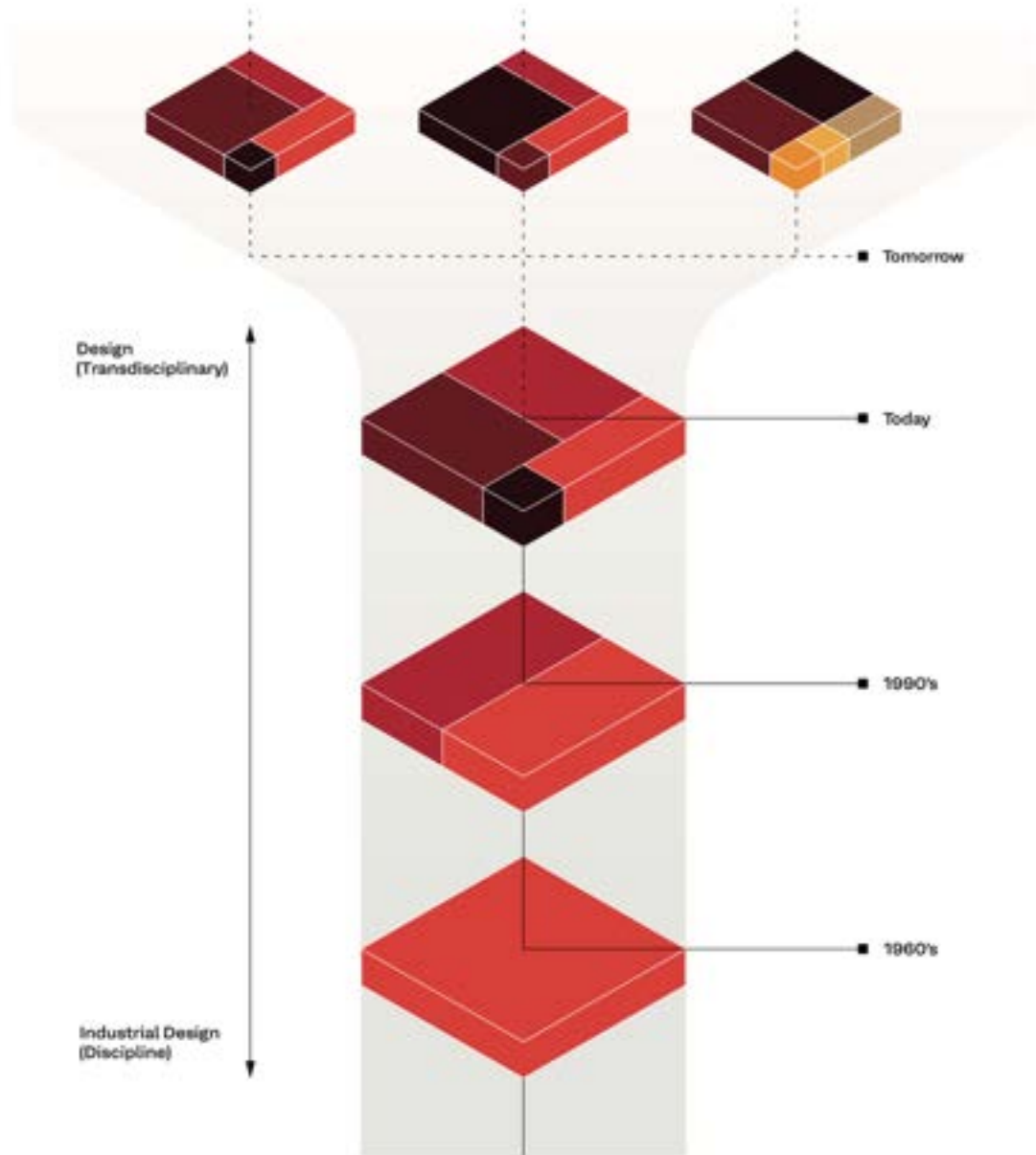
While the emerging trends can give us a hint regarding how design education is currently evolving, we think that it is too early to speculate on the direction that design pedagogy will take in the long run. Indeed, the scale of the phenomenon is small enough to warrant caution when making predictions. As things stand today, such trends constitute a niche in the field of design education. Moreover, as hitherto discussed, the ties with the past models of education are stronger than they appear.

What makes it hard to assess whether the current changes will prove long-lasting is also the great diversity of approaches to design and design education that coexist in the field today. This is perhaps the greatest difference between the current time of reform and the one that saw Maldonado and others setting precedents for a formal education in design.¹³ In such a context, a multitude of voices make themselves heard; none of them are strong enough to set a model, and yet, all of them thrive in the wake of the – claimed – need for a change.

Despite the complexity of what appears as a magmatic assortment, it is worth attempting to portray the hallmarks of the current landscape of design education. The diagram in Figure 2 outlines a possible

13 Indeed, the current reform movement is unlikely to attain the *translatio imperii* that has been attributed to the case of the *Ulm HfG* (Riccini, 2020). The most obvious reason is that while the founders of the *Ulm HfG* faced the challenge of laying the foundations of a distinct pedagogy, the educators of the present design schools are dealing with the crisis of a ripened discipline, in a highly structured educational system, with decades of history.

classification of the current – old and new – trends in the field. This classification aims to put some order in a seemingly chaotic scenery and is meant to help develop a better understanding of the current situation – far from being a final say on the matter.



CHANGING PROSPECTS IN DESIGN EDUCATION






	Macro-areas of knowledge	Role and context (for whom)	Role and aim (for what)
	Arts and Technology	For industry	Manufacturing and Communication
	Arts, Science and Technology	For industry	Manufacturing and Communication
	Arts, Science and Technology	For industry and society	Manufacturing, Communication, Service and Research (R&D)
	Arts, Humanities, Science and Technology	For industry, academia and society	Manufacturing, Communication, Service and Research (both R&D and academic)
	?	?	?

Figure 2. Old and new trends in the current landscape of design education.

The Future of Design Education

A pluralistic approach to design

The early years of this century have ushered in a wave of changes in the discipline of design, challenging the established role of design in society. The rapid socio-economic transformation at a global scale has eroded the dominant canon of design as a practice mainly concerned with mass produced objects, opening the way for new areas of application.

In response to this transformation, some design schools around the world have developed and implemented significant innovations in the curriculum, marking a break with the traditional model of training in industrial design. While the innovations implemented are the result of years of theoretical debate about the future of the discipline and the role played by education inside academia, the pressure of the changing economy – outside academia – is what drives the reform of design

education. Indeed, industry and markets are changing, together with people's habits and demands, and there are different ways of doing design – the scope of application of design is growing wide.

As a result of the expanding scope of application, a diverse set of new curricula – distinct from each other – are being developed in design schools and departments. By examining these curricula, the step change in choosing the content of training is often sizeable, as totally new professional profiles are being set. However, from an educational viewpoint, the connection with the traditional models of Ulmian inspiration is still strong. In particular, a line of continuity can be found as far as three educational principles are concerned: interdisciplinarity; science-based education; merge of theory and practice. We believe that this threefold educational gist has persisted since Ulm HfG's time. Thus, the current reform movement within the landscape of design education is characterised by a complex and ambivalent relationship with its own cultural foundations. Starting from this complexity is key to understanding the direction that design education will take in the years to come. In this respect, there are still many open questions.

Design education in the upcoming years: unanswered questions

The most significant change recently occurred in design education is the proliferation of new and distinct curricula, which reflect the transformation of the global socio-economic system – its new demands and modes of production – marking a departure from the traditional models of industrial design. Because the pedagogical legacy of such traditional models persists in the schools that are leading the current reform – despite the evident break with the past – one open question is whether the discipline of design will permanently lose unity, formalising its own fragmentation by splitting into separate disciplines.

The threefold pedagogical gist we discussed in this essay is perhaps what keeps the different instances emerging in design education under the same umbrella, besides the institutional legacy. Given the depth of

the reform, however, it is hard to predict whether such a formal unity will last. In this regard, two possible scenarios can be envisioned.

In the first scenario, the role of industrial designer as we know it today will become increasingly secondary, leaving the stage to other professional profiles. This would certainly generate a split into different disciplines and types of training, putting the schools of industrial design in minority while making the new educational programs prevalent. Designing services, processes, and methods – as well as carrying out research for public and private bodies – would thus supersede the classical product-oriented design jobs. Given this scenario, however, it is hard to clearly picture how the new professional roles would evolve. Indeed, unexpected types of jobs might emerge from such a turnaround.

In the second scenario, the new professional profiles that are currently emerging will evolve but stay marginal in the economic context. Thus, the related educational programs would be a niche in the landscape of the world's design education – not unlike nowadays. A split into separate disciplines, in this case, would still be possible, following an increasingly clear definition of the peculiarity of the new profiles. More likely, however, the new trends would stay under the aegis, as it were, of the umbrella term design, sharing a common ground with the different identities active in the field.

Both scenarios carry numerous other questions that remain unanswered, for the time being. Carefully observing the evolution of the emerging trends or movements in the following years will give us a hint about the course that design education will take in the next half a century.

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Colour. Codes and Perception through Artistic Practice and Didactics

Federica Delprino, Monica Oddone, Angelica Vandi

Maldonado's Artistic Experience: a Thematic Introduction

The role of artistic practice, according to Tomás Maldonado, constitutes one of the first cognitive and intellectual processes that, although considered a “pure manual and aesthetic exercise” (Maldonado, 1951, p. 21. Translated by the authors), leads human beings to materialise their thoughts in order to explore the space and reality that surrounds them.

Considered one of the protagonists of the mid-20th century Latin American Concrete Art movement, in 1946, through the Inventionist Manifesto, he recognised the close link between reality and art, seeing the latter as an effective tool to enhance life and to place man and the community in the world.¹

“To surround a man with real things and not with phantoms.” With this statement, Tomás Maldonado demonstrated the profound dis-

¹ The manifesto is published for the first time in the bulletin “Arte concreto – Invencción”, 1, August 1946.

tance between concretism and the previous figurative avant-garde movements of the early 20th century focused, instead, on illusion and lyrical abstraction from reality (Maldonado, 1946). If abstract works had reality as their starting point, which they interpret and elaborate, concretism aspired to contribute with the artwork itself to reality.

It also shows a strong influence of the work of the De Stijl and Bauhaus exponents, especially Theo Van Doesburg and Max Bill's. They believed that, in the same way in which man designs tools for material use, the aim of concrete art becomes the production of objects for intellectual and speculative use, based on lines, colours and surfaces that follow a geometric pattern, without referring to any further symbolic meaning.

With the *Asociación Arte Concreto-Invencción*, Maldonado also intended to contaminate his artistic practice with design disciplines, including industrial design. Indeed, the roots of Argentine concretism could also be found in Russian constructivism, confirming a functional role of art linked to other areas of production such as industry and technology. The painting was seen as a theoretical project with a solid, educational, and didactic aspect, anticipating the exercises of the Fundamental Course at the Hochschule für Gestaltung Ulm (HfG).

Pursuing the analysis of the intellectual processes arising from the interaction between the work of art, the viewer and societal engagement, Maldonado's essay *El arte concreto y el problema de lo ilimitado. Notas para un estudio teórico* investigated the fundamental relationship between figure and background, with an emphasis on issues related to space and illusion. As a matter of fact, if every figure on background determines space and if this space is within a plane (the canvas), on this surface the space becomes illusory, which is not admissible for a concretist painter. Maldonado and all the concretist artists continually strove to destroy this illusory space, first by trying to dissolve it through the objectivation of the figures in the foreground, then by trying to overcome the narrowness of the figures by "making the ground vibrate" (Huff, 2018, p. 79). It led to a representational situation in

which the “unlimited” was sought within a limited form such as the canvas, committing the error also common to the Futurists.

In this context, colour research became important for Maldonado’s artistic practice and didactic design activities. It became a fundamental medium for achieving the aims envisaged by the concretist artistic practice as it favoured games of visual perception and training to perceive space in an unlimited, undefined, closed way. Hue thus became the bearer of visual ambiguity, leading the viewer to seek stimuli for critical thought in the interference between different shades, changes of saturation, light and dark. It is important to highlight that this ceaseless study led Maldonado in his old age to reorientate his convictions on concrete art, considering figuration and non-figuration two practices of mutual stimulation cooperating for the same purpose (Maldonado, 2010).

However, it is important to underline how his research, oriented above all towards the study of the colour role within the work of concrete art, had a direct and reciprocal influence on his role as a teacher at the Ulm School, emphasising and confirming the relevance of art within the design process aimed at the production of artefacts.

The pedagogical itinerary involving the teaching of colour at the HfG confirms the revolutionary significance of the German school as a research institute for industrial production during the mid-20th century. Tomás Maldonado, who moved to Ulm in 1954, represented the culmination of a didactic process in which colour was studied analytically, then experientially, to become a mere design code, aligning with the aims of HfG didactics that were “not limited to the design of consumer goods, but also included the design of elements and systems for the development of construction, science, means of transport and graphic, visual and sound supports for a rapidly expanding media” (Fernández Campos, Sánchez Moya, 2021, p. 179).

In light of this scenario, the principal lecturers of the Visuelle Einführung chair, (the core of the visual training subjects in the Basic Course or *Grundlehre*, first year), who had a profound influence on Maldonado’s work, are briefly listed and explained below.

The first approach to colour as a methodical design asset comes from Helene Nonné-Schmidt, a former Bauhaus graduate. She constituted Maldonado's first reference as Nonné proposed students to develop a systematic study based on investigating the behaviour of hue, its lightness and saturation (Figure 1). The dissection of colour indeed led to identifying its main components used as a “tool for the generation of coherent palettes with chromatic identity for application in industrial, graphic and construction projects” (Fernández Campos, Sánchez Moya, 2021, p. 181).

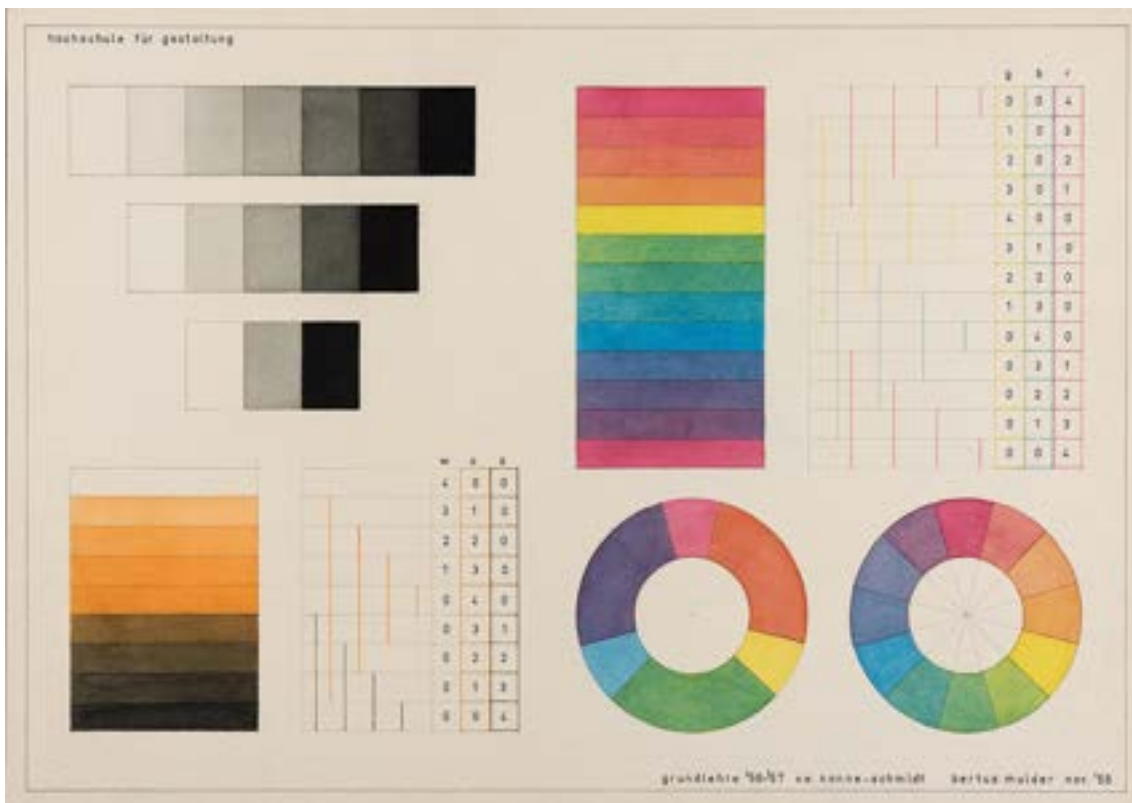


Figure 1. The careful study of the behaviour, lightness and saturation of hue during Nonné-Schmidt's course, 1956-57. From: Fernández Campos, Sánchez Moya, 2021.

The second didactic influence comes from Josef Albers and Johannes Itten and their constant research about the perceptual effects resulting from the combination of different colour sets. Both Albers and Itten introduced the teaching of colour contrasts to prioritise the “ability to see colours” over “knowledge of colours” like perceptual alterations as consequences of intersections and interactions: “the title of the exer-

cises anticipated their objective: one colour looks like two, two colours look like one, illusory mixtures and transparency, progenitor colours, intersection of colours, mixtures, transformations, quantity of colour, vibrant edge” (Fernández Campos, Sánchez Moya, 2021, p. 183).

Maldonado began his experience by observing, in a first phase, the work of his predecessors, who were developing methodical and empirical teachings in the Basic Course. This ambivalent reading conveyed in his cutting-edge conception of the design process as a system outlined by scientific reasoning and intuition and synesthetic perception.

These progressive modifications within the course contributed to a profound change in the conception of the figure of the designer who is no longer an artist (a Bauhaus legacy promoted in Ulm School by Max Bill) but an “integrator” with responsibility for incorporating a large number of competencies acquired through educational training, which was seen as a systems-thinking approach embodying both art and science.

The Influence of Maldonado’s Artistic Research: Colour and Perception Principles through Ulm’s Didactics

We consider that the HfG’s contribution to the renewal of education in applying art to the industry is particularly fascinating under the perspective of colour. Tomás Maldonado is indeed one of the key protagonists of this paradigmatic shift.

With Maldonado, the scientific and perceptive properties of colour were integrated into the methodology of design by creating systems of relationships supported by the internal logic of colour, analysed and understood thanks to shape fragmentations.

Maldonado tackled the study of colour not as the main focus of the subject within the Basic Course, but as one of the many generative laws that lead to the relationship between background and figure in a representation. As confirmed by the evidence of William S. Huff, student and professor at the HfG and a leading expert in Maldonado’s didactic work, all the generative laws (such as symmetry, topology and

the theory of Gestalt perception) taught in his Basic Design exercises were deeply imbued with concretism beliefs. The colour from simple tonality thus became a code, a design tool used to understand specific visual systems of industrial artefacts, ceasing to be an object of study but becoming a vector for solving the ambiguous perception of the background and the figure in a composition, or the visual balance to neutralise the depth of black (Huff, 2009).

This ideology was materialised through the proposal of a series of Basic Design exercises that followed “the laws of Gestalt, the topological figures of fractal structure, the laws of symmetry and the raster or grid” (Fernández Campos, Sánchez Moya, 2021, p. 184).

Colour was no longer understood as a plastic element of purely aesthetic properties but as a tool integrated into a design system aimed at realising concrete elements. In his essay, Huff listed the series of assignments that Maldonado proposed to the students of the Basic Course in the academic year 1956-1957: there were symmetry and parquetry exercises (Figure 2); exercises related to proximity and similarity based on Gestalt; depth perception exercises based on the overlapping of different grounds and their related ambiguity; Inexact through exact (Figure 3), which gives rise to imprecise figures starting from defined rasters, and vice versa Exact through inexact; Black as colour in a Peano curve (Figure 4), whose challenge was not to turn black into a hole; other perception exercises in which squares were divided in rows that step-by-step shifted into rings with increasingly rounded edges.

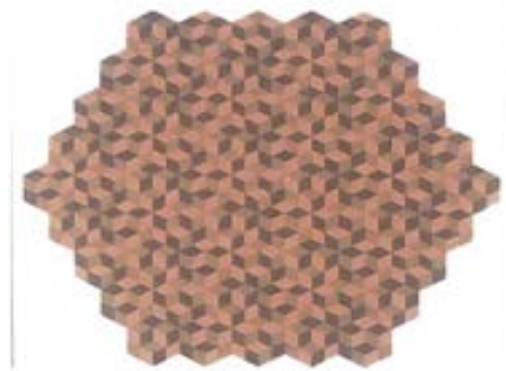


Figure 2. William Huff's assignment Parquetry during Maldonado's course, 1956-57. From: Huff, 2018.



Figure 3. William Huff's assignment Inexact through exact during Maldonado's course, 1956-57. From: Huff, 2018.



Figure 4. Klaus Krippendorff's assignment Black as colour during Maldonado's course, 1956-57. From: Fernández Campos, Sánchez Moya, 2021.

From Experience to Legacy: the Mutual Influence between Artistic and Design Practice

As seen above, starting from the analysis of Tomás Maldonado's artistic practice, linked since his debut to Argentine concretism, we can identify how much his conception of painting as “pure manual and aesthetic exercise” had a strong influence on his teaching experience during the Basic Course in Ulm. Meanwhile, his use of colour as a code and his studies on the ambiguity of perception have reverberated in his more recent paintings. As he states: “Every painting is a new experience for me. [...] It is not entirely true that my works do not express continuity. The only difference is that it is a less explicit continuity” (Maldonado, 2010, p. 56. Translated by the authors). In these words emerges the importance of artistic practice as a tool for interdisciplinary exploration involving topics that are only apparently unrelated – such as cognitive science, perception, and psychology – and the fundamental role of colour in visual phenomena. Indeed, Maldonado recognizes that colour is an important element of vision, not only based on a double binary – on one side, the abstract-mathematical component and, on the other, the daily sensitive, emotional and creative experience related to its perception – and introduces its virtual nature as a construct present in our brain, indispensable in defining our relationship with reality (Maldonado, 1997).

In design education, it is possible to recognise how School of Ulm's colour exercises anticipate an approach that is strongly linked to digital technology, using a logic of representation that is a forerunner of pixels and raster images. Because of these characteristics, which are not only formal but also conceptual, they are now taken up in the teaching of Basic Design, defined by Giovanni Anceschi (2016) as an activity that “interweaves propaedeutics (teaching how to do) and disciplinary foundation (understanding the theoretical and conceptual articulations involved)”. In continuity with Maldonado's work in Ulm, the Basic Design exercises break down the design activity into its essential components, isolating and deepening them through tar-

geted exercises. The exercises on form, perception and colour, initially carried out by hand using techniques close to artistic production (watercolours, pencils, acrylics), are now re-proposed in design courses to familiarise students with modern digital tools, thus defining a discipline called Basic Digital Design.

However, this recent evolution due to technology should not be seen as a complete replacement to the previous one but, in line with Maldonado's thinking, an additive perspective should be adopted within which the new alternatives are placed alongside the previous methods. Indeed, the principles and objectives of the exercises remain unchanged, offering dual experimentation in the field of colour, both material and digital. It allows the future designer to gain awareness in different application contexts, integrating new tools and skills. In this specific case, the computer tool could not only be proposed as a means of re-doing the exercises in a digital environment, but also as a "new prosthesis capable of characterising not only the visible results but above all the *forma mentis* of the graphic designer and his logical-operative method" (Francavilla, 2011, p. 8. Translated by the authors), in continuity with what was promoted by the *Grundlehre* in Ulm.

Within contemporary art practice, we find different ways of using colour to echo artworks and exercises related to Maldonado and his school of thought. This tendency of art to offer re-elaborations rather than real innovations is justified by the fact that the great *avant-gardes* of the 1920s, 1930s and 1940s represented the real turning point in redefining artistic practice: everything that follows can only attempt to reinterpret and deepen what has already been discovered through their language. If this is true from a conceptual and formal point of view, technological evolution, however, has offered artists new tools to express themselves coherently with their ideology: "Different artistic tendencies, albeit with opposing visions, are now gathering around the same reservoir of techniques – techniques of iconic computer production – from which each of them hopes to be able to refuel, without betraying their original programmatic matrices" (Maldonado, 1992, p. 61. Translated by the authors). Thus we speak of New Media Art, "an

artistic movement that uses emerging media technologies that address the cultural, political and aesthetic potential of these tools” (Mancuso, 2020. Translated by the authors). Brushes and pencils are replaced by photographs, video footage, film, print, fax, music, and performance to arrive at more recent experiments between computers and networks (Frieling, Daniels, 2006).

Its application is even more interesting in the discourse on colour, as it has always been a component directly influenced by highly technical aspects such as the availability of raw materials and transformation processes (Ball, 2007). The possibility of having a virtual canvas available – even reaching the point of working on three-dimensional spaces – and millions of colours made accessible by digital media – not only subtractive colours, but also additive mixing with the use of light as material – has multiplied the experimental and expressive potential inherited from concrete art and the exercises from HfG.

The Legacy: Past and Present towards the Future

Maldonado’s line of thought and experimentation show that he has always been interested in evolving his approach and techniques based on new technologies and following the social impetus of the moment. In this perspective, we can consider how he left a legacy not only in terms of design notions, but in the very attitude to design and the designer’s relationship with contemporary reality. It means taking into account emerging needs and consequently knowing how to evolve his point of view and adapt his methods according to contemporaneity. Therefore, it is interesting to consider the influences between artistic practice, colour, and perception triggered by new multimedia technologies.

Tomás Maldonado had always shown a growing interest in new technologies as essential tools for designing and proposed them in different areas of study, experimentation, teaching and professional work. Incorporating the latest technologies and the consequent de-

velopment of new possibilities does not mean excluding all previous work but rather integrating them into new processes.

This is why it is interesting to observe how artists and designers, over time, seem to work alongside his reasoning and even indirectly pick up his legacy.

From this perspective, colour exercises may find not just a different application from an experimental point of view, but also evolve into a real form of expression.

In the perceptive exercise *Antiprimadonna* (Figure 5), the aim is to create a composition by means of a sequence of five spot colours and two black and white textures (different and not adjacent), choosing isometric or isomorphic colours and screens so that none prevails over the other (Ferraris, 2014). It was an exercise aimed at training the students' ability to juxtapose colours in a considered way, triggering a critical spirit and thus creating "palettes". This can be done by putting together a series of cards, making textures by hand or creating colour fields using Pantone, watercolours, etc., which can also be of different widths to play on visual weights. Imagine doing the same exercise digitally: the result will be very different as it will be less textured, but it is useful and interesting to compare the same choice of colours with a digital creation.

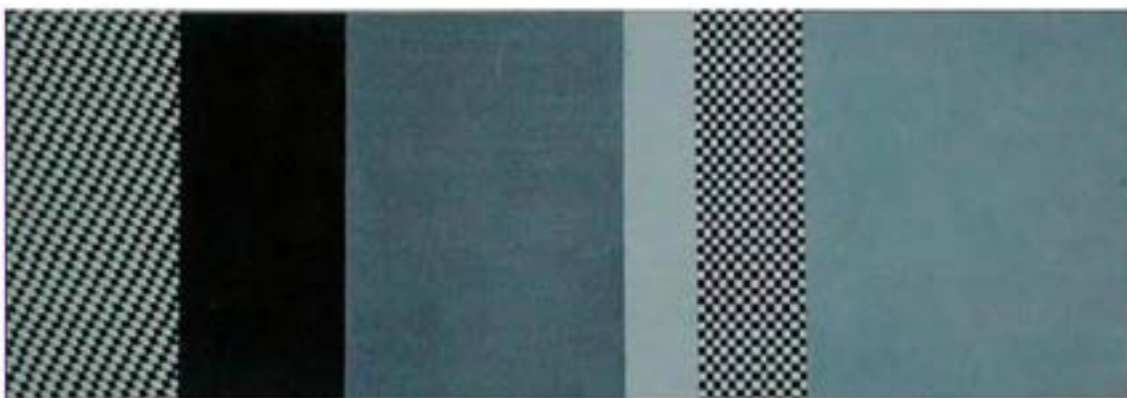


Figure 5. Giovanni Anceschi's assignment *Antiprimadonna* during Maldonado's course, 1962-63. From: https://www.researchgate.net/publication/43901647_Sviluppo_di_un%27interfaccia_audio-aptica_basata_sulla_profondita_spaziale

What if this sequence of colours was multiplied, enlarged and projected within a space? Olafur Eliasson's *I only see things when they move* (Figure 6), first set up in 2004, is an installation in which a series of rotating coloured glass panels in the centre of the room create a play of colours by projecting bands of different shades onto the surrounding walls. The Danish/Icelandic artist's aim is to create complex optical phenomena using simple makeshift technical devices such as mirrors reflecting the light beams of reflectors and kaleidoscopes producing coloured prismatic effects (Bee, Heliczner, McFadden, 2013).



Figure 6. Olafur Eliasson, *I only see things when they move*, 2004. Installation view at Moderna Museet / ArkDes, Stockholm, 2015. Photo by Anders Sune Berg. From: <https://www.olafureliasson.net/>

In addition to the chosen aesthetics and the immersiveness of the installation, the choice to make the “mechanics” of the work visible is particularly interesting, placing the artifice itself that creates the projection in the centre of the room, explaining the motive behind the choice of title: “I only see things when they move”. Indeed, it is a motor that makes the plates turn individually, thus creating a mobile spectrum of colours, of vertical reflections on the surfaces immediately around them.

The work reflects on the relationship between the human being and subjectivity, between the individual and space, creating a fruition of

the same that is not merely passive, but creates a sort of social experience.

Considering Tomás Maldonado's approach, we can identify contemporary figures with him and who have flanked and developed three main themes related to colour, which can then be re-identified in his legacy, picked up and held by modern designers and artists. These are: (i) a mathematical approach to colour, (ii) colour as experimentation with new media, (iii) colour exercises in interactive space.

Taking into account the exercises proposed at the Ulm School, based on geometric models that students had to rethink through rules of variation of given geometric modules (Neves, Rocha, 2013), a mathematical but at the same time a creative approach is clearly shown. The students were indeed called upon to interpret the form creatively, even though they started from well-established mathematical rules. As highlighted previously, this attitude carried out with Max Bill at the Ulm School was already experimented with concretism with the shape of the frame corresponding to the internal motif. Those, depicted in the canvases and with a "coplanar" composition – in which the forms were released from the canvas into space through the use of a grid and harmonisation of colour– can be found in further didactic, artistic, design-related experimentations after the 2000s (Crispiani, 2010).

Giovanni Anceschi, Nunzia Coco and Nicola Vittori reintroduced a Basic Design workshop at the Iuav in Venice in 2006-2007 (Coco, 2010), a multisensory exercise by Moholy-Nagy,² which can be traced back to the first experiments on tactility at a quasi-synaesthetic level (Figure 7). It is put into practice a pathway that starts from a sensory experience and turns it into an output with a defined and intelligible form, describable through mathematical forms and proportions.

Concepts such as rarefaction and densification, texture, symmetry and deformation represent fundamental arguments of Basic Design

2 Moholy-Nagy's Exercise, 2006-2007. Iuav PhD in Venice curated the 1st edition of the design pedagogy Seminar/Workshop in 2006. The 1st Edition was titled "Basic Design: la tradizione del nuovo", 2006. The 2nd edition was titled "New Basic Design: il basic dell'interazione", 2007.

that we have seen pass from Ulm with Maldonado, Huff and Bill, and then applied in the extreme experiments of John Maeda at the MIT in Boston. Here the basic themes of graphic syntax are revisited from the perspective of the digital tool through graphic software such as Adobe Illustrator and mechanical hardware (Francavilla, 2011).



Figure 7. Exercise inspired to Laszlo Moholy-Nagy, proposed by Giovanni Anceschi, Nunzia Coco and Nicola Vittori in 2006 at Iuav. From: “Progetto grafico”, 12, 2008.

The visual artwork Fireball (Figure 8), for example, was created in collaboration with the Italian company Sawaya Moroni by programming a dedicated algorithm to achieve a specific aesthetic and use of colour, seeking a balance between the use of technology and emotion (Maeda, 2006) of which these practices are a synthesis.



Figure 8. John Maeda, Fireball, 2005. From: Aprile, 2016.

Therefore, colour can be used as an experiment in new media and new technologies, whereby the latter can be integrated to harmonise colour digitally or automate specific processes. This is the case with Crypto-Art (Figure 9) and Generative Art (Figure 10), which focus on generating colours and shapes using algorithms and make it possible for spectators to buy, enjoy and participate in the works in sundry ways.

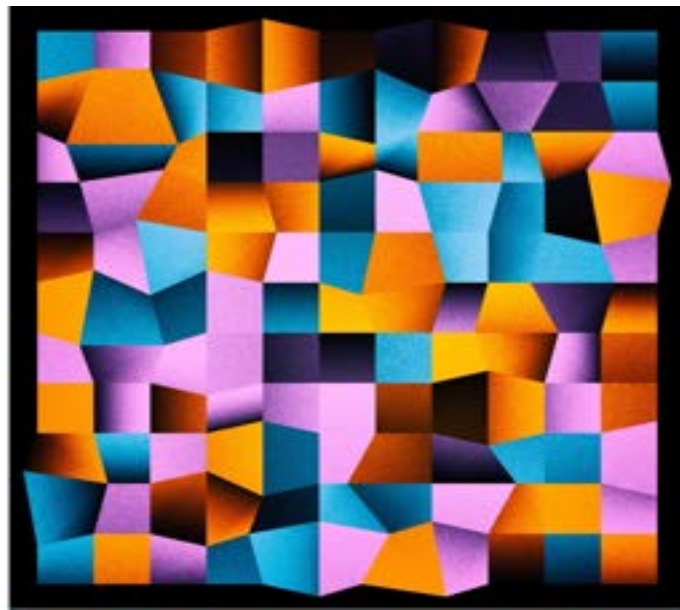


Figure 9. Manolo Gamboa Naon, ddfrcfc, 2020. From: <https://cryptoart.io/artist/manoloide>



Figure 10. Pindar Van Arman invented CloudPainter and created robots that paint for over ten years using AI, robotics arms and 3D printing, 2018. From: <https://aiartists.org/pindar-van-arman>

This switch may require mechanical tools and algorithmic processing, but it may also be relevant to a mere change of medium. After a traditional training and a long career based on works on canvas, the artist David Hockney decided to switch to iPad drawings (Figure 11), applying his knowledge and aesthetics to the potential of the new technological medium. Using a “few pounds” application (Franceschini, 2012), the artist appreciates the ability to paint with his fingers on the screen, change the thickness of the brush, mix the colour, change the brightness quickly and conveniently, and the portability and ease of use of the tool. According to Hockney, these features are the ones that many artists of the past would have appreciated: “From Tiepolo to Van Gogh” with “the only disadvantage of not feeling the resistance of the paper to the pencil or brush, an important factor for those who draw or paint, but the advantages outweigh the disadvantages” (Savelli, 2020).



Figure 11. Three works from David Hockney’s *The Yosemite Suite*, 2010-11. From: <https://www.nytimes.com/2016/05/02/t-magazine/art/david-hockney-yosemite-ipad-paintings.html>

As already seen through the experience of Olafur Eliasson’s installations, exercises with colour can be brought into interactive space with fascinating results. New technologies make it possible to practice all those colour games interactively, exploring them directly through one’s own body. With *Your uncertain shadow (colour)* (Figure 12) visitors can bring their bodies into play, reducing them to shadows

and multiplying them during this installation with different colour schemes, pervading the space and interacting with others on the gallery walls.



Figure 12. Olafur Eliasson, *Your uncertain shadow (colour)*, 2010. Photo by María del Pilar García Ayensa. From: <https://www.olafureliasson.net/>

TeamLab fielded another interesting relationship between body and space through the interactive installation *Graffiti Flower Bomb* (Figure 13) implemented in 2018 at the MORI Building Digital Art Museum. Here, flowers, drawn on a paper in “Graffiti Nature”, appear on the wall and grow in clusters, bloom or disperse by interaction with visiting people who, by placing their hands on the wall, can capture them and make them blossom, while when they move them, they make them disperse. This work is designed to spread awareness about endangered wildlife by connecting people with natural elements. The deployment by people of their bodies can create a positive memory, remembrance and attachment to the cause, a different involvement precisely because they are deployed on a personal level.

The same happens through installations in which the visitor can manipulate elements of the work and the colour itself with his own hands (Figure 14). In both cases the body is involved as an essential part of the installation, and the experience becomes immersive.

EXPLORING TOMÁS MALDONADO



Figure 13. TeamLab, Graffiti Flower Bomb, MORI Building Digital Art Museum, 2018. From: <https://borderless.teamlab.art/ew/bombing/>

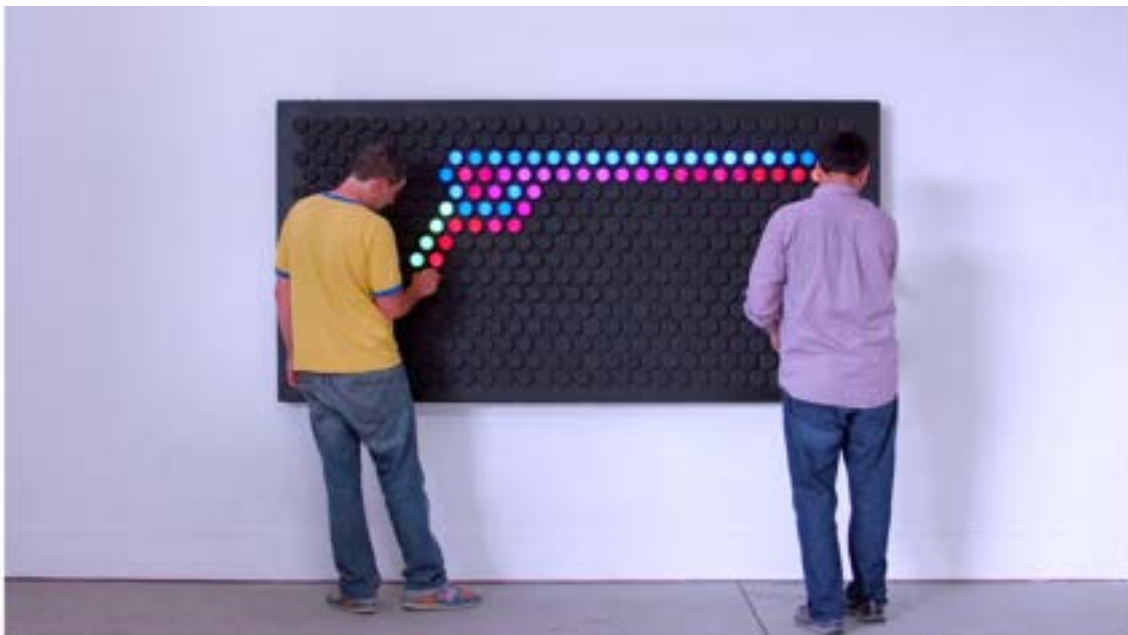


Figure 14. Hero Design, Everbright, 2015. From: <https://theeverbright.com/>

Conclusion: Future Perspectives and Directions

In interpreting Maldonado's approach to colour, originated in the artistic field and developed in the design domain through his teaching career, practises linked both to contemporary society and the evolution of technological means have been identified as vital inspiration for designers and creative people in the contemporary era. These processes can be traced back to two strands that will characterise the future art and design scene: on the one hand, colour will continue to be used to master the medium (as a simulation in the analogue sphere and as an expressive tool in the digital context), on the other hand, it will seek to overcome technological limits by pursuing the free creation of meaning.

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Art and Science

Francesco Cantini, Riccardo Fazi, Elisa Matteucci

Is industrial design an artistic activity? And, if it is, what kind of artistic activity are we facing? And if industrial design is not an artistic activity, then, in what other field of our cultural production can it be placed? Perhaps in the field of science, or in that of technology? Or is it instead a new phenomenon, for which a new reference must be found, independent of art, science, technology, but in relationship with them?

T. Maldonado, *Disegno e arte – Dialettica di un'alternativa*

In Manifesto invenzionista, Maldonado speaks of an assumed and imminent conclusion of what he defines as the “prehistory of the human spirit”. According to the author, this passage is identified as the replacement of a thousand-year-old speculative and idealist aesthetic with a scientific one: from the metaphysics of beauty to the physics of beauty. Years later, Maldonado himself, commenting on the text, will notice the fallacy of this hypothesis by stating that the ancient phantasmagorias of the human spirit kept living (Maldonado, 1946). Therefore, the centrality of scientific thought in Maldonado can be already seen in the “Argentine period”, but how do Art and Science intersect? According to the author, there is a relationship of interdependence between these disciplines – which can also be found in contemporary times – that can be read through different lenses. The following text explores Maldonado’s theoretical contribution within the debate on the relationship between Art and Science and the possibilities of semantic inversion of these two concepts.

This article analyses these two disciplines by exploring the ways of intersection between the two concepts: how they changed in history starting from the Renaissance, how they evolved during the twentieth century and how they develop in the contemporary using case studies to outline future trajectories and methods of intersection. Particular attention will also be paid to the discipline of design, which has always moved within this binomial.

In recent decades, in fact, design, understood both as a practice and as a design thought, has increasingly intersected its paths with the so-called hard sciences such as physics, chemistry, mathematics, biology, but also with the more fluid and interdisciplinary contemporary sciences: synthetic biology, neuroscience, bioengineering, nanotechnologies (Langella, 2019).

In the complexity of the relationship between Art and Science Maldonado lists, in *Reale e virtuale*, three possible forms: Art as an object of scientific investigation; Art that makes use of the scientific methods during the formative process of the work; Art that is expressed through the disclosure of some discovery or research in the field of science.

With the concept of Art as an object of scientific investigation, Maldonado refers to the mathematization (which more recently can be seen as a computerization) of aesthetic phenomena. In other words, the claim to develop a scientific aesthetic, sometimes identified with the ambitious program of an “experimental psychology of beauty”. The author also gives the example of the practice of restoration as a technical-scientific tool for the attribution and dating of works of Art. In the contemporary this type of interdependence emerges, for example, in the case of Doug Aitken’s *Sonic Pavilion* (2009). The work looks like a building located on the top of a hill, inside which visitors can listen to a continuous live feed of sounds coming from about two hundred meters deep, captured through a complex set of highly sensitive geological microphones that collect the frequencies produced by the movement of the tectonic plates. The interesting aspect is that the data the work collects in its operation provide scientists with a

huge amount of information relating to the movements of the tectonic plates; thus a fertile short-circuit is created between Science and Art, where science appropriates the results of an artistic intuition, aimed at an attempt of “translation” by the artist of signs of a natural macrocosm that otherwise we could not perceive. This kind of operation brings into play that relationship of interdependence between “Art as Science” and “Science as Art” about which Maldonado speaks in *Reale e virtuale*: Art is used as a Science and at the same time, inverting the terms, Science is used as an Art. However, remembering that also in this case the difference that Maldonado underlines between the meaning given to the research product is maintained: in the case of artistic research, the product (the perceived diffuse sound and the immersive experience produced in the visitor) is the end, while for the scientist the same sound is a means (to understand the “behavior” of the underground layers of earth).

According to Maldonado, the second way the two disciplines intersect is conceiving Art that makes use of the scientific methods during the formative process of the work. A relevant example is in the close relationship between the Renaissance revolution and modern Science. The parameters of the scientific methodology in force between the fourteenth and sixteenth centuries led artists and mathematicians to elaborate precise rules for the representation of reality (Bagni, D’Amore, 2006). Artists such as Leon Battista Alberti and Piero della Francesca also addressed the question of proportions, among others. Throughout the course of the classical age, artists had applied proportions to sculpture and architecture that provided for the choice of precise mathematical relationships. They tried to revive this concept by updating it, in order to re-establish canons of aesthetic perfection and to develop new methodologies for the construction of more harmonious architectural structures.

But art has made use of scientific methods throughout the ages. We consider, for example, the paradigm of the Baroque which, under the influence of Johannes Kepler’s discoveries on the motion of the planets, moves from the use of the circle to that of the ellipse as a ref-

erence figure in architecture; or how recent innovations in biotechnology shift the concept of “object as a built work” to “object as a growth work” (from assembly to growth).

The third and final moment of intersection between Art and Science according to Maldonado is manifested by the Art that is expressed through the disclosure of some discovery or research in the field of science. In addition to the linear perspective, the author brings as an example the relationship between Seurat’s pointillism and Chevreul’s theory of color but also that one between Dalí’s surrealism and Freud’s studies on the unconscious. The figure of Leonardo Da Vinci, in this framework, represents from Maldonado’s point of view a particular case as it is difficult to define when he is engaged in making “Art as Science” and when “Science as Art”. The notes on the behavior of water currents and in particular the observations on the phenomena of turbulence are emblematic. Leonardo is, for Maldonado, the last exponent of a long period in which Art and Science formed a solid unity (Maldonado, 2005).



Figure 1. Leonardo Da Vinci, Studies of Water passing Obstacles and falling, about 1508-9. Public domain. From: <http://www.drawingsofleonardo.org/>

Trying to trace a trajectory of this analysis, new and surprising correspondences emerge in the contemporary. In fact, the relationship between Art and Science could be extended by expanding the methods of intersection; what happens if, starting from Maldonado's analysis, we try to invert the two words? For example, in the contemporary world, an approach to art that takes science as an object of investigation is increasingly widespread. Similar approaches are found in artists such as Tomás Saraceno, Olafur Eliasson or Eduardo Kac (Myers, 2012). If we take for example the works of Tomás Saraceno, and in particular the recent work *Aria*, we notice how the artist becomes a multifaceted figure, whose creative research combines art, natural and social sciences. Saraceno invites us to change our point of view on reality and to connect with non-human elements such as dust, spiders or plants that become the protagonists of his installations and metaphors of the cosmos (Saraceno, 2020).

Semantically overturning the second point of Maldonado's analysis – therefore: Science that makes use of the artistic methods during the formation process of the theory or model – opens up a more complex scenario that can be interpreted in two ways. The first: Science which, to define a specific model, must use an “aesthetic” glossary. Therefore the mathematical beauty, linked to the concept of proportion, symmetry and synthesis, which meets the consensus of many physicists and mathematicians. With G.H. Hardy: “The forms created by the mathematician, like those created by the painter or poet, must be beautiful; ideas, like colors or words, must be harmoniously linked. Beauty is the fundamental requirement” (Hardy, 1940). The second interpretation highlights a propensity, on the part of a few scientists, to elaborate scientific theories and models by borrowing typical methods of Art. One ancient example could be seen in the *Sidereus nuncius*, written by Galileo Galilei in 1610, after the telescope observations of the lunar surface enriched with detailed drawings depicting the various phases of the moon. At the beginning of the seventeenth century, that scientific text became very famous; the reason is linked to the fact that it offered a different and radically transgressive representation of reality

towards the Church, which put the work on the index of prohibited books judging it heretical. In that period the artist Lodovico Cardi da Cigoli, inspired by Galileo's drawings, offered a representation of the moon with unprecedented naturalism, in which craters and roughness can be seen, and placed it under the image of the virgin frescoed in the church of Santa Maria Maggiore in Rome. With Maldonado: "The role of the artist would be, to put it briefly, that of transgressor towards the established symbolic order" (Maldonado, 1992). In the contemporary world, the case of Stefano Mancuso is exemplary, a plant neurobiologist with a marked propensity for interdisciplinarity, who studies the interaction between plants and human beings through an artistic installation (Höller, Mancuso, 2018). The goal is elaborating and demonstrating theories starting from the observation of the interaction between man and Art.

If we try to apply the same semantic inversion on the last point – Science that is expressed through Art – then we can trace, throughout the twentieth century, a slow and progressive rapprochement of these two disciplines. In fact, an important channel of theoretical investigation emerges. A rapprochement that starts from two scientists, James D. Watson and Francis Crick who at the end of February 1953 published their proposal for the structure of DNA (Watson, 1968), that is the physical form of the biological structure with which the genetic sequences are copied and then reproduced in the daughter cells. To make the complicated structure of DNA immediately understandable and clear, as Watson and Crick were hypothesizing it, it was decided to build three-dimensional models starting from information relating to the molecular dimensions and the bond angles between the molecules that make up the helix. The model that the two scientists had built had to be in agreement with the physical and chemical data that declared the existence of two polynucleotide chains side by side running in opposite directions, that is antiparallel. Without even conducting an experiment to verify their hypothesis first, Watson and Crick built the DNA model. They built in the literal sense of the term: an enormous model made of wire and cardboard: Poor Art at the service of Science.

It is not by chance that the two scientists decided to build a model on a human scale: through the sculpture an experiential bridge between microcosm and man was created immediately and with extreme clarity. A molecule of a few nanometers, observed up to that moment in a two-dimensional way, suddenly acquired body in human space, unconsciously acquiring the status of a minimalist work of Art where the order and repetition of the elements truly reflect that of nature. This is just one of the best-known cases in which Science has worked around a model, or a simplified representation of reality in which particular elements gain importance by graphic or material means.

The tension of Science towards Art also emerges from recent experiences such as the Collide Residency Award. Every year, CERN in Geneva invites artists from all over the world whose practice interacts with the research carried out by CERN itself to apply for periods of residence within the institution's spaces. During the residency, the artists make use of the continuous dialogue with scientists, engineers and the staff of the laboratories to develop research paths in the design or implementation phase characterized by a transdisciplinary approach that brings together artistic and scientific research to help the dissemination and communication of the CERN's research. Tomás Saraceno, Antoni Muntadas and Ryoji Ikeda are just some of the best known artists who participated in the program.

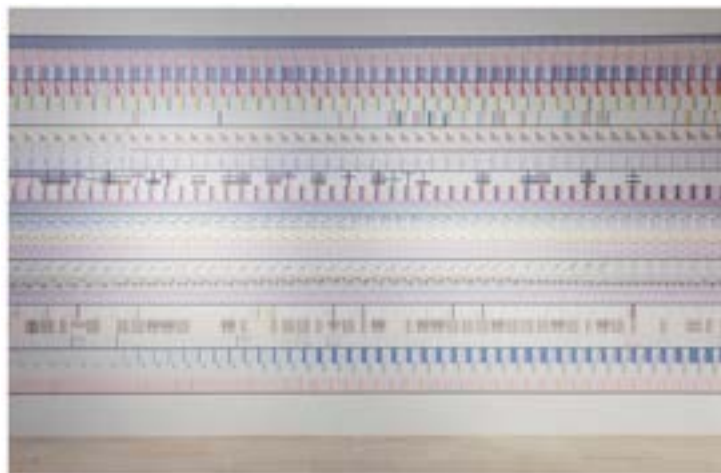


Figure 2. Accurat, *The Room of Change, Broken Nature*, 2019. ©La Triennale, Milano. Photo by Gianluca Di Ioia.

At the same time, the progressive increase in the production of data and the ever more urgent need to decipher the complexity of reality highlights the need to communicate changes in society and the surrounding environment to an ever wider audience. Data Visualization, for example, makes the world of Data Science accessible and decipherable, creating a narrative that, even through Art, manages to effectively communicate scientific data. In this sense, Data Visualization or Data Art not only provides information on the numerical quantity of data but also on social or more strictly qualitative issues, offering a more humanized reinterpretation of the raw statistical material. Information designer Giorgia Lupi, from studio Accurat, talks about Data Humanism (Lupi, Posavec, 2016), that represents the possibility of attributing to data a more human and less technical value, since data starts from people, describes their behaviors, tells stories or simply makes evident the repercussions of certain actions towards the environment around us. In this sense, the dialogue between Science and Art also takes on a strong social connotation.



Figure 3. Neri Oxman, Krebs Cycle of Creativity, from *Age of Entanglement*. *Journal of Design and Science*. (2016) From: <https://doi.org/10.21428/7e0583ad> Attribution 4.0 International (CC BY 4.0).

An interesting case of science expressed through art can be identified in the strong theoretical contribution offered by Neri Oxman, Israeli-American designer and professor at MIT. If we take for example the Aguahoja or Silk Pavillion projects, these artifacts do not have a precise function, nor do want to communicate a specific message, they are above all demonstrations of a process, of a scientific innovation or of a program. Trying to trace a trajectory for the disciplines of the project it emerges therefore that the terms Art and Science intersect in ever different ways. In particular, with regard to future scenarios, the contribution of Oxman and the Mediated Matter Group - MIT recurs, which through the framework Krebs Cycle of Creativity provides a redefinition of Art and Science, inserting the disciplines of the project in a cycle where the concepts of nature and culture enter into osmosis and the domains of Art, Science, Engineering and Design enter into a continuous bond characterized by the constant exchange of what is defined CreATP or Intellectual Energy (Oxman, Antonelli, 2020).

In Krebs Cycle of Creativity, Oxman wants to demonstrate that Science converts information into knowledge; engineering – partially overlapping the Maldonadian concept of technique – transforms knowledge into utility; design transforms utility into behavior, bringing it into the cultural context; Art takes that context and questions the perception of the world in which Science will then develop new paradigms.

The rapprochement between Art and Science is also highlighted by some recent exhibition itineraries proposed by important institutions such as the Palazzo delle Esposizioni in Rome, the Museum of Modern Art in New York, the Triennale Milano and La Biennale di Venezia. “Three stations for Art-Science”, proposed by Palazzo delle Esposizioni, is a large project developed through three exhibitions representing three different points of view: the historical one, the artistic one and that of contemporary scientific research. The goal is to demonstrate that knowledge can no longer be based on certainties or disciplinary separations, but can instead find space in the dimension of research

which is the dynamic, uncertain and free place where Science and Art meet.

The 23rd International Exhibition in Milan, curated by astrophysicist Ersilia Vaudo Scarpetta, with the name “Unknown Unknowns, An Introduction to Mysteries” will investigate, through an interdisciplinary path, what we still “don’t know we don’t know” in various fields: from evolution of the cities to the oceans, from genetics to astrophysics. An experience that will involve scientists, designers, artists, playwrights and musicians, giving the opportunity to overturn our idea of the world.

In 1964, in *Disegno e arte – Dialettica di un’alternativa* Maldonado argues that industrial design is a new phenomenon, in relation to Science and Technology, and, as such, extremely difficult to define. The examples cited above suggest a progressive realignment between artistic and scientific speculations, reinforcing this theory. It therefore remains to be asked whether it is necessary, to assist this process, to educate new “hybrid” figures between aesthetics and epistemology, bringing a theoretical advancement into the relatively young evolutionary tree of Design.

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Environment and Artifice

How the Combination of Design and Technology Contributes to the Reconstruction of Biological Connections

Chiara De Angelis, Angela Denise Peri

Environmental deterioration, which is increasingly becoming a tangible expression of a difficult compromise in terms of the interaction between human activities and the environment itself, has reached such proportions that, in the absence of effective actions, could have an unavoidable and definitive influence on the birth, development and survival, as well as the equilibrium of each *biotic* and *abiotic* factors present on our planet.

Upstream of this stressed consideration, there is a diachronic analysis related to definition of the term environment. It emerged how its components (namely the *geosphere*, the *biosphere*, the *sociosphere* and the *technosphere*) constitute a unique, complex system, in which all parts are interconnected and inseparable. It is evident that the effects of human activity cannot be relegated to a specific area but integrated in a reciprocal chain of activity that involves, directly or by extension, all the other assemblies in a substantial way coming back to reverberate on the starting subset from which the perturbation arised.

It is necessary to define the magnitude and patterns through which the *agent provocateur* more precisely intended as “Man’s working consciousness of his physical and socio-cultural surroundings” has contributed to the change in the ecological system of nature, from which he draws and transforms resources at an unsustainable rate. It is difficult to restore the situation on an earlier basis.

The main attempt of the following paper is focused on rebuilding an ideal of nature that is founded on new perspective bases, going to intervene artificially on compromised habitats.

The survey is therefore focused on the possible role of design in this context, through the study of the possible connections between the process of socio-technical evolution and the mechanisms of innovation of the industrial product, in a context where materials and technologies are “designed” means the offspring of that capacity to intervene in their constituents at a molecular level.

The examples presented operate in different contexts and application scales, aimed at the reconstruction of spaces or artificial structures that try to regain balance which has been totally or partially compromised by the action of man. The design applied to new processes of additive production and bio-manufacturing allows to generate new and locally available resources, aimed at co-planning activities, to bring value to the community within which they will fit.

The design applied to the above-mentioned technological processes and production techniques can become a functional paradigm for revisiting the relationship between man and nature, simultaneously guaranteeing design freedom and production speed never seen before. This approach, however, has a series of unfavourable implications, especially considering the long-term effects of these interventions.

Are we really going to rebuild those lost natural processes or by further introducing artifices we are contributing to a process of irreversibility?

From Primordial Nature to Compromised Environment

The theoretical itineraries which helped to define the process of interaction and mutual absorption that exists between man and nature that surrounds him are anything but recent. A quite marked contrast between the so-called *naturalists* and *artificialists* finds its most radical meaning, among the first group, in the thought of Diogenes who states that the internal order of nature should never be attacked, not even to satisfy the most primitive human needs (Maldonado, 2005).

A position that can be retraced also in Pliny the Elder's perspective, which demonises the artifice, calling it "a real calamity for nature". With Lucretius we find a substantial subversion of this attitude. He emphasises the exchange and analogous tendencies of self-organisation, self-artificialization and change of the morphological-functional reality of nature towards man. And it is precisely with this perspective that, over the centuries, we have passed from the use of the word nature to the term environment, through a process of lyophilization of its meaning from connotations of artistic and literary derivation, son of romantic values and beliefs, in favour of greater objectivity and empirical verifiability, at the basis of a gnoseological methodology of scientific nature (Maldonado, 2005).

The minimum unit of the environment system is therefore identified as the set of *biotic* (plant and animal) and *abiotic* (or inanimate) components, balanced by a series of complex, interdependent relationships. Extending the control volume of the analysis carried out by the many scientific disciplines in the environmental field, it is possible to provide the definition of environment as a set of three interconnected and dynamically interacting subsystems, namely the *biosphere*, the *sociosphere* and the *technosphere* to which, in 1967, the notion of *geosphere* was added by control engineer John H. Milsum; this latter is intended as the "set of natural processes taking place within the earth and on its surface that do not necessarily involve living processes" (Chiapponi, 1997. Translated by the authors).

In an effort to find a square that allows to further characterise the link between man and his surroundings, a significant contribution comes from the German philosopher Arnold Gehlen, who made a distinction between the human *Welt* and the animal *Umwelt*. Unlike the latter, in fact, which seems to have been designed to perform a purpose efficiently, man seems to genetically have the attitude to imagine, invent and produce objects with which he enlarges his boundaries, constituting a real sphere of social and material production, where social sphere and technosphere act as a single functional whole (Maldonado, 1990).

It is therefore clear that the man differentiated itself by its ability to use (or rather abuse) its relations with other subsets and influence their fate radically. These, too, can disturb a foreign ecological balance, but only the human one shows to have today the virtual and real capacity to cause substantial, that is irreversible, disturbances in the stability of the whole system (Maldonado, 1990).

However, since man himself is part of the environmental system, he in turn faces the consequences of his being *agent provocateur*; the effects of environmental degradation cause risks that, by their nature, are spread in space and time to future generations, which will inherit increasingly damaging and less irreversible processes (Maldonado, 1990). An almost catastrophic phenomenon that is defined by D. Pearce in the 80s through the concept *transferred irreversibility*, where those “biogeochemical conditions that make possible the birth, development and survival of every living organism could disappear” (Maldonado, 1971. Translated by the authors).

In recent decades, the three basic components of our biotic system – air, water, soil – have been savagely mistreated, to the point that in many parts of our planet, especially in large industrial and urban areas, we now see a substantial (and irreversible, that is irreparable) rupture of the ecological balance. As Maldonado has pointed out:

“Then the question arises: in a situation like this, where there are so many valid reasons for discouragement, is it still possible to

find equally valid reasons to put confidence in the future? How can we rebuild nature?" (Maldonado, 2005. Translated by the authors).

According to Maldonado's point of view, nature should not be restored on a retrospective basis, as recovering its primordial state would involve a severe sacrificial contribution by man to save the planet with all its science-related processes, industry and technology. In the context where the following discussion is inserted, that is the role of design in this process of reconstruction, the interventions must be based on *perspective attitudes*. It has been understood that during its 3.8 billion years of experience, Nature has developed projects of form, process and system that are worth observing, understanding and emulating.

Bio-emulation is not a recent matter, actually: man has always tried to understand and imitate natural processes (think of Leonardo's studies). At present, however, the new study perspectives and the greater scientific and technological knowledge offer design ideas capable of meeting both the requirements of functionality and efficiency as well as the principles of environmental sustainability. Finally, it should be stressed that being inspired by nature means reasoning by relationships and according to the principles of complexity. The elements themselves that make up a system are a network of relationships inserted in larger networks, where the qualitative result of the whole system is greater than the sum of the individual parts. This offers considerable advantages both in terms of efficiency – because in nature the processes take place at room temperature and pressure, using the most common chemical elements and in a limited way – and in terms of sustainability, because imitating nature means acting in agreement and not in conflict with it (Germak, 2008).

The Role of Additive Technologies in Environmental Reconstruction Processes. Examples and Applications

Artifice as an integral part for symbiotic design between human and biological processes

It is well-known that the greatest faults in the current environmental devastation are related both to the production and disposal processes of the industrial society and to how the design world subsequently began to draw from its tools to try to adjust what in part had helped to induce.

Maldonado, in 1990, denounced the effects of our civilization on the environment in the hope of encouraging a more sustainable world, as the proposals of the design disciplines of the time seemed to produce modest results, in proportion to the magnitude of their goals. New instruments were therefore needed; instruments that at the time were not yet able to understand and that encouraged the expectation of a new “human doing” that quickly restored the great break with ecological balances, trying to slow down the expansion of the universe of objects derived from the socio-techno sphere.

“To the present date, however, one of the most characteristic elements of our time is the central role those scientific discoveries and technological innovations take on in it” (Maldonado, 1987. Translated by the authors), whose dissemination involves all areas of our life, facilitating with their artefacts the reality at various levels, until we can no longer do without them. The point is how the project world exploits these new technologies to develop new processes, applications and materials, in favour of the restoration of those lost environmental connections, broadening its vision.

The paradox that we have to face, therefore, is that if at first it was the sphere of the social and material production of men, in particular, that has contributed to upset the environmental ties, generating the problems that the project to date finds itself facing, it is thanks to the

scientific-technological development of this sphere that new strategies and approaches have been born that aim to reduce, reuse (sometimes even to create) the matter and the energy used in production, allowing us to rediscover a hope for the future of the planet. As Carla Langella says:

Design, with its interpretative, predictive and productive tools, is able to pursue the entire process of developing new materials, from the identification of the needs of society to the development of innovative material solutions up to the production and marketing of new products (Langella, 2019).

And if design has always been recognized as a factor of competitiveness and innovation for industry – able to interpret, meet and predict the needs of the mass, contributing to the experimentation of various scientific-technological processes in favour of the environment – it apparently acts beyond the boundaries of what concerns it, aiming at the reconstruction of “nature” and almost renouncing the traditional anthropocentric vision.

Aware of the heterogeneity of the project, our intention is therefore to discuss the central role and the value that can give a technology in full evolution, such as the one related to additive printing,¹ the designers, allowing them to imagine sustainable and optimistic future scenarios, where *nature* appears to be reconstructed on those perspective bases mentioned above.

¹ Additive printing, also known as “rapid prototyping” or “3D printing”, is a manufacturing technique that deposits thin layers of material to create a solid physical object from a file digitally modelled by specific software on a computer. There are several additive printing technologies; the most common are: by extrusion of material in the form of filament heated and deposited through a nozzle (Fused Deposition Modelling or Fusion Filament Fabrication); stereolithography and derivatives, which uses the laser to polymerize parts of tank filled with resin to form the object; laser sintering (sls): in this case the laser will selectively induce fusion between polymeric powder particles within the construction area of the solid object (which unlike other technologies does not require construction supports).

The frontier of environmental systems restoration

Technology linked to extruded material filaments² is currently attracting enormous interest from industry. This production technology, in addition to improving the prototyping and production phases, reducing costs and time, offers the possibility of transforming the most surprising compounds into filaments of material to be printed. Thanks to additive manufacturing technology and the recent developments in computer modelling software, it is possible to elaborate geometries and complex structures, such as natural ones, that traditional industrial processes would not be able to achieve, offering the designer the opportunity to develop new forms, expanding the imagination, but with environmental advantages.³

The implementation of nanotechnological and digital components, also within the manufacturing process itself, further widens the application possibilities in favour of reconstruction, monitoring and preserving an environment or a risk link,⁴ creating projects and numerous experiments at different levels of scale.

One of the last most interesting design frontiers is the restoration of marine ecosystems; focus of many proposals is the creation of modules to protect them from erosion and sedimentation processes, or the

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- 2 FDM (Fused Deposition Model) or FFF (Fusion Filament Fabrication) printing uses polymeric plastic filaments that undergo a fusion process and are deposited in layers on the work plate by a nozzle. The material that has just come out of the extruder immediately solidifies, bonding to the underlying layer of material and thus forming a single structure. This filament technology is the easiest to use and therefore the most common.
 - 3 By its very nature, 3D printing minimises material waste. In fact, product structures can be designed with infinitely complex internal cavities and lattices, tailored to perform under specific conditions, maximising efficiency. Compared to traditional industrial processes, the fasteners of a moulded product can be eliminated to save cost or weight, and multiple functional components can be combined into a single element. In addition, in many cases its manufacturing filaments can be reprocessed and reused in 3D printing to have the most circular economy possible.
 - 4 To save the population of bees (fundamental to our ecosystem) that face man-made challenges related to climate change, pesticides and the introduction of invasive species, an Australian artist, Brisbane's Michael Candy, has devised a "Pollen synthesiser" based on artificially pollinated 3D printed robotic flowers, which when placed between plants encourage bees to pollinate.

reconstruction of coral reefs⁵ (Figure 1). Today they are in grave danger of extinction but at the same time indispensable to protect some of the most important ecosystems in the earth's oceans. In this case, the design, working closely with ecologists and experts and exploiting 3D printing technology, can model, replicate and reconstruct forms and structures of coral reefs to give an impulse to the regeneration of natural balances of flora and fauna (Figure 2).

Traditionally, 3D printing has been associated with polymer production, but a multitude of new materials – very heterogeneous and eco-friendly – are now available and can be assembled to be selected according to the characteristics that the final object must have. From metallic powders to wood and ceramics, but also vegetable-based raw materials, of a biological and biodegradable nature, recycled or food-based materials such as chocolate: therefore it seems that there are no longer limits to the material possibilities that this technology makes available.⁶

Adidas, for example, working with a leading company in the recycling of waste from the oceans, has modified the production chain of its consumer products to transform toxic, ocean waste into spun fibres which, combined with the 3D printing process, led to the creation of a shoe midsole. From threat to resource, therefore, plastic waste demonstrates how the discussion on the impact that the human being generates to the environment in the stages of use, consumption and

5 A symbolic project of this operation is the MARS (Modular Artificial Reef Structure) project, the world's largest artificial reef composed of hundreds of ceramic modules made from 3D printed moulds designed to look and feel like real corals. The project was created by the multidisciplinary studio Reef Design Lab founded by industrial designer Alex Goad.

6 The MIT group in particular is developing 3D printing technology for composites made from naturally occurring biopolymers, including cellulose. These materials derived from trees, insects and bones are being combined with other solutions to create composites that are highly biodegradable in contact with water. Or French company Francofil has designed a range of materials made from PLA and mussel, scallop and oyster shells that are sourced from catering waste, recycled and crushed to be made into filament.

disposal of a product can begin to set itself on new industrial standards to create sustainable solutions to major environmental problems.



Figure 1. Reef Design Lab's latest modular MARS (Reef Artificial Reef Structure) in the Maldives is 2.5 meters high with a footprint of 4 square meters. Image by Alex Goad.



Figure 2. 3D printing Reef allows researchers to experiment with restoration methods, such as how coral fragments are attached to coral reefs (here, using steel wire). Image by Alex Goad.

Agri-food 3D manufacturing

The combination of design and biology, applied to 3D printing, could stimulate further scenarios that would encourage symbiotic co-operation between nature and human development, generating new ways of producing locally available material resources, without affecting the autochthonous ones that would have time and way to regenerate over time. This is the case of the Algae Geographies project by Atelier LUMA, which sees in the wetlands excellent biomaterial⁷ incubators for the production of renewable algae (Figure 3), that can be transformed into filaments to obtain raw material of biological origin; designers can apply it in projects addressed at the community: from textiles to the agro-food industry, up to the most recent solutions applied in the architectural and urban field, in order to replace fossil plastics based on oil.



Figure 3. Artist Filip van Dingenen and herbalist Ellen Schoenmakers collecting seaweed in Zeeland (Netherlands) ©Atelier LUMA.

7 The definition of a biomaterial was established during the 2nd International consensus conference on biomaterials, held in Chester (England) in 1991: “A biomaterial is defined as a material designed to interface with biological systems in order to evaluate, support or replace any tissue, organ or function of the body.” Currently, however, a biomaterial is considered a material derived from cells (for example, human skin) or obtained from substances of animal or plant origin, which allows the creation of a product that will interact with a biological system.

The investigation about the relationship between the cultivation of biomaterials and local producers through additive technologies proposes new bio-fabrication circular models that generate products made of biological matrix transformed by artificial processes.

We could hypothesise an interconnected network of biomaterials *prosumer*⁸ communities equipped with 3D material filament printers (FFF) easily available and assembled thanks to basic assembly kits.

Internet connectivity would allow the sharing of product files from one territory to another. The recipient will therefore be able to use his own technological tools and materials of biological origin, also locally grown, to start the production process and decentralised printing of lamps, containers, plates, cutlery, etc. (Figure 4) saving on environmental costs for transport and subsequent product disposal at the end of life (as they are biodegradable).

If we were to look at modern industrial agriculture, which has tried to expand more and more quickly to support the growing population and consequently the increase in demand for food, we could go further by winking at new ways of producing fruit and vegetables.

3D printed forms with mixtures of seeds, spores and yeast sprouting plants and mushrooms can change flavour over time, having nutritional properties such as to constitute a healthy and nutritious snack⁹; or artificial edible fruits printed with an organic material such as cellulose and subsequently filled with a nutrient-rich liquid (Figure 5). These projects, although speculative, are some of the examples that focus our attention on a future scenario in which we will artificially design, through software and moulding of edible compounds, all our food, to try to resolve the imbalance between the actual nutritional requirements that our bodies need and the daily caloric surplus.

8 Composition of pro-ducer and con-sumer. A prosumer is therefore a consumer who is himself a producer or who by consuming contributes to production.

9 Food designer Chloé Rutzerveld has developed “Edible Growth”, an experimental project based on the “edible growth” concept combining 3D printing with living organisms that, through a gelatinous substance contained within, will grow over time, changing flavour. The goal: to find a way to create fresh and healthy food at home.

The solutions previously identified could prevent the future perpetuation of industrial processes which were proven to be unsustainable in the food chain and, in addition to having altered the products, have charged the environment a very high price: in the first place the pollution in the air, soil and water (which penetrates into the fruit and vegetables consumed), to have in the end only huge quantities of fruit and vegetables discarded, thrown away because they did not meet the aesthetic standards for the reference market.



Figure 4. 3D printing of vases created with a biopolymer derived from algae to replace the use of plastic. The production is located within the Algae Lab bio-laboratory of Atelier LUMA and Studio Klarenbeek & Dros, which focuses on studying local renewable resources to propose circular and decentralized production.



Figure 5. One of five artificial edible fruits that designer Meydan Levy developed by 3D printing soft cases made of cellulose skins (an organic compound that gives plants their structure) filled successively with a liquid rich in nutrients such as vitamins, minerals and flavors.

Beyond the boundaries of the project

Additive printing technology is set to evolve towards processes that offer more and more possibilities for testing responsive objects, consisting of special materials with a high elastic capacity, which change their appearance in response to environmental stimuli such as heat, light, electricity, humidity, temperature, change, etc.

By combining a fourth dimension, such as time, you can print *smart materials*¹⁰ with self-modelling capabilities, which can react in precise ways based on programmable inputs (4D printing). It, combined with the continuous prospects of development in the field of biomaterials applied to the computer field to generate bio-microchips, see experimentation towards processes that offer more and more opportunities to emulate the ones of biological beings (Figure 6).

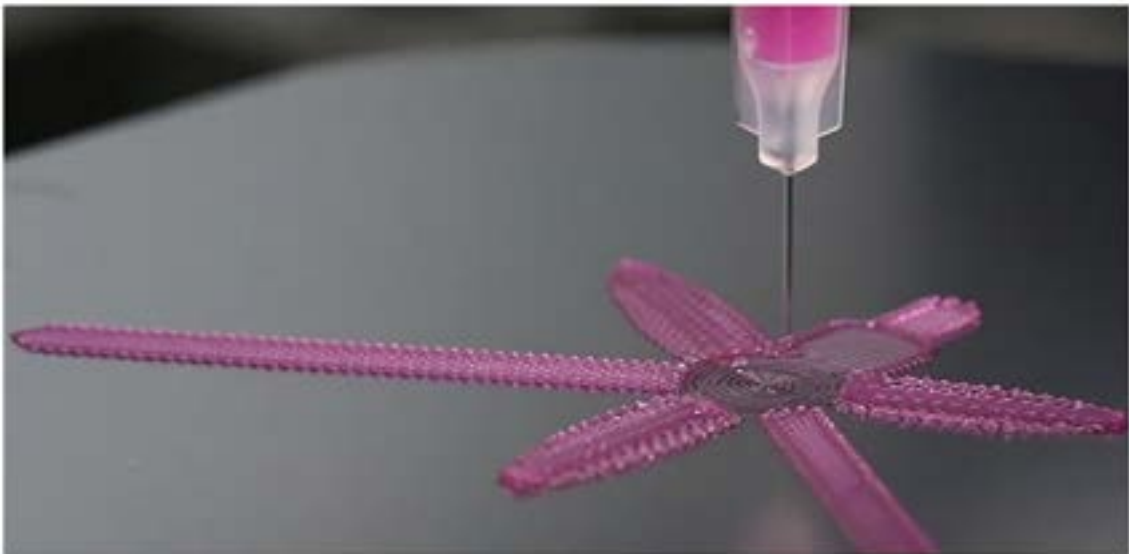


Figure 6. The team of scientists from the Wyss Institute for Biologically Inspired Engineering at Harvard University and the Harvard John A. Paulson School of Engineering and Applied Sciences has created 4D flowers composed of Hydrogel that can change shape when immersed in water.

10 4D printing processes employ multiple materials. They are mainly composite materials added to hydrogels, such as carbon or wood fibres or shape memory polymers (SMP), which are materials that can store a shape, preserve it for a certain time and return to their original shape.

These studies find an application in the so-called *smart textiles* which, in contact with the human body, react adaptively to external stresses. Using a bio-mimetic approach it is possible to design parts of complex soft-robots that mimic, for example, the movement of the octopus tentacles (Figure 7), up to the possibility of “build artificial systems that are born, develop and die, reproduce, exchange energy and information with the environment” (Parisi, 1994).

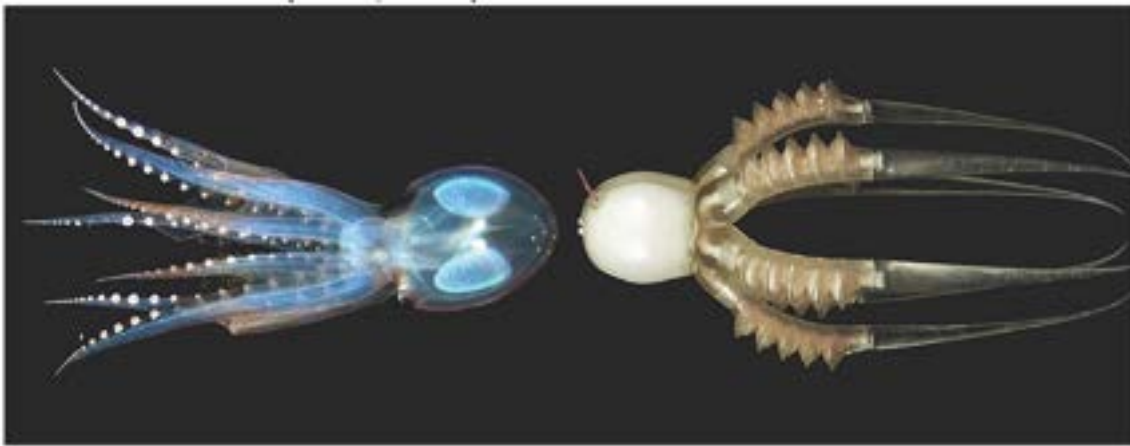


Figure 7. Comparison between an octopus and a soft-robot designed at Oregon State University in order to emulate the behaviors of living beings through technology that has allowed the implementation of elastic, dynamic and intelligent components, redefining the limit of what is possible to produce and emulate.

3D printing combined with the scientific-technological developments in recent years allows the creation of infinite, environmentally friendly hybrid products, showing the potential to regenerate and rebuild the broken links between humans and nature. Over time these products are becoming more and more interrelated with ourselves and with the reality that surrounds us, artificializing more and more life and sometimes giving life to the artefact, making it become deeply biological and existential thanks to the implementation of what Maldonado defined as *mini-electronics*, superimposing reality with artifice weakening even more their borders.

It opens interesting scenarios that highlight how the cooperation between project, science and technology can affect the future of our planet, demonstrating that technology can no longer be pushed aside because it itself is part of our evolution and therefore of our reality.

The radical transformations induced by the culture of sustainability and the spread of nanotechnologies in new digital manufacturing processes open up new opportunities for collaboration between design and materials where interactions will be less and less random and occasional, and increasingly aware and constructive. (Langella, 2019).

The design discipline, therefore, can fit in and make its contribution in its most diverse meanings and expressions, taking up the epochal challenges that stimulate it to rethink, anticipate and reinterpret, also critically, sustainable models of economic development to contribute to a new horizon, aware of the importance of learning from nature in every field of science and technology.

On the other hand, although of a different nature, risks also exist in this context: the product's evolution in increasingly "alive" systems, functional and in symbiosis with the environment, will always correspond to artefacts grafted into biological systems.

These products, even if "programmed" to degrade over time, are composed of substances that come from industrial processes and will in turn be released into the environment. We have to understand the real implications and effects that these integrations will have in a long-term perspective, whose risks can however directly affect our health and the survival of our species.

The American biotechnologists L. J. Fogel, A. J. Owens and M. J. Walsh, in their book *Artificial Intelligence Through Simulated Evolution*, discussed how man has long fulfilled the evolutionary task given him by the biosphere and that his presence, to date, has reached its peak, becoming a factor of disorder. Therefore, "the intelligence of the biosphere" will have to create (again as a result of an evolutionary process) a new "intelligence" that could replace man and be more suitable for a universe with still different and changed ecological requirements.

In conclusion, despite the efforts we are carrying out, in order to find again a hope for the future, will we really rebuild the biological links and environments compromised by human action, or by intro-

ducing further artifices we are actually doing nothing but contributing to a process of irreversibility?

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Sustainability of Lifestyles and the Implication of Design

Elena Cioffi, Daniela D'Avanzo, Davide Romanella

How we live, work, and relate to each other has a direct impact on the meaning of the term *lifestyle*¹ that, according to the current etymology, defines the set of trends and behaviors referable to a precise cultural, social, and economic typology of individuals living in the same geographical area.

At the beginning, individuals as humans or animals built different kinds of relationships among each other in order to establish social cooperation to assure their and community survival. Nowadays, the contemporary society has a different way of living: the consumerist one, characterized by a lifestyle centered on the democratization of luxury that allows every citizen to access to the secondary goods on the market. The society, or better the consumerist society, is based on the purchase of superfluous goods: things not necessary for survival, that often respond to the needs created by the advertising and/or

¹ Lifestyle as a set of fashions and cultural reference models and related behaviours. From *Treccani Encyclopaedia*. Translated by the authors.

by the phenomena of social imitation, very common among different parts of the population.

For a few years, a lot of researchers focus their studies on the possible social consequences that a consumerist lifestyle can have on the surrounding environment. Among them, there was Tomás Maldonado, who started to raise this question during the 70's, when the discussion about the environment was not so obvious as today. In particular, his contributions to environmental design stem from the idea of design as a social practice and from the idea of artifact as the input for the transformation of society.

Environmental Design Discipline: Maldonado's Thoughts as a Starting Point

Starting from the reading of Maldonado's *Design, Nature, and Revolution* we pointed out the importance of environmental design in Maldonado's philosophy and the importance that still has nowadays.

The environmental design discipline, as imagined by Maldonado, was at the intersection of architecture, industrial design and urban planning and had the aim to study and eventually guide the interaction among buildings, objects, and urban structures toward an environmentally and socially sustainable system (Maldonado, 2010). According to these words, we can define environmental design, or *Umweltgestaltung* (Maldonado, 2010), as an environmentalism that pivots on design (Maldonado in Chiapponi, 1997). It has its roots in the word *Welt* that has the meaning of "human environment" and differs from *Umwelt*, that means "surrounding world" (Maldonado, 1970), strictly related to the animal world, in which every living being feels at home. Chiapponi also refers to *Lebenswelt* as the "environment of life" (Chiapponi, 1997). The main characteristic of the human environment is the huge presence of artifacts, operational and communicative (Maldonado, 1970). Either way, the artifacts are seen as the object that can have an influence on the consumptions and lifestyles, and give input to the transformation of the society (Quinz, 2020).

Artifacts are in fact an answer to human needs and whether you control needs, as capitalism does, you can control the production of artifacts (Maldonado, 1971). The capitalist speculation on human needs gives input to the proliferation of artifacts and to a consumerist lifestyle. To go deeper in this definition, we should first analyse the term lifestyle as the set of values and behaviours that characterise a particular society (Maldonado, 1990). Then the term consumerism as a typical economic and social phenomenon of industrialised societies, consisting in the indiscriminate purchase of goods, aroused and exasperated by the action of the capitalistic society. Gillo Dorfles defined consumerism as an entropic condition that tends to dominate the economy and mentality of the Western society (Dorfles, 1972). But since Eastern and Western societies are becoming closer, it can be seen as the main lifestyle of the more industrialised countries, with a huge responsibility for today's environmental emergency (Maldonado, 1990).

Maldonado also pointed out some ways of living in the contemporary age that could be discussed in order to have a lighter impact on the environment. Among them we focused, in particular, on those that seem to be more approachable from a contemporary point of view: the relationship between cars and humans, the idea of comfort and the production of waste (Maldonado, 1970).

They are all strictly related since the environment is a very complex system, but to all of them we found a suitable answer in the contemporary thoughts that gives us hope that it is still possible to design in an environmentally sustainable way.

Cars and Humans

Starting from the car, Maldonado considered it in the 70's as one of the fiercer factors of destruction of humanised nature (Maldonado, 1972) and today we can still consider it in the same way. Although technically innovative, concept cars rarely deal with the social and cultural implications of transportation systems and consistently focus on the car as an object (Dunne, Raby, 2013). But to solve the overpop-

ulation of cars the point should be exactly that: finding a more rational and organic approach to the needs underlying the various forms of travel (Maldonado, 1972).

Ezio Manzini tries to address this problem by imagining a new kind of city based on proximity: a city on a human scale, dense and diversified in functions, livable because everything that a person would like to have and to do is close. A city in opposition to those ones developed in the last centuries that were driven by a territorial specialisation: where each area of the city was specialised in something, and people and goods had to move around them, causing pollution, traffic jam and problems to the citizens themselves (Manzini, 2021). A city where the use of cars is strictly reduced to the essential.

Manzini's approach shows us that there is a way of design that does not only imply designing objects but also gives the input for an improvement of people's living conditions, and this should be the real aim of design (Quinz, Zappa, 2020).

Comfort as a Source of Environmental Discomfort

According to the original concept of the term comfort, its definition is expressed in the meaning of "what contributes to making everyday life easy and well organised".² In consumerist culture, this declination has found added value in the wider context on the quality of life, taking the form of an aid and relief from the fatigue of work (Maldonado, 1991).

It is difficult to set up a discussion on the quality of life without taking into account the concept of comfort; in fact, one of the main factors that define the lifestyle is the continuous search for comfort, and habits change based on it.

Although comfort brings benefits in the daily life of the individual, it is easily configurable as a probable source of discomfort and suffer-

² Oxford Languages, <https://languages.oup.com/google-dictionary-it/>.

ing, so as to be understood as a “social control device” (Maldonado, 1991) thus reaching its own negation.

Research published in *Sole 24 Ore* analyses the similarities between different lifestyles between Eastern and Western populations; in particular Alfonso Emanuele de Leon diversifies the consumption behaviours implemented by the population of the Asian continent, classifying them into four styles, with the aim of knowing in advance the future of Western countries, offering a key to understanding consumers (de Leon, 2017).

In particular, the study highlights how the consumer dynamics in all countries are identical, but covered in different periods and characterised by the value of the annual income of the individual citizen. Starting from the poorest consumer to the richest, the search for comfort influences the type of product purchased, outlining how the principle of possessing material objects is a prerogative closely linked to the poorest social classes, while the others, vice versa, do not need to possess more things, but consuming them better call for a principle of experiential consumption.

For example, referring to the data on the WAQI platform (World Air Quality Index), a project that analyzes the values of atmospheric pollution in each continent in real time, it is possible to note that 90% of the 200 cities with the highest levels of pollution are distributed between India and China.³ From this scenario we can deduce that it is necessary to bypass the “concept of excessively growth” of the production system, aiming at degrowth and a change of course towards a lifestyle that is more attentive to environmental dynamics.

³ Published in ANSA.it https://www.ansa.it/ansa2030/notizie/asvis/2020/03/03/inquinamento-atmosferico-livelli-record-in-asia-india-soffocata-dallo-smog_591ac78d-66cf-4610-9644-335f196bf415.html (Last consultation February 20, 2020).

The Production of Waste: Relationship between Contemporaneity and Westernisation

The challenge of globalisation favoured the opening of the international market, towards a larger number of consumers; this phenomenon known as the “democratisation of luxury” arose from the increase in purchasing power and the rapid evolution of communication tools, representing an important phenomenon capable of modifying the market, under the dual influence of factors concerning supply and demand.

If we consider the fashion sector, but not only, as a reliable reference to the case, we note how the entire textile industry is resetting its design to carry out a real technological and digital revolution that leads most consumers to modify their purchasing needs, introducing the concept of “omnichannel” as an image strategy. This concept is based on the constant presence of products, in digital platforms, able to reach the consumer in every virtual place and interact with him, in such a way as to collect useful information to understand his tastes and his lifestyle.

Although in different eras, an idea of social control, attributable to the phenomenon of omnichannel, is expressed by I. Joseph through his studies on tactics and disciplinary figures at home.⁴

The result of such a large mass commercialization can lead to negative phenomena; just think of the fast fashion phenomenon understood as a commercial model based on the idea of a product characterised by reduced prices, which quickly passes from the catwalks and influences current fashion trends.

Specifically, proposing a low-cost item of clothing means producing it at low cost, often to the detriment of disadvantaged populations such as African or Asian ones, exposed to various forms of slavery, such as the exploitation of child labour, exhausting hours, precarious

⁴ They are the control devices of daily life, used by capitalist society, such as conceiving objects of use in a certain way.

working conditions, and inadequate wages that characterize the entire supply chain, from harvesting in the cotton fields to packaging in artisan workshops and large factories.

In particular, the fast-fashion phenomenon develops a quantity of waste that equates to the quantity of production; in fact, the garments are thrown away at the same speed at which they are produced. Being mostly synthetic fibres, the garments cannot be disposed of in an ecological way, thus remaining to accumulate, contributing to the formation of the waste population.

As evidenced by the Ellen MacArthur Foundation study (Ellen MacArthur Foundation, 2020), 87% of materials are sent to landfill or incinerated, with a volume comparable to a garbage truck full of textile waste every second, whereas 13% of textile products are recycled in some way after the use, while another 12% are employed in uses of lower value, but often extremely difficult to recycle.

The data are alarming if we consider that textile waste is not only used to create new clothes, but can converge in various sectors, (even unrelated to fashion) such as construction, to produce technological materials, sound-absorbing elements, or thermo-acoustic insulation.

Thinking and acting with ecological awareness means operating according to the logic of “risk reduction” (Maldonado, 1970), according to which environmental effects spread over time and space, affecting future generations; the phenomenon defined by D. Pearce with the name of “transferred irreversibility” explains how each new generation bequeaths to the next one ongoing processes that are increasingly harmful and less and less reversible.

Design Culture for Sustainability

Decades after *La speranza progettuale* and Papanek’s thought on the role and responsibility of designers, who must contribute to the necessary transformations of society, the need to implement a transition towards new socio-economic paradigms that offer circular and

regenerative scenarios, alternative to those no longer sustainable for the planet, is more and more urgent.

The exhibition *Il giardino delle cose* of Andrea Branzi and Silvio De Ponte, and curated by Ezio Manzini at Triennale of Milan, already from the 90s exposed the metaphor of a world possible for its sustainability and the considerations in this regard introduced approaches that today represent the main characteristics of good design: the reduction of inputs necessary for extending products life cycle, or the production of artifacts with a short life cycle but highly recyclable (if it cannot be avoided), and systemic and integrated approaches, where each of the parts of a product can be valorised in new production cycles. The model of product as service is presented as an alternative to consumer goods following the principle of dematerialization, defining new values for products born from the object-user relationship.

The designer role is defined as a transversal and mediator figure who can draw on multiple and diversified basins of knowledge, integrating production culture and design research towards sustainable scenarios in which intercepting and prefiguring behaviours and lifestyles that are sustainable becomes necessary.

Most solutions to implement and maintain a sustainable industry are inter-sectoral and interdisciplinary; design, as a restorative practice, implies a joint action of scientists and designers to address urgent issues related to the ecosystem, combining traditional and cutting-edge sciences and tools to determine global actions that are sustainable and responsible but at the same time stimulated by creativity.

Up to 80% of the environmental impact of products is determined in the design phase but the linear “take-make-dispose” model does not adequately incentivize manufacturers to increase the circularity of their products. However, starting from the Programma nazionale per la ricerca 2021/2027 of Italy, the European Green Deal and the New European Action Plan for the Circular Economy up to the definition of the Sustainable Development Goals 2030, it is possible to observe that more and more national and international programs promote efforts to favour virtuous approaches throughout the supply chain through

zero waste, circular and systemic production processes and consumption models, through the discipline of design up to focusing on and influencing consumer acceptance of new patterns of use, consumption and possession.

Design driven innovation has been identified as a key step in growth within the EU. In recent years, the European Union has encouraged member states to include design in national and regional innovation policies through the synergies between the circular economy goals and the aims of the “Action Plan for Design-Driven Innovation”. It is assumed that the “Design for a Circular Economy” action plan that adopts design-driven innovation will facilitate the transition from the linear economy to the circular economy.

New Design Roles Configured through Research

Designers are invited to reflect on their role and responsibilities; designers must consider that we are all part of complex systems that go beyond human constructions (cities, companies, governments); that we cannot have control over them; that we can do damage; and that we should recognize and protect such complex systems.

As Latouche stated, we are now aware that a system based on continuous growth and production is no longer sustainable, and part of the responsibility is our individual consumerist lifestyle. So, if we really want to slow down the effects of irresponsible land and city management, one of the first things to change is our contemporary lifestyle. (Latouche, 2008).

“These underrepresented systems, such as the microbiotic system and the environment, have suffered and still give designers important challenges. While these systems are complex and self-adapting, our unintended effects on them will likely cause unintended negative consequences for us” writes Joi Ito (2016) about the relationship between design and science.

Design must also imply ethical responsibility, if possible interspecies (Oxman, 2020) – expressing concern for all Umwelten, as Jakob Johann von Uexküll argues, from the environment to other people up to other beings with whom we come into contact, even inanimate ones.

Understanding this universal interdependence should stimulate consilience – the convergence of many fields of knowledge towards the same strong conclusions and which should shift people’s attention from an immediate, personal, and discreet interest to a collective, systemic, and long-term attitude (Antonelli, 2019). As Fredric Jameson stated: “It is easier to imagine an end to the world than an end to capitalism”. Still, the alternatives are exactly what we need. We need to map out new scenarios for the future. As Maldonado says:

“It is therefore time to conceive and implement vast and far-sighted design programs, which include the needs of society, and stop dealing with the creation of exemplary but isolated objects. The designer does not have the function of increasing the irrational devotion to goods but – above all – of giving structure and content to the human environment” (Deambrosis, 2020).

In these words, we can find Maldonado’s idea about design, as a tool of mediation between needs and objects, between production and consumption. In this perspective hypothesising zero growth in technical-scientific knowledge to make an alleged reconciliation with nature feasible is pure madness (Maldonado, 1987). But hypothesising a degrowth using the tool provided by technical-scientific knowledge along with a change in people’s lifestyle is something feasible nowadays and explainable by a systemic approach to design: a world with limited resources and a biodiversity crisis must necessarily imagine a circular future (Maffei, 2020).

But how to define and configure the role that design can play in this transition process?

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The Relationship between Natural and Artificial

Insight into Contemporary Environmental Design Processes

Mariangela Francesca Balsamo, Matilde Molari

The Environmental Crisis

The notion of environment has progressively changed to the current ecological-environmentalist meaning with a consequent strong accentuation of the awareness of environmental issues. This sensitization implies the awareness that the degradation of the environment cannot be dissociated from the more general programmatic decision-making process, i.e. planning, which must take into account the complexity of the problems and their strong interrelationships.

The issues of climate change, the excessive consumption of land and non-renewable resources, the ever-increasing production of waste and the socio-economic crisis, have entered our daily lives. Although dramatic, these issues can be taken as an opportunity to rethink the way and the world in which we live.

There is therefore a clear awareness that a built environment characterized by a metabolism that is based on the continuous increase and exploitation of resources and non-renewable energy, with the consequent increase and production of pollutants and waste, and with

disarming effects on the entire ecosystem, is no longer ecologically sustainable. It is necessary to rethink the relationship between man and nature, which calls into question the Hegelian concept of “man’s supremacy”, and to resize the action of the human hand to “dominate” and to “humanize” nature.

Thanks to the environmental awareness that occurred during the last century, since the ’70s different scales of the design field have begun to decline the theme of sustainability, progressively understanding the characteristic complexity that belongs to the design “for the environment”. Hence the awareness of the need for a design practice able to act in an ecosystemic logic (Bistagnino, 2016), overcoming the anthropocentric point of view that has characterized our contemporary society to move towards a new biocentric paradigm.

Environmental Design, Nature and Systems

According to Maldonado, designing “is the strongest link that connects man to reality and history”; both the ability to design and the ability to do belong to man’s operational universe. The typical doing without designing is game, the typical designing without doing is utopia (Maldonado, 1970); both the game and the utopia are to be understood as free and spontaneous activities, and both are “preparatory exercises: the game for doing, the utopia for designing” (Maldonado, 1970, p. 32. Translated by the authors). The utopia, however, has an extra component that game lacks, and that is hope (Maldonado, 1970).

Considering the great importance of the environmental crisis and starting from the themes treated by Maldonado, such as the competences and the limits of environmental design and the conditions for nature reconstruction, this contribution advances a future scenario of the design processes to be practiced in order to re-establish the balance between man and environment. Processes that, although related in an almost utopian way, present aspects and characters that can be rationalized in the operational practice of design. This contribution advances our elaboration of “design hope” that takes its cue from the

reflections and references made by Maldonado within his texts and led us to develop and deepen reasoning about contemporary environmental design practice.

The reflections developed in this work follow the theme of the “reconstruction of nature”. In particular, we reflect on the necessary conditions for an effective reconstruction of nature. It is interesting to note that in *Natura e Società* (1971) Maldonado decides to start from the works of Marx to develop his reflections on the responsibilities and possible human actions for the environment preservation. As argued by both authors, although the decay and corruption of the natural environment are undoubtedly linked to the linear-capitalist development model, no strategy for the nature recovery and reconstruction is defined by Marxian thought. It leaves a theoretical, and therefore practical, void for the structuring of effective strategies. In Marx, the theme of nature is rarely debated and it leaves a glimpse, as is historically plausible, of a strongly anthropocentric vision, in which the environment is a reservoir of resources for man and his labor, only in the background of human society (Schmidt, 1969). However, Maldonado highlights a key question in Marxist theorizing: what does it mean to reconstruct nature?

The difficulty lies precisely in the complexity and indefiniteness of the human-nature relationship (not addressed in Marxian theories) within society and, as increasingly found globally at present, within the built environment.

But what are the ways and conditions that can lead to a re-construction of the natural environment? In this sense, particularly relevant is the position that Maldonado takes on environmental design in the text *Diagnosi per il Disegno* (1967). In fact, according to his statements, in today’s society (in its ethical condition in particular) environmental design is usually presented as a “grotesque falsification”, which has been reduced to “restore hither and thither some partial crumbling on the facade of our environment” (Maldonado, 1967, p. 223. Translated by the authors). This problem is still present today; it is undoubtedly attributable to the degree of complexity that increases in sustainable

design, from theoretical planning to practical execution and to the observation and interpretation of the project's environmental outcomes. According to Maldonado, it can be deduced that environmental design must broaden its field of analysis to understand the complex context in which it is inserted and operates, the bio-socio-techno sphere (Maldonado, 2001). Therefore, this is the direction to follow in order to develop an effective and coherent sustainable design, a practice able to act with rationality by simultaneously modifying men and their environment (Geddes, 1915). As argued by Maldonado, this strategy is still not taken into account.

According to Marx, to whom Maldonado refers, the nature reconstruction arises spontaneously alongside the concept of simultaneous operation previously described and the mechanism of the "system of control" (the process that defines the characters of any human society), governed by the interaction between the system of human needs and the system of objects (all the material and immaterial production of society).

Resuming a key statement within the text *Natura e Società*, human society will be ready to reconstruct nature only when its system of control will be changed, i.e., when a modification of the system of needs and the system of objects will have taken place "simultaneously" (and consistently with what was said earlier).

A further point of reflection was found in the book *La speranza progettuale*, in which Maldonado states that in order to face the environmental crisis, it was necessary to act with "applied rationality". In the management of environmental design, it is impossible to not take into account the environment as a complex system, recognizing its boundaries, its characteristics and its level of complexity (Chiapponi, 1997).

A complexity that cannot be standardized, but needs to be defined every time we want to operate in the integrated needs/objects system, privileging the typical exchange modes of open systems characterized by elasticity and adaptability.

As it is intuitable, the knowledge skills needed for the planning and management of the design process for the complex environmental system are multiple (Maldonado in Chiapponi, 1997).

The Union of Two Bio-Inspired Disciplines: Biophilia and Biomimicry

Dealing with the great theme of nature reconstruction and environmental design, the discussion will focus on the characteristics of two design approaches that have seen a progressive development in recent years: the biophilic approach and the biomimicry, two disciplines aimed at redefining and establishing a new relationship between man and nature.

The two design practices are based on the research and theoretical elaborations of exponents belonging to areas outside the project culture.

In her book *Biomimicry: Innovation inspired by Nature* (2002) the biologist Janine Benyus defines the principles of biomimicry, the discipline that “mimics” nature to solve men’s complex technological problems. Subsequently, the biologist Julian Vincent, with his definition, links the biomimicry application to the field of design (Vincent, et al., 2006).

The concept of biophilia, on the other hand, is a scientific hypothesis, sociobiological in nature, proposed in 1984 by American biologist Edward O. Wilson. When applied to the built environment, biophilia aims to emotionally and physically re-connect humans to the natural environment. A first diffusion of the biophilic approach to design began in the 1990s thanks to realizations that combine technology and vegetation, such as the Mur Vegetal by French botanist Patrick Blanc.

The discussion assumes the particular complementarity of the two bio-inspired disciplines, which already aim at the management of the environmental crisis. Their structuring into a single design methodology could support the redesign of the society by acting simultaneous-

ly on its material components, i.e. the production system, and immaterial ones, considering the psycho-physical sphere and human needs. The combination of these two disciplines responds to the need for “operational simultaneity” in nature reconstruction by including in the project: the psychological and social sphere, derived from anthropological and natural sciences, and the biological sphere, as a source of sustainable solutions in design practice.

Although a methodology, or *forma mentis*, that can guide the implementation of solutions in an ecosystem logic is still lacking, these approaches show the possibilities of a new biocentric paradigm, a possible way to overcome the anthropocentric point of view that still influences sustainable design.

Multi-Scalarity and Complexity: Case Studies

Four international case studies, two biomimetic and two biophilic, have been selected and analyzed to highlight the characteristics and effects of the two design approaches considered. The period of time under examination includes the last twenty years, during which a rapid evolution and acceleration in the application of bio-inspired design practices has been observed.

Considering the state of innovation that still characterizes the two disciplines (Meyers, 2018), the actual realization of the projects was not defined as a discriminating factor in the selection of the case studies.

The cases presented move across different realization domains and scales to show the applicative flexibility of the two design approaches. Multi-scalarity is considered as a defining aspect of the projects since properties, boundaries, and complexities are integrated into the interaction of environment/needs/objects systems depending on the context of the design intervention.

The biophilic design supports the community and its environment

As argued by the Biophilic Cities project (Beatley, 2010), biophilic design can “re-brings” natural elements into depleted urban places with a highly impaired livability (Perrone, Russo, 2019). Cities can be considered as laboratories for continuous experimentation and identification of innovative means to balance the citizen-nature interaction (Beatley, Brown, 2021). The object of biophilic design is therefore the “relationship” between man and nature, perceived as a mutually beneficial relationship.

The complexity of biophilic design lies in the understanding of the relationships occurring in the context of analysis, which necessarily includes the environmental, social and psycho-physical human components.

Alice’s Garden Urban Farm (USA, 2001) is a two-acre urban farm located in Lindsay Heights, one of the poorest areas of Milwaukee. The farm practices and teaches sustainable agriculture and offers a variety of local community development programs. The project focuses specifically on the education of young people (Figure 1). In fact, to support children and adolescents of the area, educational and work training programs have been activated. Starting from the agri-environmental education, young people in the district are inserted in the retail activity of the products harvested in the communal garden. A relevant element of this urban community concerns the attention to food heritage, considered a fundamental aspect to teach and share African-American culture. The rediscovered connections to natural cycles and their products, the understanding of cyclic ecological processes, directly observable from the particular vantage point of the communal garden, create a new urban culture, rooted in the past and in balance with the natural environment.



Figure 1. Alice's Garden. Educational activities within the common urban garden. Alice's Garden Urban Farm.

Another relevant case in the construction of a “biophilic city” is the Green Cloud, implemented in the Ganxia urban village, in Shenzhen (China, 2018) (Figure 2). In this city, the uncontrolled rate of urbanization has led to the occurrence of consistent urban heat island effects and severe flooding episodes. In order to mitigate these criticalities, the Zhubo Design studio has realized a steel structure that can contain 640 plants on the roof of a residential building (Figure 3). This project for rainwater containment and drainage is part of the Chinese government's “Sponge City” initiative for the establishment of a nature-based solutions network throughout the country.

EXPLORING TOMÁS MALDONADO



Figure 2. Green Cloud. Top view of the green roof designed by Zhubo Design. The Nature Conservancy.



Figure 3. Green Cloud. Steel structures to contain the different plant species. The Nature Conservancy.

The added value of the project consists in the creation of a common green space, totally absent in the compact grid of the Chinese city. Through an organic and irregular development that simulates a rocky slope, the green roof connects two adjacent buildings. The result is a flexible suitable space for socialisation and relax. The outcomes of the project are already noticeable, the inhabitants of the building and the neighborhood organize several involvement events of cultural and recreational nature.

Through daily contact with the vegetation and moments meeting and sharing, the biophilic design of a space has led to the regeneration of a new community.

Biomimicry: driver of innovation for the design of environmentally sustainable artifacts

Bioinspired solutions respond to complex human problems of a design and technological nature. By replicating natural forms, functions and processes, this design approach aims to reduce environmental risks.

A case in point for this discipline is the Eastgate Center in Harare (Zimbabwe, 1996), a shopping mall and office building designed by architect Mick Pearce in collaboration with Arup. The building cuts energy consumption by 10% by exploiting passive climate control mechanisms. To ensure optimal constant temperature, the building mimics the ventilation structures of termite mounds. In these natural constructions, air from the outside is drawn in by convection process at the bottom of the earthen mound; from there it passes through the entire termite mound, maintaining a constant temperature (Figure 4).

EXPLORING TOMÁS MALDONADO

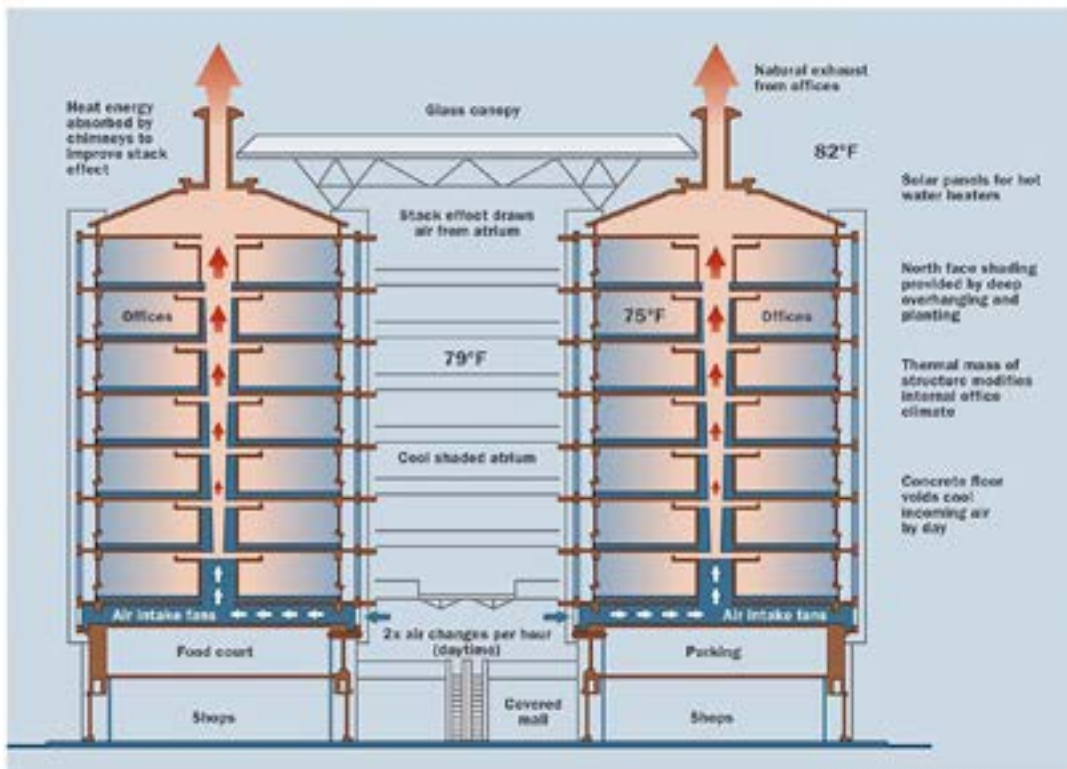
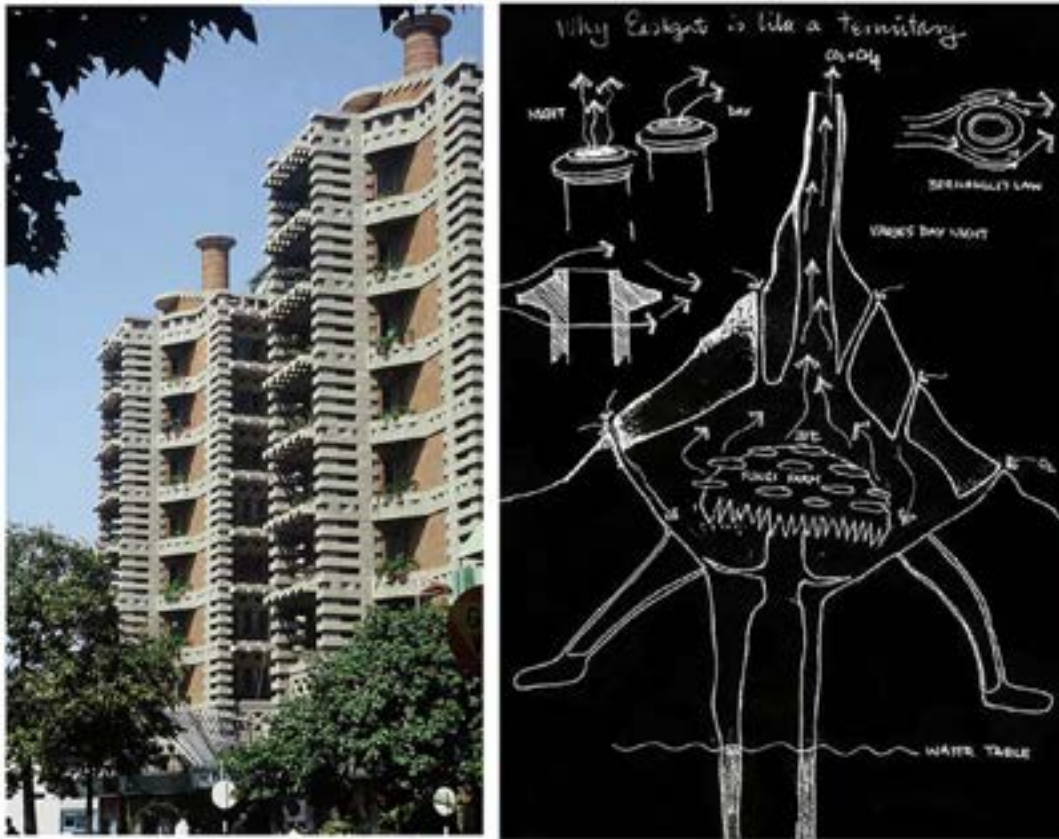


Figure 4. Eastgate Center, Harare, Zimbabwe. Passively cooled building inspired by termite mounds. Mick Pearce Architect.

Similarly, Mick Pearce’s design stores and releases heat gained from the surrounding environment through building materials with a high thermal capacity. The process is facilitated by fans that operate on a programmed cycle to increase heat storage during hot days and heat release during cold nights. Various openings throughout the structure allow passive internal airflow driven by external winds. A decrease in energy consumption, and therefore environmental impact, has been consequently followed by an economic saving.

At the domestic level, it is relevant to note the project Microbial Home (Philips, 2011), a concept of self-sufficient space that uses household waste to create energy. Winner of the Red Dot Design Award Luminary 2011, the domestic “system” filters, processes and recycles what is conventionally considered waste: sewage, effluents and wastewater. It is therefore proposed as a biological machine where the output of each function is the input of another. Acting as an “ecosystem”, it contrasts with traditional design solutions. Implementing the biomimetic principles such as self-sufficiency and matter reuse, it takes into account natural criteria and rules aimed at resource efficiency (Benyus, 1997), thus simulating biological processes (Figure 5).

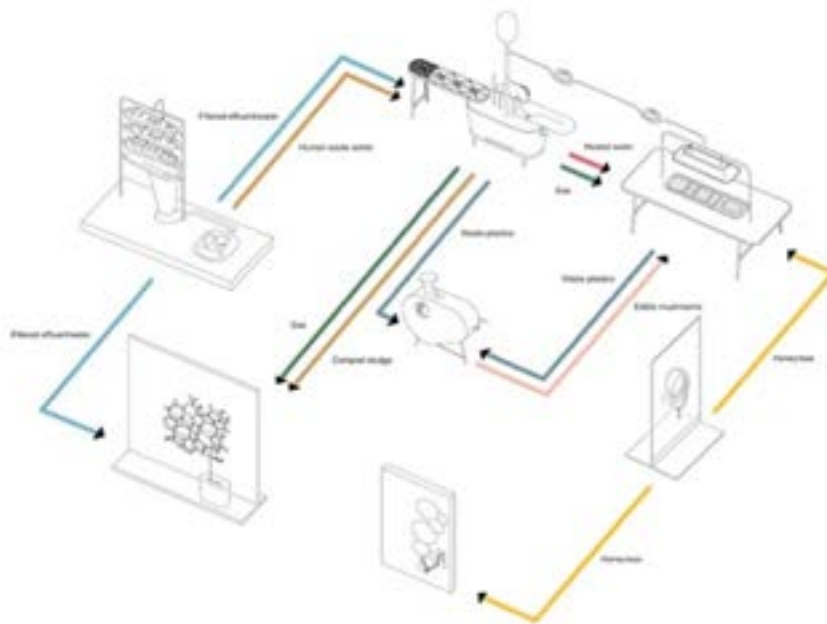


Figure 5. Microbial Home. Product system diagram. Philips.

The fulcrum of the project is the Bio-digester Island, a plant that collects solid waste from sanitary and food waste, converting them into methane through the metabolic activity of bacteria. The resulting biogas powers other components of the system, from kitchen stoves to lights up to water heating. The sludge residue dewatered by the digester is finally used as compost. Other devices include: the Larder pantry (Figure 6), which exploits the heat of methane through an evaporation mechanism to preserve food at different temperatures; the Bio Light lamp, based on the metabolic processes of bioluminescent bacteria fed with methane and composite materials; the Paternoster composting system, in which plastic waste is naturally degraded by fungal agents; and finally the Filtering Squatting Toilet, which takes methane from human physiological waste, reintroducing the resource into the domestic system.



Figure 6. Larder, dining table with evaporative cooler. Philips.

Discussion and Conclusions

As shown by the case studies just described, biophilic design allows for the thinning of the demarcation between urban and natural.

Through a physical, cognitive and functional link with natural processes and elements, these projects lead to a reactivation of urban ecosystem services including, in particular, cultural and social ones. In the cases presented, in fact, the contact with vegetation and natural processes becomes an opportunity for regeneration of the local community, through educational, cultural, commercial and recreational activities.

The renewed presence of nature within a historically foreign context to it leads to strategic effects that influence the use of the environment, mitigating critical climatic conditions and improving the livability of the human habitat. Thus initiating a new relationship between citizens and nature and redesigning over time a new habitat of reconciliation with ecosystem processes (Francis, Lorimer, 2011).

The result is a sense of “appropriation” of urban space (Manzini, 2017), achieved in practice through reconnection with natural systems.

The biomimetic approach in the design of architectures and industrial products can foster the processes of innovation, development and lifestyles in a more sustainable direction. “The concepts of ‘completeness’, ‘coherence’, ‘correlation’ and ‘integration’, used to express the relationships among the parts of a biological organism, can be used to describe similar qualities in critically designed artifacts” (Steadman, 1979, p. 17). So, whether it is a built complex or a system of products, integrating biomimetic principles into the design process means emulating the logic of nature, from the efficient use of resources, such as materials, to the systemic approaches replicating natural ecosystem processes.

At present, there are still many limitations in bio-inspired design. The complexity and multidisciplinary of the required mindset need a multi-perspective debate between different academic fields, from natural to technical and social sciences, and with actors with diverse skills and backgrounds. Training programs and common languages are priorities in the development of these disciplines.

In contrast to biomimetic achievements, which are often resource-saving oriented, the environmental impact of biophilic pro-

jects is still poorly investigated. The few studies developed often show negative results. To achieve a reliable sustainable design process it is necessary to formulate appropriate evaluation systems that allow a quantitative and qualitative definition of impacts and benefits.

The degree of biomimicry innovation that can be achieved by adopting the “process/system” analogy is still speculative. This is due to the high complexity of abstraction of the natural logic. To overcome this theoretical gap, it is required a radical change in the perception of objects and interaction with them.

The union between the “efficiency” in the processes and in the resources use, typical of biomimicry, and the project “empathy”, which characterizes biophilia, can materialize the simultaneous operation necessary to effectively modify our development system.

This union arises as a strategy to avoid speculations of a technological nature on the one hand – thus acquiring ethical, moral and social values – and “verdolatric” (Bellini, 2017) on the other, paying proper attention to the real environmental fallout of the processes that belong to the sustainable project.

It is therefore hypothesized that the structuring of the two disciplines into a single design methodology can become a supporting tool to redesign the control system of the current society. By redesigning the system of objects and the system of human needs in an ecosystemic way, a coherently sustainable development plan can be implemented.

By including both approaches, sustainable design would necessarily achieve a high degree of complexity. However, by rationalizing the boundaries and characteristics of the intervention systems –environment/needs/objects systems – it will be possible to plan and manage the interactions between the elements inside and outside the systems themselves. As shown by the examples previously presented, the characteristics of elasticity and adaptability between environment, humans, and artifacts are essential features of bio-inspired projects.

It is relevant to take up what Maldonado said at the end of *Natura e Società* regarding the interventions that were not possible at the time

due to a “theoretical weakness” in sustainable design. In light of what has been discussed above, it is possible to state that the possibilities offered by the two bio-inspired disciplines allow for the implementation of:

- a) control interventions in the field of object augmentation, acting on production processes and developing alternative and sustainable technologies, also based on the Lo-tek principle (Watson, 2020).
- b) less energy-intensive efficient technical-plant interventions, which base their innovation on new bio-based habits and mechanisms.
- c) technical-urban interventions that expand the debate related to urban forestry and reconciliation ecology, redefining the relationship between city and countryside.

Finally, the case studies clearly show the hybridization of the two types of product, defined by Maldonado as artifact (product of man) and “ecofact” (product of nature). It is relevant to underline a last Maldonadian reflection, traceable at the end of *Mondo e Techne* (Maldonado, 2001).

Talking about the future of design, previously described as man’s ancestral propensity to create objects and solutions, he states: “I think I can assert that in the future the world will be more and more as techne, and the techne will be more and more as world” (Maldonado, 2001, p. 15). At present this observation well represents the common goals of safeguarding and reconstruction of the ecosystem and the human society, as interrelated and interdependent systems.

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Human-Machine Interaction and AI in the Factories of the Future

Enrica Cunico, Ilaria Lombardi

Introduction: Principles of Interaction

Human-machine interaction deals with the system design able to support people in carrying out their activities productively and safely (Preece, et al., 1994). Some ideas foresee future factories where workers can be closely cooperating with machines programmed with an artificial intelligence (AI) in customizing specific operational activities. Therefore, it is necessary to physically and psychologically analyse the interaction between man and machine.

Automated systems have been defined as devices that are able to perform (in part or entirely) human labours (Wickens, et al., 1998). The machines are intended to not replace humans, but to perform specific tasks in order to reduce the risk of error and relieve the operators from psychological and physical stress. This matter is subject to constant discussions which predict to increasingly benefit the overall performance by developing the AI.

After World War II, the design methodology focused on improving the ergonomic aspect inside the production process. According

to Maldonado, the ergonomic feature helps in determining unknown variables that can disrupt the production process by involving a physical approach of the users to alleviate psychological matters (Human Factors).

Francesca Tosi (2005) defined the cobots as advanced robots that are provided with complex capabilities, such as perceiving and understanding the environment, equipped also with decision-making processes. In addition, they are characterised by flexible reaction to input information, in order to adjust the activity according to even transient intentions and emotional state of the workers.

It has been predicted that in a near future cobots will share more space, time and work activities with humans. Since people have been equipped with different cognitive models, the cobot design should also consider human reactions. Human centered design (HCD) aims to create machinery to be adapted to the user's needs, based on the concept of usability as defined by ISO 9241-11:2018 (Ergonomics of human-system interaction – Part 11: Usability: Definitions and concepts), effectiveness, efficiency and satisfaction. Given the importance of the environment and the activities to be performed, usability is characterised by other factors, including learnability, efficiency, memorability, errors and satisfaction (Nielsen, 1994). We can say that the correct design is considered as concept that greatly facilitates the workers' operations by reducing the number of incidents and injuries in the working environment.

Maldonado and the Prosthetic Body

Generally, it has been told that the human works will be replaced by machines. Up to date, the new technologies, including AI, are not programmed to replace employees but to afford monotonous, dangerous and specific operations.

Figure1 schematically indicates an automated process where different tasks can be reorganised by achieving a faster, safer and less tiring task execution. The additional value is characterised by the monitor-

ing and coordination of the entire production process in every phase (Save, 2019).

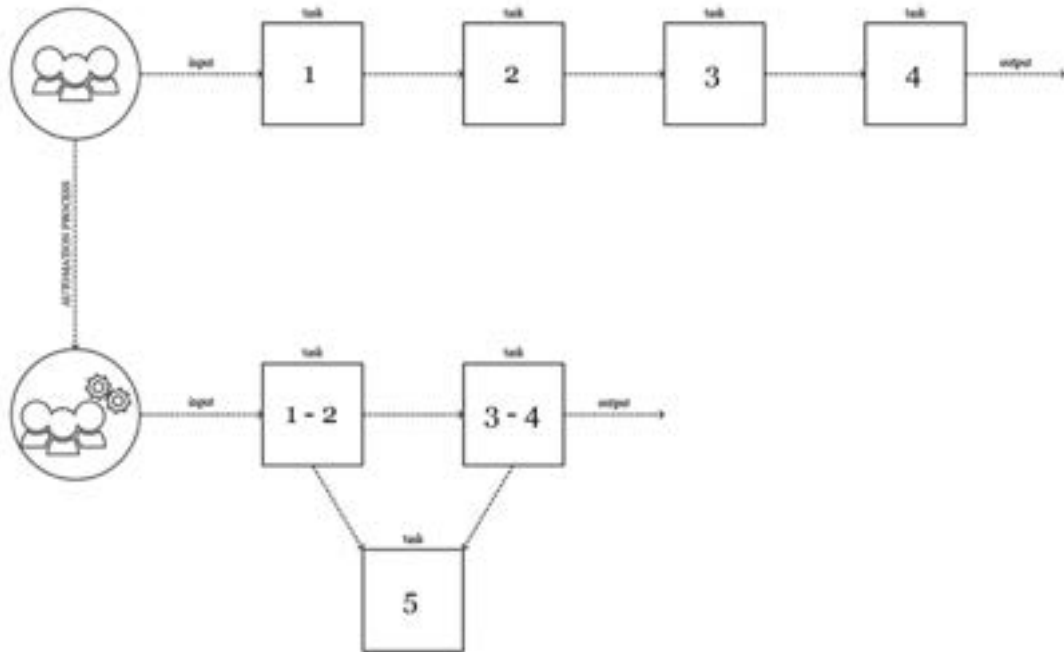


Figure 1. Scheme of a developed production process (Save, 2019).

Maldonado (1997. Translated by the authors) investigated the technology and the production process and come to three conclusions, indicated as follows:

1. Artificialization of the body: “However, the prosthetic body, the body that acts as a technical (or rather technified) subject, does not only have an operational relevance, it does not only serve the need to make us more effective in the performative relationship with the environment. The prosthetic body has become, nowadays, also a formidable cognitive tool of reality in all its articulations, without excluding, let it be clear, its own reality.”
2. Prosthetics: “Which, at the end of the day, means nothing more than the creation of new artefacts intended to make up for (and complete) the inherent performance deficiencies of our bodies. Thus, around it, a varied belt of prostheses is born: motor, sensory

and intellectual prostheses. The body, in short, becomes prosthetic.”

3. Intelligent robots: “One variety of these prostheses, if not the only one perhaps the most important, are industrial robots. Especially those of the latest generation, the so-called intelligent robots”.

This paper deals with the debate between natural and artificial body in relation to the interaction between humans, techniques and artefacts as per the above. In detail, the prosthesis as a production technique is considered more effective in relation to the environment; furthermore, it has surrogate or integrative functions, but it is also considered a cognitive tool of reality.

Maldonado (1997) in his theory likes to differentiate the motor from the sensory and the intellectual prostheses. The concept of prosthesis refers to the presence of a subject having a substitutive or integrative function. Therefore, if the robot becomes self-referential, it could no longer be considered a prosthesis because it would be able to choose on independent basis, according to the surrounding conditions.

Despite the fact that machines can be considered more powerful than humans in terms of strength, absence of fatigue, they are not able to evaluate the impact of their actions on the environment. The main difference consists in the emotions, which provide a basis of judgement in order to discern what is good or bad, safe or dangerous (Norman, 2008). This statement is favourable to the medical prosthesis, based on the fact that the human errors can be compensated by machines, nevertheless these latest ones cannot replace entirely. One of the purposes of this research study is to analyse the syncretic prosthesis.

In recent years, Michele Zannoni (2018), professor of industrial design at the Department of Architecture in Bologna, has been interested in the concept of prostheses developed by Maldonado, where in one of his essays he divides prostheses into replacement and improvement. Replacement prostheses are understood as those prostheses that include all those objects and systems that restore a missing function of the human body, while improving prostheses include all those devices

that amplify the functions of human beings that are scarce and limited. Therefore, sticking to this last distinction, it can be said that the latest generation robots are tools that replace the human operator in carrying out tasks that are too heavy and tiring, so can be considered as improving prostheses.

Continuing with the reading of the text, the author proposes a final classification of prostheses: passive and interactive prostheses. Passive ones can be represented by hearing implants, while interactive ones by wearable devices with which humans interact and change their relationship with space. Remaining in the robotics sector, exoskeletons could be part of interactive prostheses, i.e. wearable robots that act as external support systems, able to enhance the physical abilities of the wearer.

But, remaining in the field of collaborative robotics, it is clear that cobots are characterised by a surrogacy function towards human operators, where the former is entrusted with the heaviest and most exhausting tasks of the work and the latter with monitoring, data interpretation and the decision-making, and where the intent seems to be to entrust a position of centrality and relevance to the human being.

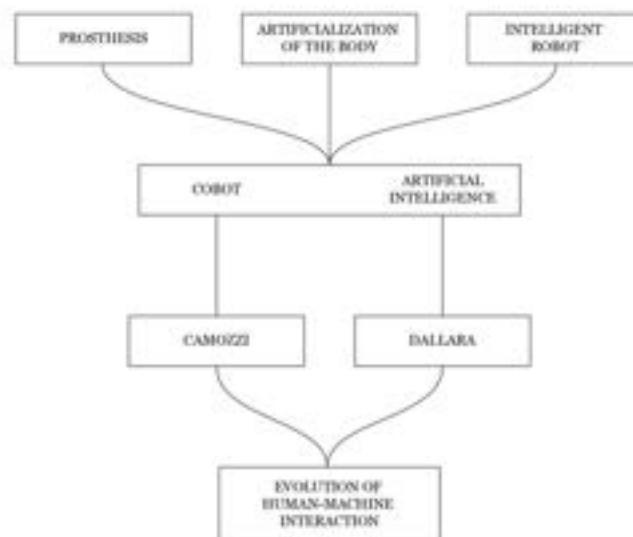


Figure 2. Overview: from keywords to case studies.

In a variety of robots, it is possible to identify cobots and AI. The cobot is a machine that is not able to perform tasks in a completely autonomous and independent way, as it requires to be set by an operator. Robotics provides a physical interaction between man and machine. Similarly, AI is a sort of setting which aims to make the machines more autonomous, although this is not indicated to substitute the humans.

Prostheses of the Future: Cobots and AI

Maldonado (1997) considered the prosthetic body as a technical (or technified) subject provided with both an operational relevance, to make human beings more effective in their performative relationship with the environment, and a formidable cognitive tool of reality. He considered prostheses as artefacts designed to compensate (and complete) the innate performance deficiencies of the human body. Maldonado's concepts are contemporary and can look towards the future of Industry 5.0. Maldonado elaborates a concept of a machine that is in synergy with the man. The skill sets are unprovided of any primordial instinct and based on a strong intelligence and resolution. The machine is considered by Maldonado as a prosthesis, capable of representing an everyday tool that can grasp objects instead of a human arm.

The method of designing the prosthesis as a tool is done with a dress. Maldonado states "The fact of giving a priority role to the re-design of the machine has led us to privilege the study of the sensory-perceptive and sensory-motor behaviour of man in an operational function. And this for the simple reason that it was difficult, if not impossible, to try to adapt the machine to the user without having a thorough knowledge of the subject to whom it had to adapt, i.e. the operator" (Translated by the authors). Therefore, it is possible to talk about a progressive artificialisation of the body. The goal is to support the operatives in their tasks and to simplify the process through the use of AI.

Specifically, as for collaborative robotics, it represents one of the fundamental elements of today's companies and Industry 5.0 in terms of flexibility, adaptability and reconfigurability of production. Collaborative robots are part of an "evolutionary" growth of machines (Magone, Mazali, 2016) which are totally transforming the relationships between machine and user with greater attention to the needs of operators. In this context, the latest generation of intelligent robots can be considered like prostheses, as they have the task of supporting the operator in performing a series of tasks, usually tiring and wearing. Given this close collaboration between the machine and human elements, the structure and body of the robots are specially designed to have the appearance of a human arm. In fact, Maldonado (1997) states that the robot's joints, that is, his arms and hands, resemble those of a human being. In this way it is no longer only the artificial that takes its cue from or imitates the natural, but it is the artificial that unites.

Instead, as far as artificial intelligence is concerned, it is an intelligent system that allows current machines to be able to increase their "cognitive" performance, such as being able to see images, hear sounds, perceive vibrations and tactile sensations, measure the temperature etc. Thus providing the possibility of being able to have an increasingly accurate knowledge of the outside world (Maccheroni, 2018). In this case, it is evident how humans tend to want to expand their intellectual abilities by resorting to technology. In this regard, Maldonado (1997) also argued that man tended to increasingly resort to the use of new devices, such as computers, in order to store and process a large amount of data.

Therefore, both robotics and artificial intelligence can be considered to all intents and purposes as prostheses, as the former is used to perform a series of dangerous and tiring tasks together with humans, so extending the physical capabilities of the operator, while the second is used to expand human cognitive and intellectual abilities. This, of course, generates impacts along the entire company production process, starting from the operational tasks of the employees up to a different management of production rhythms and organisation methods.

This paper deals with the physical interaction between man and robot, including the changes at the process level. There is a general idea in considering those artefacts as nothing more than prostheses. The artificial structures can be replaced, partially or totally, to give a certain performance to the organism (Maldonado, 1997).

Case Studies: Dallara and Camozzi

The Dallara company was founded in 1972 by the engineer Gian Paolo Dallara. It plays an important role in the motorsport environment and is characterised by different areas of expertise, including simulation. The company's motto states that "innovation comes from the error" (Andrea Pontremoli, CEO & General Manager of Dallara Group), meaning that it is necessary to make a mistake to improve the technologies.

These mistakes can be planned to be possible solutions to meet the project objectives. One of Dallara's most innovative technologies is the simulator, which provides drivers and engineers with valuable data without any risk of costs regarding the track testing sessions. The simulator consists of six large, electronically controlled dynamic actuators that are ground-bounded. These actuators support the driver's cabin, enclosed in a steel cage. The driver sitting in the cabin is surrounded by five screens that cover a view of more than 180 degrees of rotation and reproduce the view of each racetrack. The data stored in the software faithfully reproduces the details of the race track (real or imaginary), including the vibrations.

The technology has been developed to analyze all the necessary parameters to evaluate a good performance. The simulator is used in three areas: training, set-up and creation of new vehicles. Since it operates in a controlled environment, the simulator can reproduce an infinite number of scenarios and any potential real situations. The action of the simulator can be undertaken instantly through the user interface, designed to be fast and easy. It is based on a mathematical model characterised by a monoskeleton used on the track and con-

trolled with pedals, brake and dashboards. The mathematical model can give out performance feedback (steering wheel and brake effort). Required PPE are helmet, gloves, shoes and racing suit. The advanced system to complete the circuit simulations, created by high-fidelity laser scanning and combined with a sophisticated multi-body model, allows to replicate the behaviour of a real vehicle with high precision.



Figure 3. Dallara simulator. From: www.dallara.it

The Camozzi Group was founded in 1964 in Lumezzane (Brescia, Italy) by the brothers Attilio, Luigi and Geronimo Camozzi. Today it is one of the most important Italian industrial firms in the field of automation, machine tools and mechanical-textile. The Camozzi Group has been keen to the opportunities offered by the most advanced technologies. The Camozzi Digital has been founded with the aim of supporting companies that want to succeed in digital innovation and the Internet of Things. The synergy for Industry 4.0 between Camozzi, Abb and Evolut has led to the creation of an innovative robotized assembly cell at the Camozzi site in Polpenazze del Garda (Brescia). Abb's experience is direct and concrete: the company has developed the first collaborative robot, named YuMi, that is equipped with two arms and its weight is about 38 kg. The robot is designed for the assembly and manipulation of small components and has a structure conceived to

work near operatives in complete safety. Furthermore, the robot is equipped with a cell consisting of a series of sensors that transmit data in real time to the Camozzi Digital platform to be elaborated for process optimization.

“The simplicity of use is one of the aspects that will allow collaborative robotics to take hold in different environments, even with people who are not specialised in programming or lack specific skills” explains Pedretti. YuMi has been placed inside the production lines in order to facilitate the operators in repetitive tasks, which can potentially lead to a focusing loss and incur in errors. Based on this new set-up, the operator has to perform management control tasks, such as supervising the correct operation of the cell according to a predictive maintenance protocol, in line with the Smart Manufacturing principles adopted by the Camozzi Group. The anatomy of YuMi is very similar to a human, composed of distinct loading lugs and equipped with valves and bottoms, assembling two screws at the termination.



Figure 4. YUMI Camozzi, ABB and Evolut Cobot.

Conclusions: a Look towards Industry 5.0

Even though it is with Industry 4.0 that the new concepts of digitization, industrial automation and interconnection of production processes are mainly developed, through the development of enabling technologies such as ICT, robotics, 3D printing, AI, machine learning, virtual reality, augmented reality, big data, cyber physical system (CPS) and IoT, the environmental sustainability aspects have not been taken care of, and this represents a limitation for environmental protection and sustainability (Mavropoulos, Waage, 2020). Therefore, the Industry 4.0 process of automation and digitization of production systems risks overlooking the needs of operators to give more importance to other different aspects. As stated by Skobelev and Borovik (2017), there are already many people looking towards the future imagining the creation of a “human-centric” society, or “Society 5.0”, where the social welfare of workers will be more important. It is a clear reference to the natural evolution of Industry 4.0, which will try to achieve the realisation of an industry focused on the collaboration between man and machine. This would be representing a business model characterised by the cooperation of digital, technologic and human systems (Magnaghi, 2020). This will increase the value of operators’ skills even more, as they will work more closely with intelligent systems to improve the efficiency of processes and workflows, leading to the creation of new professional figures.

The scope of the employment of all this technology is to develop intelligent interfaces and advanced robots, combined with the use of AI, and to determine a more natural and safe human-machine interaction. Collaborative robots act as prostheses for human operators precisely because they are able to coordinate their movements with those of the operators, controlling their actions and the forces exerted and detecting not only the presence of the human being, but also his intentions and expectations.

Robots have been designed, programmed and reproduced to be under human control. Industry 5.0 does not represent an exclusively

technologic transformation, but aims to meet the needs of humans and to safeguard their safety during the execution of tasks. Over the years, human work has been gradually transferred to robots, creating continuity between natural and artificial. However, the goal is to avoid fully automated factories without humans, as human skills are still of primary importance for production processes.

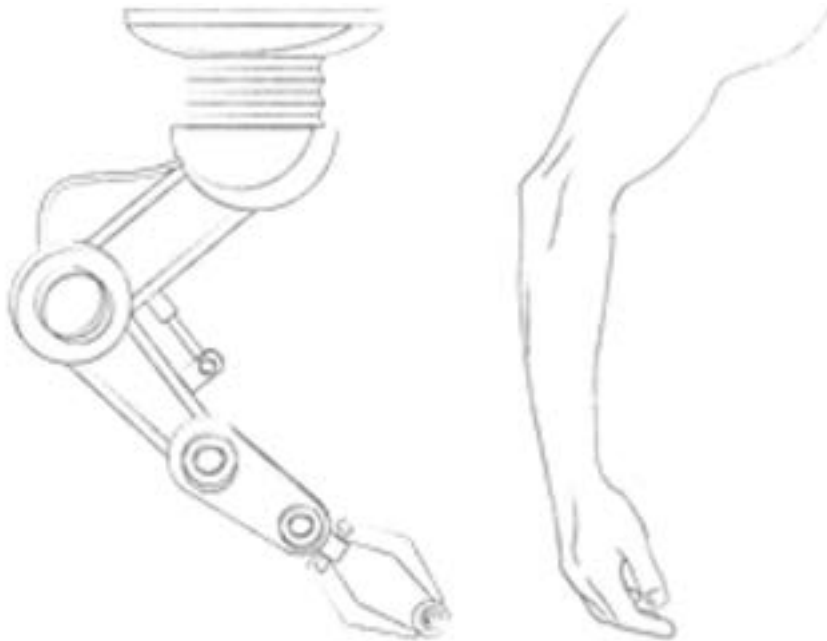


Figure 5. Robotic arm and human arm.

Many factories envision operators working together with machines and AI. This explains the reasons for a robot design inspired by human functions. Maldonado developed a concept projected towards the future. Maldonado (1997) states: “Nowadays, the robot, even the most sophisticated one, is designed, programmed and reproduced by us. It is therefore our own creation. In practice, our double to which we entrust the task of carrying out, in our name, certain functions that we, no matter for what reason, prefer not to perform ourselves. From this point of view, the robot must be considered, beyond any reasonable doubt, a prosthesis” (Translated by the authors). However, the question of the central role of humans in the production process is no longer taken for granted: what will the use of even more sophisticated and ‘intelligent’ machines bring in what is beginning to be called Industry

5.0? Will we remain in a framework of prosthetic design – of machines with an integrative or surrogate function and therefore at the service of human beings – or are other possible scenarios emerging?

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Body and Interaction in Dematerialisation

Eva Vanessa Bruno, Giovanna Tagliasco

Permanence and Individuality in a Dematerialised World

In a world that seems to dematerialise and to digitalise gradually and steadily, it is crucial, and plausibly necessary, to understand the new elements that characterise the individuality and permanence of matter concerning the concept of virtuality as the next challenge for designers. The topic results highly relevant due to the constant progress of virtual reality technologies and cloud services, increasingly sophisticated and affordable for everyone. This progress generates new problems for the discussion for which no significant solutions exist yet.

The purpose of the following essay explores how the concept of dematerialisation takes on different meanings regarding different project areas. Moreover, it highlights how materiality is silently preserved in the concept of virtuality.

Materiality results, despite the constant evolution of simulation technologies, software of data visualisation or cloud computing (such as cloud storage, SaaS - Software as a Service), on the contrary still

present in control hardware (eye-gazers, controllers), visualisation (monitors) and data storage (servers, processors) respectively.

Through a careful selection of case studies, the essay aims to explore the concept of dematerialisation in the world of digitalisation, of virtual and services. Moreover, projects about the return to materiality, done by designers and artists, are analysed. The intention is not to demonise technological advancement but, on the contrary, to show the sincere and natural nostalgia and attraction to physicality, presence and interaction.

Thus, the argument presented here is the constant need of materiality, in antithesis with the persistent “contraction of the universe of material objects, objects would be replaced by increasingly immaterial processes and services” (Maldonado, 1994, p. 10. Translated by the authors).

However, can virtuality overcome what is defined and perceived as real?

As shown later, the matter remains even in the virtual and “there is therefore no escape from the constraint of physicality” (Maldonado, 1994, p. 12. Translated by the authors).

The intention is to re-materialise the virtual, where the prefix “re-” has a double meaning of duplication and repetition. This inverse path involves new forms of gestures that do not disregard the will to sincerity, a term understood here as assuring the truth of a thing, specifically the materiality.

It is then explored the antithesis scenario: the current dematerialisation trend and digitalisation of the user experience. To conclude, we return to the initial thesis, showing case studies that show how the new complexity needs re-materialisation.

The essay thus takes up the thesis proposed by Tomás Maldonado: the constraint of materiality as a kind of postulate.

Ideas and Reflections, the Legacy of Tomás Maldonado

Is it really certain that permanence and individuality of objects have begun to yield their characterizing value concerning the material order of our world?

(Maldonado, 1994, p. 11. Translated by the authors).

Tomás Maldonado, in the essay *Reale e virtuale*, finds that individuality and permanence,¹ the two defining properties and states of sensory perceptions of the material object, are losing their value in an increasingly digitised world. Individuality, defined as “the note or set of notes proper and exclusive that characterises the individual and distinguishes him from other individuals of the same species or other members of the same society”,² gives way to multiplicity and replicability. Permanence is described as persistence, but this definition clashes with the concepts of evolution and transience over time. The issue becomes even more complex outside of classical mechanics, characterized by those properties. The lens of quantum mechanics is used, distinct from the dualism of the wave and corpuscular nature of the behaviour of matter.

Starting from this reflection, the aim is to understand how permanence and individuality are configured in this new digital world, composed of strings of codes. A world that is at once intangible but visible, abstract but real. The doubt is crucial since there is an increasing attempt to re-materialise the digital.

The process that needs to be analysed before re-materialisation is dematerialisation, which for Tomás Maldonado in *Reale e virtuale* is a phenomenon linked to emerging technologies (information technology, telecommunications, bioengineering, robotics and advanced materials technology) and software or, as the author prefers to define,

1 Defined by the French physicist Alfred Kastler.

2 <https://www.treccani.it/vocabolario/individualita/> (Last consultation February 3, 2022. Translated by the authors).

the technologies of thought. In the word dematerialisation, the prefix “de-” means removal and deprivation. Following in the footsteps of Tomás Maldonado, the essay takes up the three steps through which this removal/privation of matter takes place. The first is the transition from hardware to software (e.g., the transition from the physical calculator to the application that can be downloaded on the smartphone), the second is the condensation of several pieces of hardware into a single piece of hardware (the personal computer contains several pieces of hardware in one, like the typewriter, the calculator), and finally, the transfer of a product as a service (from car ownership to car-sharing). It is interesting to note how artificial transposition often recalls its material ancestor in this process.

There is no doubt that between natural and artificial life the boundaries appear increasingly blurred today. [...] this does not mean that the issue concerning the relationship between body and technology is not of extreme importance in hypermodern society. It concerns above that our bodies will live the adventure of continuity between the natural and the artificial taken to its extreme consequences (Maldonado, 1997, pp. 137-138. Translated by the authors).

The term “critica” is intended in this essay as an analysis, i.e., an exploration of the pros and cons of the phenomenon of the internet and the new technologies of computing and telecommunications, to arrive at conclusions. The essay *Critica della ragione Informatica* splits the theme into sub-areas such as: the role of technologies in society, the apparent contradiction between progressive dematerialisation and the accumulation of material goods, and finally, how communication and interaction between people is changing.

In the visions of probable and/or desirable future scenarios, there is a conviction that we are witnessing an increasing of dematerialised reality. The essay is questioning this assertion, which is often taken for granted. As early as the 1990s, Tomás Maldonado pointed out how the information society wasted many material resources. The issue is now

unquestionably urgent, and it raises the question of whether information infrastructures can mitigate material infrastructures. Indeed, the role as a saver that many people attribute to the new technologies is exaggerated. This is because this has significant impact on daily life and the environment and on this topic many questions are still open. The virtuality does not disregard the management of the infrastructures needed to support it, nor of the outputs produced. The contemporary society makes these supports obsolete long before the end of their lives through programmed obsolescence (through software updates that the hardware cannot withstand) and semantic obsolescence (through fashions and trends).

The effects of these virtual actions are anything but immaterial, a “tendency to continuously generate what, out of metaphor, might be called ruins” (Maldonado, 1997, p. 101. Translated by the authors).

From *Les Immatériaux* to the Metaverse

As Tomás Maldonado argued, in *Reale e virtuale*, the concept of dematerialisation was made accessible during the exhibition *Les Immatériaux*³ at the Centre Georges Pompidou. This exhibition created awareness of a world in a process of dematerialisation in various fields such as biology, art, architecture, astrophysics, etc. During the opening of exhibition the press release issued was “Matter is not what it used to be...”. The authors of the exhibition wanted to say that all processes of dematerialisation are processes of transformation. The passage from one state to another is a clear example. There are a series of processes in which technology can have a role in making the matter “intangible”. In this way the technology increased the distance from the natural origin to flows of electrons and then flows of informa-

3 *Les Immatériaux*, exhibition curated by Jean-François Lyotard and Thierry Chaput in 1985 at the Centre Georges Pompidou, Paris. https://monoskop.org/Les_Immatériaux.

tion data. Based on these indications, three different reflections on the subject of dematerialisation are given below. The first concerns dematerialisation as digitalisation, and the consequent decrease of bodily experience; the second introduces the theme of sincerity linked to the theme of dematerialisation in virtual reality; in the third paragraph, it was attempted to rematerialize algorithmic data and memory through physical installations. Finally, the theme of dematerialisation in services and brands is finalized questioning on the Mark Zuckerberg's *Metaverse* project, where a digital and immersive world is accessed mainly – but not exclusively – through virtual reality.

Dematerialisation and digitalisation, bodily participation in the experience

In *Reale e virtuale*, Tomás Maldonado linked the concept of dematerialisation and digitalisation, talking about emerging technologies. Concerning dematerialisation, in digital terms, we are often faced with a sort of Swiss army knife, with several functions. In the process of digitalisation, there is a tendency to unify different artefacts that perform different functions into a single technological instrument. An example is the computer or smartphone which contains in itself: calculator, telephone, notebook, etc. An example of an artefact, that includes several functions in one, is the smarty writing set by *Moleskine* (Figure 1). In the beginning the standard notebook, purchased for writing/drawing, was made to be able also to digitalises the created products. Then *Moleskine* designed another smart notebook, which allows you not only to write as in an ordinary notebook, but to digitalize content and share it through an App.

This hybrid model gave the possibility to maintain to reproduce the physical gesture of writing on a real paper, through a smart pen and, at the same time, gaining the advantages of digitalisation. This example brings to a question: how can we combine the progressive and inevitable digitalisation with its advantages, with the counterevidence of the needs of physical and sensorial experiences? In the case of writing,

the process can be either whole reconfigured, such as writing through a keyboard, or simulated, in the case of the tablet with its electronic pen. In the first case, the experience with the material tool requested the distancing from the previous model and the acceptance of the new one. In contrast, in the second case, the experience of writing remains almost unchanged.



Figure 1: Smart writing set by Moleskine. From: <https://www.wired.it/gadget/accessori/2016/04/08/set-moleskine-per-appunti-su-carta-tablet/>

This brings us back to Tomás Maldonado’s statement: “There is no escape from the bonds of the physicality” (Translated by the authors). In the case of the *Moleskine* notebook, it guarantees to the user the possibility to maintain the link with the past, reproducing an experiential gesture. We can hypothesize that the digitalisation process has to do with processes and modes of interaction. Therefore, it is necessary to build new physical tools that enable the production of new dematerialised and digitised processes.

The discussion on physical experience must do, first of all, with the attempt to reduce the level of intermediation, for example making the numbers code, indecipherable by any user, more tangible. So, it is not necessary that handling a physical object, such as Moleskine smart book, is a process of re-materialisation of experience. However, it tries

to reduce the levels of intermediation, increasing bodily participation in the experience.

Dematerialization between simulating and sincerity

The concept of dematerialisation has a different meaning in the context of virtualisation. Ezio Manzini dealt with the theme of dematerialisation with virtualisation, defining it “simulated reality”: “[...] the opening of a new dimension reality: the production of simulated worlds, whose ‘materiality’, or better the perception of what we can define their materiality, is pure information” (1990, p. 23. Translated by the authors). If, as Ezio Manzini proposed, the material must “sincerely” show its intrinsic quality and, the “design culture” must define the “sincere” and therefore “just and beautiful” form, the process of virtualisation does not have to deal with materiality. In the virtual reality the levels of intermediation that occur between us and the perception of the world are so complex that we cannot be aware of the mechanisms in which we move. Even if virtual reality creates environments in which interaction tends to be as friendly as possible, it represents a synthesis of processes that, anyway, remains obscure and opaque to us. The “becoming sincere”, that Manzini evokes, is independent of the ethical dimension, but it claims the need for interactions with the world, the reality and the material. People have increasingly demanded more authentic experiences. The “sincere image” that Ezio Manzini hypothesized in 1990 refers to being visible and transparent. Sincerity, which in the object and the matter was physically perceptible, in virtualisation “escape from our ability to perceive” (Manzini, 1990, p. 150. Translated by the authors).

The need to re-materialise complex information

In re-materialisation, where the prefix “re-” has a double meaning of duplication and repetition, there is a shift from software to hardware and a translation from data to a more comprehensible information.

The progressive increase of complexity in the reality and the consequent proliferation of myriads of data has created in people not a simplification, as was desirable, but a greater difficulty in understanding. Now the Covid-19 showed us how the interpretation of data could be dangerous for the politician in terms of consent. The people were asked to make a significant act of faith in trusting the representation of reality transformed in data. Probably, in this complex reality, the act of trust for people must be followed by the creation of tools that allow them to understand easily this data, and consequentially the reality. This could allow them to make informed decision and consciously affect reality. One of the most interesting answers comes from those “artistic” experiences that attempt to make data tangible through a process of re-materialisation.

The Datapoietic Artwork (Figure 2) is a game of light lamp that points out the attention on the conditions of poverty on our planet. The system collects the data of people living in poverty conditions, with less than \$ 1.80 per day, and displays it through a flashing red light. The light, which represents a man lying and crouching, will disappear only when the number of people living in these conditions will efficiently decrease.

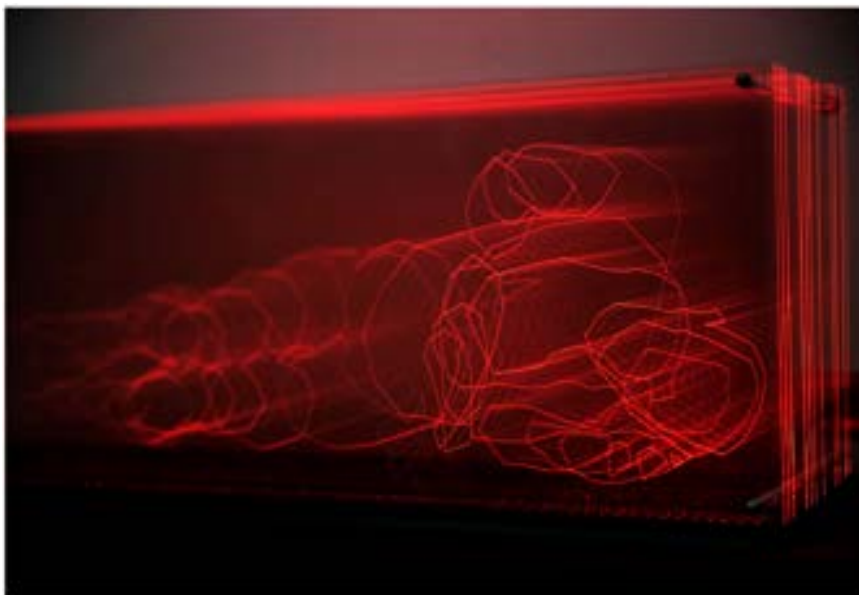


Figure 2: Obiettivo by Iaconesi and Persico. From: https://datapoiesis.com/home/?page_id=138,

Neural Mirror (Figure 3) is an installation that represents an ordinary mirror at a glance. However, when the user goes in front of the mirrors an Artificial intelligence transforms the reflected image into data. These data there are translated into a stream of information and written with a pen on vast rolls of paper. In this way, the data became tangible and visible through the transformation of user's image in "a flow of printed data".



Figure 3: Ultravioletto, Neural Mirror. From: <https://ultravioletto.to/fondazione-carla-fendi-neural-mirror/>

*The Basilica of Siponto*⁴ (Figure 4) by Edoardo Tresoldi, instead, attempts to re-materialise what is no longer there or what could have been in the past. The author created an ancient Paleochristian Basilica through what he defines as *Absent Matter*, a “transparent” sculpture made of wire mesh.

The processes of re-materialisation of data, or in general digitalization, in these cases started from a physical form where is possible to interact. Therefore, the focus is, above all, on the emotional aspects of perception. The trust relationship between the user and the author is based on the authenticity of the experience, involving emotional aspects. The interaction, indeed, happened not only with cognition or rational interpretation but also with perception.



Figure 4: Basilica di Siponto by Tresoldi. Photo by Blind Eye Factory. From: <https://www.edoardotresoldi.com/works/basilica-di-siponto/>

⁴ Promoted by the MIBACT Regional Secretariat and the Archaeological Superintendency of Apulia, the project is linked to a conservative intervention. <https://www.edoardotresoldi.com/opera/>

Intangibility, invisibility, miniaturisation, de-substantiation

The other theme introduced by Tomás Maldonado in *Critica della ragione informatica* and in *Reale e virtuale* is the overcoming of the material object in favour of process and services. It is easy to associate the theme of services with concepts of invisibility and intangibility. The design is no longer only the artefact, but also the relationships and connections of spaces, things, and people and therefore, the experience. Moreover, in this context, the themes of sincerity and trust returned because these are two indispensable elements in the world of services. The experience must be built using the sincere method proposed by Manzini. In this way, the user can verify that the process is “beautiful and fair”. Now, the most widely used tool for verifying the reliability of the service, but also of the product itself, is the feedback. However, it is necessary to understand whether this tool is sufficient to verify the actual effectiveness of a service or product, because the review model is not very visible and tangible.

Andrea Semprini also treats the subject of services by combining the concept of dematerialisation with two new ideas: miniaturisation and de-substantiation. Before dematerialisation there was the process of miniaturisation of products reducing their size. The concept of de-substantiation, on the other hand, goes further: “the tendency of consumption practices to move towards products that have less phenomenological density, a greater physical presence, but on the other hand often an increasingly important symbolic and imaginary density” (Semprini, 2006, p. 31. Translated by the authors). In the contexts of services, as Andrea Semprini points out, also “ideas, images, emotions, imaginaries, stories” (2006, p. 32. Translated by the authors) are consumed and, in these new models of consumption, brands could bring more value. A sort of new re-materialisation and concreteness, not anymore only physical, but also semantic.

So finally, we arrive to our days with Mark Zuckerberg’s proposal. The idea of creating a new Metaverse where everyone can build different scenarios where experiences can happen: “3D spaces in the

metaverse will let you socialise, learn, collaborate and play in ways that go beyond what we can imagine”.⁵

Is this new way of interaction feasible after Tomás Maldonado’s statements on the inescapability of materiality? Furthermore, what consequences would have this new scenario in facing the need of experiences connected to the physical world?

A Desire for a Return

Nowadays technologies are pushing towards increasingly sophisticated processes of digitalisation and virtualisation. This leads to a generalised belief in a dematerialisation of reality and the human starts to feel an urgent need to go back a few steps along. There is a desire for physical experiences where matter, such as the body and each other’s presence, have a meaning, a sense that is irreplaceable.

The case studies analysed present research for authenticity, something that can be experienced without too many intermediary processes but through immediate uses. How can we reconcile extreme digitalisation and the research for a direct connection with reality? Through guided processes of trust and the protection of sincerity. In particular, the trust given by the user to those who produce artefacts and processes is a form of passive trust, which today is challenged and tested. The sincerity, as Manzini says, is the requirement that designers must apply to allow a new relationship between artefact and user. The designer’s role is to reshape virtual reality, give sincerity and inspire confidence through physical and concrete experiences, and understand the complexity generated by virtuality.

The following essay is not intended to demonise the consequences of acting and experiencing in a virtual space; the intention is to show how virtual actions could have material consequences; experience, therefore, seems to be never immaterial, but the progressive loss of the senses in this process is evident. The body apparently disappears

⁵ <https://about.facebook.com/meta> (Last consultation February 20, 2022).

in virtual communication, which substantially changes people's interaction. The "disappearance" of the physicality of the interlocutor is translated into a loss of senses that substantially changes the interaction. The consequences of this were sadly evident during the COVID-19 health emergency, which wake up again a desire of presence and materiality, necessary conditions, even in extreme cases of dematerialisation, to not humanity's condition.

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Designing the Experience

Among the Contemporary Phygital Multiplicity of Bodies and Spaces

Giovanna Nichilò, Gabriele Pontillo, Beatrice Rossato

Introduction

This paper aims to examine the multi-layered nature of space-user interaction, integrated or generated by digital technologies whose experiential dimension is activated by the user through the body as interface. The increasingly pervasive use of new technologies defines a state of seamless interaction between user and inhabited medium, imposing the definition of new scenarios concerning new sensibilities and new proxemics where people, both in the individual and social dimension, are extended physically, mentally and emotionally. Contemporary life is increasingly characterized by dematerialization and digitization of products, processes, and services and, therefore, there is an urgent need for a critical discussion on the experiential value of spaces integrated by digital technologies and the consequent limits and design possibilities that they can offer. The relevant literature – starting from the critical analysis of Maldonado’s writings to the considerations of Caronia (1996), Benyon (2014), Morganti, Riva (2006) – focuses on the

importance of designing the experiential dimension of the interaction between body and space.

Based on these observations, the present study contextualizes the subject matter, starting from Tomás Maldonado's critique to more recent interpretations that find continuity or discontinuity with the author's thought. Next, reflections that have emerged around the relevant literature are presented, focusing on current practices that testify to the evolution of the space-body relationship – in the examples, in particular, of the “transparent body” (Maldonado, 1997; Floridi, 2017), the “shared body” (Floridi, 2017), and the “digital self” (Granelli, 2006; Floridi, 2017) – towards an increasing digitization of the body.

The analysis is therefore focused on identifying the multiplicity of bodies and spaces that the co-presence of the physical and virtual dimensions entails, investigating whether and what kind of experience can be designed and whether this can constitute a cognitive enrichment or impoverishment for the user.

The Inheritance of Tomás Maldonado: Bodies and Spaces in the Real-Virtuality

The need to investigate both on a critical and design level the aspects related to the multiplicity of bodies and spaces and their interactions arises, first of all, from Maldonado's reflection on the meaning of the word virtual and on the relationship between real and virtual space. The author in *Reale e virtuale* (1992) recalls how human beings have always virtualized concepts, illusorily furnishing the world, so he rejects the definition of virtual only as a technological expression of immersive three-dimensional space. He, instead, searches for the meaning of illusory reality where man produces images that he persuades himself to consider real. A practice that goes back to the ability of primitive man to depict symbolic worlds rather than a novelty triggered by technological progress. In this regard, it becomes interesting to resume the definition of Pierre Lévy that in *Il Virtuale* notes that the word virtual comes from the Latin *virtualis*, derived from *virtus*,

or strength, power. “In scholastic philosophy, virtual is what exists in power and not in act” (Lévy, 1997, p. 10. Translated by the authors) thus not a concept opposed to the real but rather the potential of the real itself, an opportunity for creativity.

The consideration around the definition of virtual becomes necessary to understand how, in this paper, spaces understood as virtual will be considered. They embrace not only the virtual immersive realities that transport the user into an immersive digital three-dimensional world, but attention is paid above all to the middle ground that constitutes a continuity between the real world and the illusory world, of which immersive realities are naturally one part. In this regard, Maldonado offers the cue to reflect on the theme of the plurality and complexity of middle-lands, a condition that arises from the increasing dematerialization that the contemporary context has experienced and is experiencing and about which he speaks critically in *Reale e virtuale*:

In this sense, we find it in the scenarios that are envisaged on the role of science and technology in the next century. In such scenarios, it is often argued, the impact of emerging technologies (information technology, telecommunications, bioengineering, robotics, and advanced materials technology) would lead to a progressive thinning of the materiality of the world, to a dematerialization of our reality as a whole. [...] a contraction of the universe of material objects, objects that would be replaced by increasingly immaterial processes and services (Maldonado, 1992, p. 10. Translated by the authors).

Maldonado anticipates the contemporary situation in which more and more products, processes and services are being moved away from their physical sphere in favor of a digitally integrated experience. The sudden and strong push to digital transition linked to the epidemiological emergency from Covid-19 actualizes Maldonado’s thought and criticism around the topic, highlighting his strong skepticism in considering plausible a complete dematerialization of physical artifacts and, above all, of the body. Antonio Caronia, in his essay *Il corpo virtuale*,

takes up and emphasizes the critical issues proposed by Maldonado about the dematerialization of reality, in particular emphasizing the criticism of the “increasingly obsessive craving for evanescent worlds” (Maldonado, 1992). In Maldonado’s thought, it is in fact unlikely that a total cancellation of corporeality, which is a constitutive element of human experience, will be achieved. In 1997, in *Critica alla ragione informatica*, Maldonado refers to the body as object of knowledge – for the experience that passes through the senses – and technical subject – as a reference point for technical operativity. In particular, he highlights how the link with the body is almost indispensable: “for me, the body should rather be understood as our inalienable daily reality, as the body experienced every day, and in the first person, by each and every one of us, as the body that is sensoriality, sensuality, and sensitivity, in short, as the body that we are” (Maldonado, 1997, p. 140. Translated by the authors).

Maldonado, in fact, specifically questions the experience of the body in continuity between natural and artificial, real and virtual, where he identifies numerous unknowns: the interaction between the body and the environment and with other body types or the types of new forms of sensoriality, sensuality, and sensitivity that are created, to name a few.

The attachment to the body and its physicality opens interesting considerations around sensoriality in virtual realities and it is worth mentioning in this scenario the ambivalence that Maldonado recognizes in the very nature of virtual realities: on the one hand the discontinuity with the real body, on the other hand, their potential as a tool for rehabilitative medicine, design, industrial robotics. Maldonado’s discourse, therefore, emphasizes not only the increasingly contemporary tendency to perceive the world through virtual simulacra of reality but also in their duplicity, as a limit and an opportunity. The limit of the body and the perception of the body within virtual realities becomes central to Maldonado’s discourse:

The experience of space, to varying degrees and intensities, involves at least four of our senses: sight, touch, hearing, and smell. It is therefore fair to define space as a perceptual system [...]. Our sensorimotor behavior, whether normal or abnormal, always refers to a perceptual system. When this is lacking, as happens with virtual space, sensorimotor behavior suffers (Maldonado, 1997, p. 162. Translated by the authors).

Caronia also takes up this concept by proposing the definition of unidirectional disseminated body when explaining the characteristics of the experience in the virtual reality of a dislocated body:

We move our limbs, we turn our heads, and this has the same effect as in the real world, but the space of the effects lacks one of the characteristics of the usual everyday space, namely materiality. The possibility therefore of extending one's own body and perceiving the bodies of others albeit distant, but the limitation of not having a perceptual intervention on one's own physical body (Caronia, 1996, pp. 73-74. Translated by the authors).

As cited earlier, the ambivalent nature that Maldonado finds in virtual realities also identifies the areas of application in which they can be successful – depending on the environment. Among these, the case of medical rehabilitation is discussed extensively primarily because it brings attention back to “a question of responsibility that we should not dramatize, but neither should we evade” (Maldonado, 1997, p. 159. Translated by the authors). The intent is to emphasize the importance of the role of perception in rehabilitation practice which, as seen above, Maldonado believes is a complex condition for virtual realities:

It has been said [...] cognitive science, because of the central role it assigns to perception, cannot afford to ignore action. But if this is true, the reverse is no less so. In a cognitivist approach, nothing can be more misleading than to isolate action from perception (Maldonado, 1997, p. 158. Translated by the authors).

Action and perception thus become issues to be analyzed in the design of places of experience, wondering whether the absence of bodily sensory perception can still be considered, as Maldonado states, an intrinsic limitation of virtual realities and whether this consequently constitutes a limitation also in the experience that can be generated between digitally integrated space and the body.

The limits and fears for virtual realities and digitally integrated spaces become clear when the author introduces the theme of desocialization linked to the dematerialization of the real. From considering domotics as the cause of a “housing coma” (Paul Virilio in Maldonado, 1992, p. 53) to the use of telework, once again Maldonado seems to anticipate the current scenario in which we are forced by necessity to consider digitally mediated forms of social interaction, while not excluding the primary importance of the physical interaction that they contain. Therefore, there is no doubt that Maldonado’s thought still offers critical considerations on the relationship between real space, virtual space, body, and interaction.

Contemporary Considerations: Bodies of Multiplicity Inhabit Spaces of Complexity

Talking about digital transition, body and space, the maldonadian thought about the concept of transparency of the body is still relevant: digital technologies allow at the clinical level to enter the physical body and explore as well as modify its structures and functions, without it being configured as a black box; one can observe *in vitro* and at the same time intervene *in vivo* (Maldonado, 1997, p. 148. Translated by the authors). Floridi (2017) takes up Maldonado’s words to mark the shift from black boxes to transparent boxes, crediting ICTs with being able to measure, model, simulate, monitor, and manage the body with extreme accuracy and without this process being invasive to the body itself. A process, remembers Floridi, that is not limited to diseases but to wellbeing in general where the awareness of one’s own body

is increased and improved. In contemporary times, the use of technologies in the investigation, communication, representation, fruition of the body, and its design, configures a hybrid scenario in which body and technologies are in a continuum of close correlation, they influence each other and interact.

The body can no longer do without technology to empower itself, communicate and self-represent since the awareness of its physicality has expanded following the double track of the immateriality of the media and the materiality of its imprint: it is a body that modifies itself because it wants to achieve the image it has always dreamed of itself (Ciammaichella, 2015. Translated by the authors).

Today, having arrived “from the opacity to the transparency of the body” (Maldonado, 1997), techniques and processes of medical imaging, nanotechnology, biosensors, and communication technologies allow us to detect, communicate and interact with bodies in a multidisciplinary dimension in which fall not only diagnostics, therapy, surgery but also decision-making models, disclosure extending to the conception of spaces and artifacts, both physical and virtual, at various scales of design.

An example in the rehabilitation field is the D-Wall project by Tec-nobody (Figure 1), a medical device that works with virtual and augmented reality that looks like a digital mirror able to monitor and visualize the movements of the patient (body recognition) thanks to a frontal 3D camera and the floor equipped with sensors that allow to reconstruct up to 16 joints of the body. The real-time detection returns through digital avatar the movement that is being made, then analyzes it and produces informative data becoming a system of continuous learning. In this example, the automatic movement of the body, made transparent, is virtualized by informing the user about the actions performed. Participation in the rehabilitation process is enhanced, thanks to the playful component included in the device, with immersive environments that help to focus on the goal to be achieved. The interac-

tion, mediated by the screen, involves the physical body of the patient and its virtual transparent double with favorable consequences on the physical body in terms of rehabilitation.



Figure 1. D-Wall, TecnoBody, 2020. Virtual and augmented reality medical device for rehabilitation.

The ability to collect, store, and analyze individuals' physiological, behavioral, and geolocated data has come to influence a wide range of domains of daily life, from marketing to epidemiology. The body increasingly becomes a “shared body” (Floridi, 2017) and, therefore, it is human beings themselves who are owners and sources of information, as well as channels that transfer it. The “datafication of health” (Ruckenstein, Schüll, 2017) is encompassed by different domains – by scales and registries – that have never been sharply distinguished: data-driven medical research and public health infrastructure, of which biobanks are an example; clinical health care, including eHealth practices such as continuous patient monitoring, implantable biosensors, and personalized medicine; and self-care practices, such as wearable fitness and health devices and smartphone apps. Problematizing the value of data in today's society, Ruckenstein and Schüll call on scholars to pay more attention to the phenomenon of health datafication and, in particular, to probe and experiment with new relationships

with areas not only directly related to medicine. For example, recalling the work on health care by Oriana Persico and Salvatore Iaconesi,¹ the authors talk about data activism exploring how data technology can be exploited to promote social justice, equality, political participation, and collective action. In this regard, they write:

Individual self-tracking data, for instance, can have social and political potential when it is pooled to identify health inequalities, collective environmental exposure, or disparities in quality of life [...]. Such data might demonstrate that physiological stress is tied to everyday rhythms defined by societal norms and pressures rather than by individual predilections [...], or they might highlight the physiological and emotional costs of particular work schedules for caregivers [...] (Ruckenstein, Schüll, 2017, p. 280).

Similarly, the installation *Protoni e Dati*, which sits between science, technology and art, converts medical data from proton therapy into 3D sounds so that the patient can perceive the area in which the proton radiation is acting. This allows greater awareness of the treatment process on one's own body, implementing the intimate and relational sphere with the treatment itself. Such a system transforms the therapy into a cultural artifact, sounds that become pieces of music and can be shared with relatives and friends, triggering a dialogue and an empathic relationship that promotes the well-being of the patient.

Still, about the quantity and potential of human body data and its sharing, it is relevant to report the case of the Human BioMolecular Atlas (HuBMAP) project, a program funded by the National Institutes of Health, whose goal is to develop a human biomolecular atlas conformed as a global open data platform that maps healthy cells in the human body.

1 Salvatore Iaconesi, by online sharing information about his brain cancer and requesting crowd-sourced answers to his condition, has successfully created a public space where, by experiencing his own disease and recovery, he can not be reduced to a "category", that of cancer patient consisting of a set of medical data.

HuBMAP researchers are studying the connections that cells – 37 trillion in an adult human body – have with each other throughout the body to determine how those relationships might affect an individual’s health. The open-access platform enables the development of new approaches for integrating, visualizing, and modeling imaging data for reuse by the global scientific community in areas such as computational research, biology, teaching and education, and project disciplines.

Interacting with all aspects of daily living, the intervention of ICTs in collecting, analyzing, and measuring data about the human body creates a community dimension in which this is shared; technologies consequently become tools for the constitution of personal identity, “powerful technologies of the self” (Floridi, 2017) that mediate and construct a “digital self” (Granelli, 2006). According to Granelli, the birth of the digital self can be attributed to three different digital phenomena: peer-to-peer digital information exchange, blogging, and the spread of digital identifiers such as personal emails, avatars, or digital aliases. The sharing of information online constituted and enabled by the content that humans themselves communicate through social networks, instant messaging, or through digital avatars, all become micro narratives of their own identity that modify the social relationships established between individuals.

It is increasingly natural then, as Floridi reminds us, to consider the body as a source of shareable information. Moving in the context of the network, the intersections of multiple data sources and therefore the connections between people and bodies, influence the environment in which we live, in its different notions of material or immaterial state. From metaverse to home automation, to responsive environments, the flow of data, processed with different purposes, offers new forms of sensory, motor, and spatial interaction. Bidirectional communication is established between the sensed bodies and the space in which it is translated.

From this point of view, it is interesting to observe the first installations of the Pulse series, the work of the artist Rafael Lozano-Hem-

mer. He tries to overturn the use of biometrics from mere control to a continuous representation of a community. The installations, in fact, are conceived in the wake of the debate on the use of absolute identification by businesses and the state, as acquisitions of biometric data translated into sequences of flashing lights, soundscapes, animated fingerprints, waves of water moving through space. Such an approach allows us to look at ICT beyond the network or our own home environment, and projects towards a new way of experiencing social space that becomes both a physical and digital experience. In the last decade, in fact, technologies such as IoT have become affordable to be integrated and connected to spatial design to contribute to the creation of hybrid and connected environments that include spaces, structures, objects, and people equipped with sensors and actuators, and to acquire messages, data and information from as many environments to transfer them over the network to further spaces, structures, objects and people outlining a complex relational infrastructure full of potential for everyday life.

The potential of such an approach has been further highlighted by the recent period of isolation due to the Covid-19 epidemiological emergency. Since March 2020, human activities have shifted from taking place in common physical spaces to the network: educational activities, medical visits, work shifts, and cultural experiences have been transformed respectively into distance learning, telemedicine, smart working, virtual museums, and streaming services. Nonetheless, a real rethinking of social spaces is lacking, which certainly cannot be reduced to sharing platforms and social networks. Today we can see the psychological damage due to the restrictions imposed during the pandemic in which people were not ready to a sudden reduction of communication to the digital form only.

In this regard, the design experiments of the Interactive Architecture Lab of the Bartlett School of Architecture in London, which has always been engaged in design and research on the behavior and interaction of things, environments, and their inhabitants, are interesting. One example is Dysphasia, an interactive telepresence project that,

in response to the need for distancing and subsequent digitization imposed by the pandemic, encourages reinventing social interaction (Figure 2, 3).“It builds bridges between digital and physical space connecting users to places and people geographically distributed around the world” (Deng, You, 2021). In addition to an exponential increase in the use of chat and social networks to compensate for the lack of relationships, Dysphasia authors Doris Deng and Bojia You observed an increase in the use of live streaming of public space during the period of isolation to satisfy the lack of familiar, everyday experiences. Based on these observations, the project connects a web app and an associated physical installation via a feedback loop. Users, in fact, access the website from private rooms around the world and interact in real-time with the public space by remotely and simultaneously viewing and controlling the light installations. Theirs are not only virtual visits to the social space to which access is forbidden, but they are involved in a non-communicative remote dialogue that affects feelings and sense of presence.

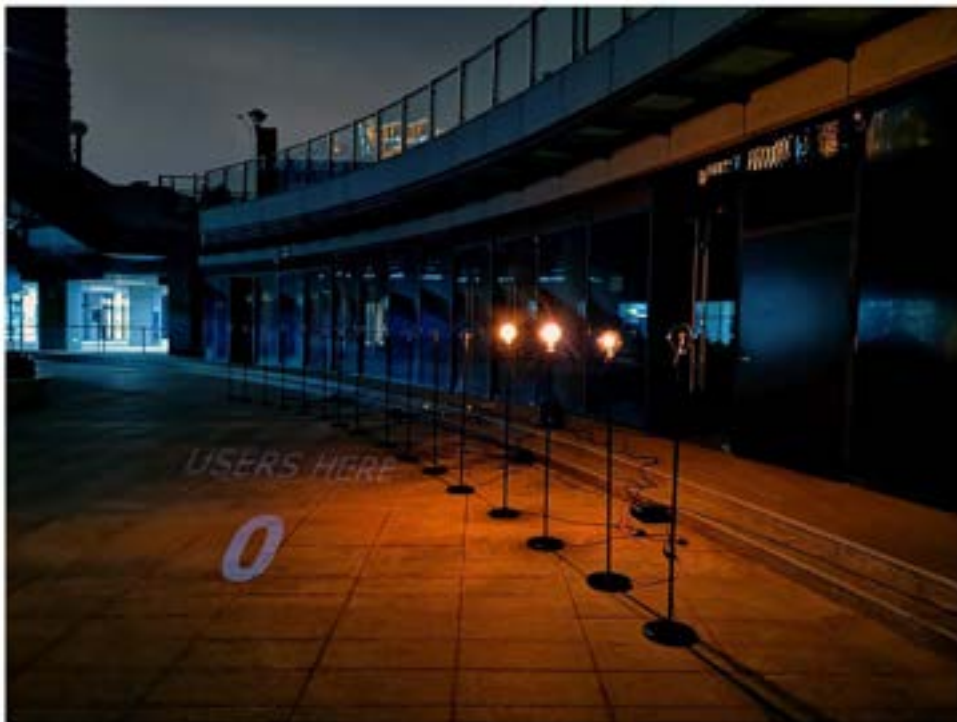


Figure 2. Dysphasia, Doris Deng and Bojia You, 2021. The ground projection shows the real-time number of virtual visitors and helps engage people in interaction.



Figure 3. Dysphasia, Doris Deng and Bojia You, 2021. Access portal.

In this sense, the sharp distinction between presence and location of the self is hybridized, to digitally re-appropriate sociality in physical space.

A different approach, but triggered by the same design urgency, is the one adopted by Mahalia Henry-Richards and Stephen Henderson for the design of *The Playground*, a system of sociality in a digital dimension that involves digital bodies and is mixed with the physical body that is involved (Figure 4, 5). Also created during the pandemic in collaboration with the Interactive Architecture Lab, *The Playground* is based on unconventional collective interactions that take place on the physical and digital plane. It is configured as a hybrid world that integrates physical and digital spaces and proposes a social interaction based on gameplay determining changes based on the position one holds in the virtual space. The narrative of the digital experience is focused on understanding what interaction is possible when physical presence is lost, with creative means of visualizing and sharing information.



Figure 4. The Playground, Mahalia Henry-Richards and Stephen Henderson, 2021. “The chatbox changes behavior based on location in the virtual space, encouraging different types of engagement and interaction” (Henry-Richards and Henderson, 2021).



Figure 5. The Playground, Mahalia Henry-Richards and Stephen Henderson, 2021. Landscape Interactions.

The examples of the Pulse series, Dysphasia and The Playground demonstrate how the concept of space becomes central to shaping the user experience and underscore the need to design, in complementary ways, both space and experience. As David Benyon (2014) reminds us, interaction can be conceptualized as the relationship between four elements that make up PACT: people, activities, contexts and technologies. In any form of interaction, you have people immersed in an environment, physical or digital, performing an action. The environment

itself is described by the context and the technologies that comprise it, and the interactions that are created in this system can be multiple and simultaneous. Benyon also recalls: “There is an essential physicality to these media that derives from the fact that humans are embodied. The concepts that we develop, how we classify things and how we approach interaction derive from the embodied and embedded notion of interaction” (Benyon, 2014, p. 27). A thought close to the strict relationship that Maldonado emphasizes between the user’s body and the perceived experience. Considering Benyon’s assertions, it can be said that there is a close relationship between the user’s body and space, terms that in the formation of experience influence each other. Mallgrave states: “We are organisms-within-environments that continually evolve and self-organize, and it is this dynamic field of relationships between mind, body, and matter that configures our pre-cognitive and cognitive understanding of the world, rather than some static extraction of our presumed human nature” (Mallgrave, 2015, p. 13. Translated by the authors).

The authors and the examples put the attention to the importance of experience design and the interaction between the body and space, whether digital bodies, transparent bodies, physical spaces or virtual spaces. Around this concept, Morganti and Riva’s (2006) study of spatial presence in virtual realities is interesting. If for Maldonado perception and bodily physicality constitute an indispensable element for the formation of experience, the authors emphasize how being in a place can be fostered by the nature of the action being performed.

We can assume that the sensory perceptual depletion resulting from the simulated world can assume a minimally interfering role in the acquisition of knowledge. We can further understand how, if the actions allowed will be sufficiently fluid and consistent with those possible in the non-simulated world, VR will not constitute a higher level of complexity in information processing such as to necessitate cognitive overload. It will therefore become important to design virtual environments not only technologically

advanced and able to improve the correspondence between VR simulation and external reality, but also a functional design able to allow a large degree of action in the same spaces (Morganti, Riva, 2006, pp. 99-100. Translated by the authors).

In actions, therefore, the authors recognize the key point for learning and experiential growth of the individual, no longer considering the perceptual limit as an interference of the learning process. Moreover, as Melacca and Invitto (2019) remind us, the actions performed in the simulated environment take place within a framework of meanings proper to the user's culture, that is, they respond to the human tendency to explain situations never experienced before through additional information coming from their cultural experience. This leads to consider the simulated realities themselves as constitutive of original experiences and reworked by the user and not as separate and arid moments.

In conclusion, it is possible to report this Maldonado's last statement, considered particularly relevant to the concepts outlined so far: "Are virtual realities experiences? I would not hesitate to answer affirmatively" (Maldonado, 1992, p. 42. Translated by the authors).

Conclusions: Design for Places of Experiences

If Maldonado proves to be, implicitly or explicitly, critical of digital technologies and their relationship with the body, it is important to contextualize not only the reading of his thought in time but above all to place doubts or certainties in the design sphere.

From the Canon of Polykleitos to Leonardo's Vitruvian Man, from Vitruvius' *De Architectura* to the Modulor (Le Corbusier, 1948), from the body techniques to the body-object (Foucault, 1975), from the prosthetic body (Maldonado, 1997) to the augmented body (Arduini, 2020), from the virtual body (Caronia, 1996) to the digital self (Granelli, 2006), from the transparent body (Maldonado, 1997; Floridi, 2017) to the shared body (Floridi, 2017), the concepts of body and corpo-

reality have always been, and particularly during the last decades, a place of exchange between different scientific knowledge and design disciplines. As Riccini (2015) reminds us, while reflecting on the relationship between body and space has always emerged in architectural thought, starting from the symbolic link to the synaesthetic body/building relationship, the link between body and design has only recently emerged – brought to light by Norman's (1990) critique – despite the fact that it is precisely design products that interact with the body directly, actively and reciprocally. The author continues:

As we have seen, the culture of the body in design is grafted onto some pre-existing traditions, such as architecture, fashion, avant-garde arts, including dance and theater, and the organization of work (factory and domestic). From these, design borrows a series of specific tools for the analysis of the body, through an elaboration that becomes more autonomous, since the design is constituted not only as a profession but as a discipline, with its own theories and design methodologies. Although this has always been true, only recently has the link between body and design finally emerged as essential, autonomous and qualifying through the idea of interaction between artifact and user (Riccini, 2015, p. 21. Translated by the authors).

Interaction design, one of the main expressions of contemporary design, exponentially expands the relationship between artifact and user, coming to involve different disciplines on the one hand because of the need, during the design process, to place side by side its own methods and knowledge with those of neuroscience, sociology, anthropology, cognitive and behavioral psychology, form psychology, marketing, and engineering, on the other hand, because it now invests different design scales.

In this sense, with this contribution, recognizing the multitude of possible bodies and usable spaces – physical, digital, conceptual, information, mixed – we look at spaces not as an architectural phenomenon but as environments, social and technological, of relationships

between people, between people and objects, between objects and the environment, between the environment and people. Space is not a conceptual abstraction but an embodied practice that is primarily constituted through emotional and multisensory experience. Mallgrave argues:

From this perspective, the organism and the environment are complementary and reciprocal in their relationship and perception is an active extraction of invariants or configurations that always involves the perception of the self. It is thus psychology of embodied realism in which the cultural environment cannot be separated from the natural environment, as if there were a world of mental products distinct from the world of material products (Mallgrave, 2015, p. 12. Translated by the authors).

Therefore, we align ourselves to a spatial vision of interaction design so of user experience. In this sense, as Benyon says: “Thinking spatially makes us think about layout, topology, density, direction, and distance. The idea is not to use space as a metaphor for what goes on in HCI, ID, and UX; it is to bring concepts of spatiality and of people being in spaces to understand the design of user experience from a different perspective” (Benyon, 2014, p. 27).

With this in mind, Benyon, while considering and acknowledging the importance of micro-interaction design, emphasizes the importance of a broader aspect to consider: the user experience. Extending the concept of UX from the digital to the diffuse dimension of the environments that humans inhabit through devices, in time and in physical spaces, allows us to see beyond interaction as a cognitive activity and achievement of tasks but to focus on how people are connected with the world, create meanings and feel feelings. It puts the focus of interaction design on users’ encounters with technologies in their environment to make places of experience whereby: “it will make no sense to talk about emotions, or the sense of presence as something separate from our embodied experience of being in the world” (Benyon, 2014, p. 98).

Inhabited spaces are now more or less mixed and vary in correspondences between the physical and the digital. To date, although the points of contact between physical and digital are largely visible, the design actions, that lead to their definition, are not yet outlined with a specific methodology, which can lead to the creation of a hybrid context where the distinction between the two becomes less and less clear. The tendency is to move towards a configuration of mixed spaces where the physical and the digital are configured as a continuum in which the environment becomes an interface. In this sense, interaction design welcomes another design field that deals with users' experiences in movement between different environments and, therefore, with multimodal interactions between shared bodies and physical spaces, real bodies and digital spaces, transparent bodies and mixed spaces, and so on. The designer now becomes essential to translate the multiplicity and multidisciplinary nature of this design field, where the project itself becomes the opportunity to shape the subsequent enrichment or impoverishment of the user experience.

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Semiotics of the Virtual in Design

Camelia Chivăran, Roberto Cognoli, Alessandro Ianniello

Introduction

In the contemporary context, the virtual dimension is gaining an increasingly significant role as tool for sharing knowledge and for the construction of an augmented experience by integrating new perceptual stimuli. Such potential and opportunities are having an impact on different disciplines and sectors, influencing the ways how an architecture, a product, and a system are designed and used. The project can no longer be conceived considering only its physical dimension. It has in fact become necessary to integrate the virtual dimension in order to allow on the one hand to represent and thoroughly visualise all the phases of the process, and, on the other hand, to facilitate the users' interactions or the communication with the potential clients. Additionally, tools of virtual and augmented reality enable the experimentation of spaces and products in an immersive way, before being physically constructed (Riva, Gaggioli, 2019). Therefore, the virtual dimension becomes a tool that favours interaction with the reality (Bur-

dick et al., 2014), being one of the layers that constitutes it, and where interactions that might impact it take place.

Over time, the meaning of virtual has gone through several transformations, from *virtual-actual* to *virtual-illusory*: in the first case, the new perceptual stimuli are thought to expand knowledge, while in the second case, the non-perception becomes stimulus for new knowledge. In this regard, during the last sixty years, different meanings have been given to the concept of virtual: Gilles Deleuze (1988) defines it as potentiality which is realised in the present and which, although not material, is real. In the same direction, Pierre Lévy (1998) claims that the virtual is not opposed to the real, but to the concept of presence.

A different direction is that of Berthier (2004), who indicates the virtual as something that is not real, but which has all the qualities to be considered as such, thus claiming the existence of the possibility to perceive what is virtual; Massumi (2014) sees the virtual as a complementary abstraction to the concept of actuality. Recently, Bailenson (2018) reconnects to the concept of illusory, claiming that a virtual system creates in the user the illusion of being situated in a space where one can interact with objects and agents situated within.

The contrast, or the closeness, between these two concepts represents an important stimulus for the semiotic, sense and meaning research which, in turn, represents one of the constituent elements of the apparatus underlying the design disciplines (Zingale, 2012).

To approach this topic, the paper is structured into four sections, namely dealing with Maldonado's vision regarding the semiotic problem around the real and the virtual; a review of the issue from a contemporary point of view; an examination of several useful examples to put the state of the art of the topic into context; and, finally, the conclusion reporting on issues that remain open and unsolved.

Binomials in Maldonado's View of the Virtual

Maldonado fits into this debate by stating that he considers the virtual as an illusion, and thus adheres to the line of thought that sees a strong antagonism between the two terms.

One can notice how, in his own works, Maldonado deals with the topic by introducing several binomials, strongly connected with one another, that take into account the various relevant aspects: he talks about the concepts of *navigation and immersion*, *similarity and simulation*, *representation and communication* and, finally, *creativity and knowledge*.

In the following subsections, the different binomials will be analysed, providing a first reinterpretation updated to the contemporary context.

Navigation and immersion

Maldonado states that the perceptual behaviour of the individual in front of a figurative image reminds of the typical motion during navigation, as a continuous flow of movements between surface and depth, through different calls for the observer's attention and curiosity (Maldonado, 1992). Delving into the topic of navigation in a virtual space, Maldonado compares the representation made with the support of traditional techniques, to the computer simulation of a virtual environment. He actually claims that in the first case navigation is certainly virtual, since it is subjective and mental, while in the second case navigation loses virtuality, since the observer gets the feeling of (almost) actual navigation in an (almost) real space. Specifically, in the case of a computer-modelled space, the user has the illusion of being an industrious actor within a space, without realising that this is a space where degrees of freedom are very limited, a space where he can only operate, so to speak, under conditions of probation. Therefore, according to the author, the distinction between strong virtuality of

the digital space and weak virtuality of the analogical space should be re-examined (Maldonado, 1992).

Although at the time of writing *Reale e Virtuale* the author's statement was not only true but extremely far-sighted, a series of subsequent transformations and technological innovations, illustrated in the following paragraphs, have led to a further reversal of the dichotomy. A strong virtuality includes more immersive navigation in spatial terms and not in temporal terms: the temporal connotation is instead assigned by Maldonado to weak virtuality.

In fact, with reference to the concept of immersion, Maldonado argues for the usefulness of understanding the temporal aspect of experience within a synthetic space, i.e., the possibility of immersing a subject in a virtual construct, leaving him locked in it forever, only exists in science fiction. Therefore, he claims that the actual time duration of immersion in virtual space must necessarily be limited, and it should be followed by resurfacing, i.e., the return to physical reality. One should be free to abandon virtual reality, to voluntarily interrupt the experience (Maldonado, 1992). Nowadays, such a concept is still applicable, despite the tendency of increasing the time length of immersion and, especially, by engaging the various senses in the process, expanding it from a spatial and experiential viewpoint.

Similarity and simulation

Maldonado introduces the concepts of similarity and simulation in relation to the project, underlining the need of the commissioner since the Renaissance period to see in advance the development of the building he wanted to realise. Referring to the virtual as a synonym for the *illusory*, the author highlights the need for people to illusorily decorate the world, to generate illusions and believe (or make believe) that they are real. The concept is thoroughly analysed with reference to the differences between the perception of a highly realistic virtual object and the perception of the same object in the real world, with the intention to understand the degree of reliability from a cognitive point

of view, and to analyse, therefore, the *adequate simulation* between a virtual and a real object. From this perspective, also the prototype of a product can be more or less similar to the product to be realised, expressing different intensities of modelling. To this effect, Maldonado also highlights the need to take into consideration the context of study, i.e., “lo spazio della vita” (*life space*) that provides insights regarding the interrelations between objects, spaces and people (Maldonado, 1992).

One can notice how the current systems tend to transport the observer into a *parallel* space and to transform such space of a *virtual* project into a second reality. Thinking about the preview of any architectural or design project, the current systems enable the user to step inside the project space, to feel *present*, therefore to transform it into a true, personal, parallel reality. Nowadays exploration becomes the first form of interaction inside a virtual environment (Riva, Gaggioli, 2019).

Thus, the concept of presence gains a fundamental role: a virtual environment is performant based on how much it can make people feel present; presence represents, therefore, the subjective degree of how a person perceives being physically and mentally present inside a simulation (Riva, Gaggioli, 2019). For the design of a virtual reality system, it will therefore be necessary to analyse the role of the perceptual, cognitive and emotive processes engaged in the experience (Riva, Gaggioli, 2019): the more the model generated by virtual reality is similar to the brain model, the more the individual feels present in the world of virtual reality (Riva et al., 2019).

Representation and communication

Maldonado wonders about the ways of discovery, invention or explanation enabled and made possible by representation: from the author’s viewpoint, the architect is born as a visualizer. It becomes therefore compulsory to understand how to represent ideas, concepts, projects, in order to communicate them efficiently to the customer

and to the final user. The author thus defines models and mock-ups as tools and, in a way, communicative interfaces, acting as pre-realisation, visualisation elements, thus facilitating dialogue between designers and clients. A particularly interesting element in Maldonado's writings is the *drawing*, that he sees as a *drawing-project*, i.e. *a spontaneous and intuitive exercise on a specific problem to be solved, an object of the project* and a *project tool*: if the previously named elements have an explanatory and communicative function, the *drawing-project* becomes a tool for discovery (*a problem to solve, an object of the project*), and at the same time, a tool for invention (*spontaneous and intuitive exercise, project tool*).

For Maldonado, the revolution in information technology has helped to open up new perspectives for modelling, both in its *design and communication functions*, giving professionals access to the tools, methods and functions of traditional modelling and increasing its effectiveness (Maldonado, 1992).

The contemporary interfaces and specifically the innovative ones, enable a series of design and meta-design opportunities, starting from the representation techniques until the simultaneous exploration of the material behaviour and of the production limits.

Creativity and knowledge

Maldonado claims the existence of a connection between the evolution of the creative practices of representation and the one of the production techniques, each of which has generated a different response to our innate need for virtual (Maldonado, 1992).

He participates in the debate on the concepts of invention, iconism and referentiality, questioning whether it is justifiable to consider the icon as reasoning in the logical sense, or whether it is correct to assume that it can take on the character of a true declarative propositional form. He states that when it represents an object through inanimate means, it constitutes a configuration with a high degree of

systemic compactness, emphasising homogeneity between the constituent parts (Maldonado, 1992).

He also acknowledges that we do not yet know what surprises the development of thought technologies combined with the most advanced technologies of perception, such as computer graphics, may bring us (Maldonado, 1992).

Referring to this issue seen in a contemporary perspective, one can notice how the *extended realities*, one of the most innovative elements of the virtual, offer the opportunity of imagining and building new meanings, often outside the traditional semiotics sphere and mechanisms.

Contemporary Vision

As previously stated, during the last period, a growing innovation drive in several technological areas has opened up new and unexplored opportunities which in turn have led to a change of perspective in the real-virtual issue. One could therefore state that in the strong virtuality, the navigation becomes more immersive in spatial and not temporal terms, a feature that Maldonado assigns to weak virtuality.

Consequently, a process of *spatial exploration* of the models themselves becomes accessible, through a progressive approach and magnification of the element under consideration, and investigating its *micro* aspects, without losing a *macro* point of view.

Furthermore, the current systems allow us to simulate spaces and environments in a parallel reality, transporting the observer into a space that enables him to actually feel present. Presence becomes in fact one of the most important characteristics for the authenticity of experiences within realities beyond the exclusively physical one.

The strong virtuality has acquired a representative and communicative dimension similar to the one of weak virtuality: one can therefore talk about *virtual-project*, intended as Maldonado's *drawing-project*.

The design opportunities provided by the *extended realities* (Skarbez, 2021) enable designers to imagine and build new meanings, often

outside the traditional semiotics spheres and mechanisms. They allow therefore to go beyond the concept of referentiality and iconism, since they are not traditional media (theatre, cinema, television, social media), instead they involve a different level of user engagement.

As the traditional media have stimulated the semiotics debate, the extended realities are shifting the focus to the creation of new or different senses and meanings, generated by or attributable to elements which are not normally considered in the traditional view. These not only act as representations and simulations of the physical reality, but they are also capable to deconstruct the sensory, perceptual paradigms and therefore the creative and imaginative ones, that all exist in the physical world (Wellner, 2018): digitalization and virtualization are not supposed to be seen exclusively as technical means, instead they refer to the ways through which one gets closer or farther from a representation (Wolfe, 2010). One can speak, in post phenomenological terms (Ihde, 2009), of technological mediation in the examination of human experience.

In this regard, one can define a perceptual enhancement through technology, which thus makes it possible to experience what would not be so without its integration; and a shift in perception by means of instruments, relating to the hermeneutic aspects of experience (Wellner, 2018).

One can state that human actors and technologies (digital, virtual, extended, and immersive) interact and share cognitive capacities inside the *cognisphere*, defined as a complex and interconnected system where human actors and technological actors coexist (Hayles, 2006).

After examining the theoretical issue from a historical and contemporary point of view, several questions were identified which we sought to answer through an analysis of examples of interest (as presented in the next section). Resuming a question posed by Maldonado himself in *Reale e Virtuale*, one wonders about *the future of modelling caused by the information technology revolution*, and in relation to this: *how do virtual tools influence contemporary design practice?*

Taking into consideration the definition of virtual, its future developments and its knowledge and experiential value, a further question raising particular interest, but also a more complex one and, therefore, subject to different possible interpretations, is the following: which definition (virtual-actual or virtual-illusory) is the most adequate?

The Virtual in the Project

The dimension of the project is virtual by definition, as a place where ideas which are not yet concrete can be foreshadowed. The individual has always used mediums and interfaces to visualise and understand representations of the virtual (project - prefiguration) in the real.

If, once, intuition and experience were the only available tools, in the course of history the individual has constantly searched for new means in order to be able to represent and make real increasingly complex ideas. The perspective and the passage to the digital drawing are two crucial moments of this searching process. What makes the relationship between project and representation interesting is certainly the relationship between different media.

The use of the virtual dimension in the various facets of the project becomes a potential strength since it can increase the levels of information about space, about the product and about the system, enabling to preview elements that once could only be imagined. It contributes to rendering the entire process more efficient, and it allows in some cases to increase safety, to optimise the flows of pre-production and to envisage the functionalities and ergonomic qualities of the products (Riva, Gaggioli, 2019).

One wonders, therefore, how the cognitive and experiential dimension of the project will be affected, when physical and digital reality will be mixed and mutually interactive.

In order to answer this question, a number of examples have been considered, categorised into project tools, software and platforms, some of which will be reported and described below.

Project tools

Besides providing a higher level of simulation and a major realism to the virtual experiences, the current project tools have the potential to provide tactile properties to elements that do not normally have them, provoking synesthetic effects.

Due to these innovations, it is possible to give humanity back to the operations of 3D modelling and provide three dimensional gestures to traditional tools. The current dimension goes beyond the analogical, trying to immerse the user in the project, increasing the awareness and enhancing the production. The concept of *virtual* often departs from Maldonado's *illusory* where digital elements contribute to the construction of physical reality, or at least of a hybrid between the physical and digital dimensions.

In particular, in support of these theses, the example is given of a pen for modelling and drawing in virtual environments (Figure 40), produced by the company Massless as of 2017: due to this tool, designers can carry out increased and ergonomic activities from a three-dimensional point of view; immerse themselves in the various technical, formal and usage aspects; allow a sensory and perceptive amplification that enables them to experience the project in new ways (Massless, 2020).



Figure 1 VR Design Pen, Massless

Project software

Recent applications in programming and software are making it possible to design free of rationalisation schemes that can, to some extent, influence design choices, thus allowing the design to be subject to a few different constraints than more traditional practices.

The role of drawing as the sole means for achieving the design goal, as stated in one of the preceding paragraphs, is therefore no longer indispensable. The dimension of the project succeeds, in a sustainable manner, in recovering the scale of reality of the 1:1 prototype.

To support this statement, the example of the Fologram app and plugin is given (Figure 41). Produced by the company of the same name, it allows designers to build an interface with a hybrid, phygital dimension, in which the virtual becomes a new layer of reality, containing a series of peculiar and unique information, structures and tools (Fologram, 2022).



Figure 2 Mixed Reality App and Plugin for Design and Construction, Fologram

Project platforms

The virtual dimension enables designers to exchange information in real time, through the use of specific digital platforms. In this way, a multidisciplinary process is facilitated, a process of integration and sharing of knowledge, supported by the mixing of the two dimensions considered.

Here too virtuality moves away from Maldonado's *illusory* concept, becoming a constituent part of reality. It can be stated that the project moves into a shared, virtual and accessible space, where several players contribute to the creation of a *computer model*, which is no longer representation, but reality in which it is possible to verify every design choice.

As for the previous categories, one of the analysed case studies is shown to highlight the stated aspects: the 3D Experience platform, designed by Dassault Systèmes (2022), an actual project ecosystem, within which it is possible to access modelling, simulation, information, and applications for collaboration (Figure 42).

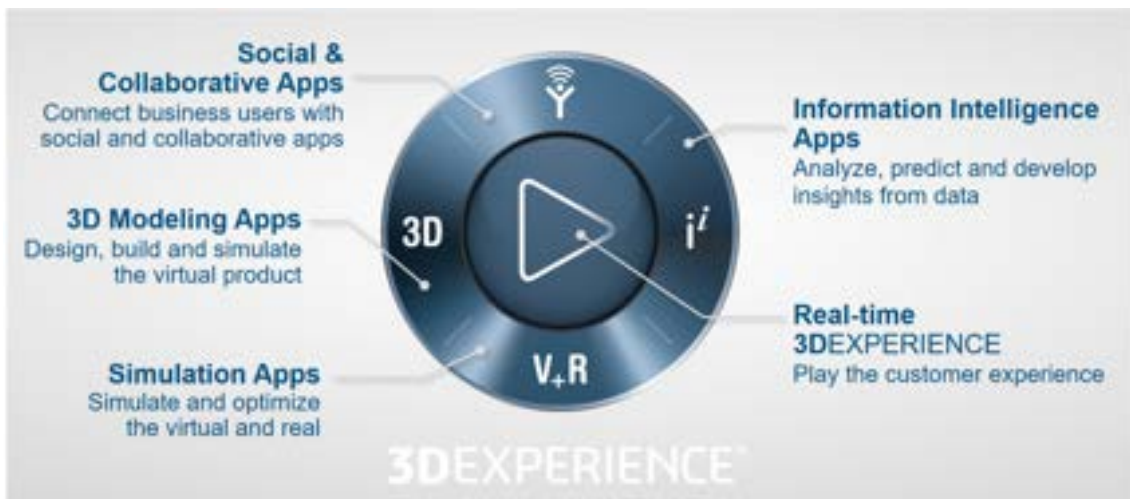


Figure 42 3D Experience, Collaborative Design Platform, Dessault Systèmes

Conclusion

The analysis and reinterpretation of the concepts of real and virtual, both in Maldonado's work and in the thinking of other researchers and academics, leading to practical and design applications, stimulate various reflections on the subject. As reflected in Maldonadian thinking, the continuous evolution of the technologies and the numerous applications in the project suggest that *we do not know yet, or we do not know enough, how the design creativity will be able to develop in the context of this new modelling universe* (Maldonado, 1992). Not only in the modelling field but in all aspects of the project, the influence of the virtual is generating a series of relevant transformations.

In this regard, it is interesting to consider *mixed reality*, the latest frontier of technological innovation in the area of the *continuum* between real and virtual: it allows a deep blending of real and virtual space, permitting the interaction, in real time, between physical and digital elements and a consequent transformation of the latter ones according to specific requests or actions. The question arises, therefore, of how the cognitive and experiential dimension of the project will be affected when physical and digital reality are mixed and mutually interactive.

As demonstrated by the different case studies, the virtual becomes a new tool, a new interface and design platform, it goes beyond two-dimensionality into a shared three-dimensional space, where there are interactions with the real.

Not only does it have the same characteristics as a *drawing-project*, but it evolves them in a new and peculiar way.

The contribution concludes with an open question, which can serve as a stimulus for further research and investigation: what is the future of the virtual and how can its cognitive and experiential dimension be defined in relation to the practice of design?

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Designing with(in) Open Materiality

Crafting the Intangible to Manage the Real

Andrea Cattabriga, Maria Claudia Coppola, Antonello Garaguso, Manuel Scortichini

Design, Technologies and Power Structures

Today we live in hybrid ecosystems where the organic and the artificial co-evolve, the engineered and the synthetic are entangled in human-machine ecologies organized as cognitive assemblages (Hayles, 2020). Design has been deeply intertwined with digital technologies for over two decades, leading to the establishment of new relations and organizational structures which have eventually established new forms of power. As a result, questioning the relationship between digital technologies, their underlying power structures and design became soon an urgent matter of concern for design researchers and practitioners. The technologies that today dominate our daily lives work in closed and inscrutable environments, hiding the variables and the logic of nested and dislocated processes – also physically – beyond the reach of even those involved in their development. Designers today should be aware of the consequences of the gap that emerges between what is designed and what is generated by the interaction between

data and algorithms – as well as how, by whom, with what impacts, rules and datasets.

Today digital technologies are entering human systems fragmenting big powers in decentralized micro-powers (Naím, 2014), leading to the crisis of current political systems, democracy included. Algorithms, in fact, sneak into everyday life, enacting change in decision-making processes, which move far from any corporate or state view. By sorting, filtering, searching, prioritising, recommending, and deciding, the social power of algorithms (Beer, 2017) mediates how reality is experienced. Thus, cognitive assemblages gain social status since humans, artefacts, data and algorithms become altogether part of new social assemblages (Bennett, 2010; Kamalipour, Peimani, 2015). As a result, algorithms are becoming the new means of production of the XXI century. Therefore, the need to better understand and manage them proves to be more relevant according to the pervasive impact in democratic systems (Vespignani, Rijtano, 2019) exacerbating the struggle for authority and power through the spread of territorial and individual surveillance (Zuboff, 2015). For instance, technologies like end-to-end encryption have by design rewritten the rules on human rights, since its use creates channels that are less accessible to states, corporations, or other individuals, and throws up new dilemmas around power and policing, as for the San Bernardino's case.¹ As political and social participation seems to be defined even through technology, new challenges arise about how humans may exercise and recognize power in a world filled with algorithms (Krasodomski-Jones, 2021).

Seizing the urgency of these matters to designers, public authorities and private actors, design culture had already anticipated some of the questions concerning precisely the political aspect emerging from the

1 Reference is made to the court case between Apple inc, the Federal Bureau of Investigation and the DOJ (U.S. Department of Justice), generated by the request to unlock an Iphone 5C used by one of the killers of the San Bernardino's massacre in California in December 2015. The bomber's phone was recovered intact, but was reportedly locked. Apple Inc. gave various technical and legal reasons for refusing to allow the creation of software that would have made it possible to bypass the security systems of their devices. Thereafter, the FBI managed to hack the iPhone 5c used by Syed Rizwan Farook through private agencies.

digital paradigm. In 1997² Tomás Maldonado already showed his concerns about the promises and pitfalls of digital technologies, which would have needed social values and meanings as constraints to avoid mere technological solutionism. In fact, it seemed that the potential of new technologies and their narrative, enhanced by market needs, was going to envelop everyday life with a charming coat driving us to assign a thaumaturgical role to technologies (Maldonado, 1997). Moreover, the question gets a further level of complexity if we consider what Maldonado defined as a “flagrant contradiction” within which design struggles between the “relatively mature” technologies available to the society³ and the “absolutely immature” decision-making centers of power in our society (Maldonado, 1970). While digital technologies shape social transformation at an exponential pace, political structures fall behind suffering from Runciman’s “technological takeover” (2018), recalling what Maldonado (1997) already discussed as the “false democratic promise” posed by information and communication technologies (ICTs). In fact, even though ICTs would have soon become widely available, Maldonado pointed out how the democratization of technological means could not imply their inherent democratic status. Similarly, today algorithms take part in social assemblages, producing new kinds of knowledge and culture (Beer, 2017), but their logic is elusive, so unpacking black boxes underpinning algorithms is becoming the most effective strategy to understand them as powerful tools for human wealth and development.

Such premises help us in introducing the main aim of this article, which intends to offer an overview about the power dynamics intrinsic or emerging from digital technologies, focusing on their consequences for design researchers and practitioners. As artificial intelligence technologies (AI) prove to be essential tools to address the

2 The first Google domain was registered in 1998, just a year before the publication of Tomás Maldonado’s reflections on the impact of computer technologies, in the book *Critica della ragione informatica*.

3 It is relevant to notice that Maldonado wrote his most influential book *La speranza progettuale* in 1970, a year after the first Apollo moon landing, which marked history as a technological and political showdown by the United States.

volatile indeterminacy of contemporary issues, designers might need to engage with the political impact of their proposals to contribute to cultural solutions and counter-bureaucratic approaches to social dilemmas (Maldonado, 1970; 2010). Here, Maldonado's warning sounds clearer than ever: the issue related to the interplay between design, understood as an autonomous practice, and technology, an all-encompassing and impersonal infrastructure, is not technical, but inherently political. Therefore, the core of Maldonado's thought can be found in the political responsibility of design, which embodies the most valuable legacy for future designers to better handle the challenges posed by current digital artifacts.

Algorithms, Biases and Infrastructures

Immersed in AI networks constantly learning from each other, social assemblages dwell in a physical world bound to an algorithmic megastructure. The "stack", as described by Bratton (2016), is an accidental and planetary superstructure that transcends traditional authorities by working at six interdependent layers with computational power: earth, cloud, city, address, interface and user. By exerting forms of power on different scales, it is remaking the political world order in its own image, leading to new forms of governance (Costanza-Chock, 2018). Algorithms are shaping human environments and affecting human behavior, producing immaterial and material effects which designers could no longer ignore. From one hand, algorithms practice a form of soft power in everyday life: bypassing geographical and political boundaries, AI performs data extraction globally, producing "algorithmic knowledge" which impacts on psychological and cognitive modes of action.⁴ On the other hand, AI is also made of a material component (Dourish, 2017), providing them with the essential structure to work properly: this is related to a form of material

⁴ Pattern recognition and remediation are at the foundation of alluring filter bubbles and dangerous deep fakes, which highly affect modes of social interaction, cognitive abilities and the perception of trust.

extraction (Crawford, Joler, 2019), responsible for political and environmental impacts in under-developed countries.⁵

Digital technologies and their application shape the human world, changing it from the core: if planetary computation (Bratton, 2015) gives us the possibility to gain new knowledge in a very short time through data elaboration, it is relevant to note that we are dealing with biased knowledge. Here, reference is made to biases (Willson, 2017) as the consequences of uncontrolled correlations and incompleteness of data sets which will inevitably lead to flawed knowledge and, thus, to serious implications. During the last decade a growing critique fueled the debate about the reproduction of race, class, and gender inequality through biased machine learning and AI decision-making processes (O’Neal, 2016; Buolamwini, Gebru, 2018; Crawford, Joler, 2019; Eubank, 2018). Thanks to these studies it appears clear that power structures emerging from biased outputs are caught in a reinforcement cycle. This means that algorithmic decision-making processes and outputs establish the power structures coming from the dominant culture, which ends up transmitting its own distortions to the algorithms it designs. As a result, algorithms are oriented towards the reproduction of the “One World” ontology, a world shaped to bend many cultures into “one underlying reality” (Escobar, 2018).

A clear example of the impacts of algorithmic biased knowledge comes from exploring how AI systems might deliver discrimination if trained with incomplete data. Buolamwini and Gebru’s work (2018) highlights how shallow datasets, labeled by ethnicity, impact on gender classification accuracy in matters of subject recognition. Several corporations took part in the test, equipping AI with incomplete datasets, performing a failure in face detecting darker-skinned subjects compared to lighter-skinned ones. Gender shades focuses on gender classification specifically applied to general subject identification. However, machine learning techniques to determine gender

5 Rare mineral resources extraction and the energetic demand of computational power plants make an outstanding example for the impact of algorithms on the biosphere.

are broadly applied to many other areas, like law enforcement and airports (Eubank, 2018; O’Neal, 2016), where algorithmic design might affirm or deny a person’s identity through labelled datasets. It seems clear that automated systems are not inherently neutral: they end up mirroring the flaws in poorly managed datasets, autonomously reiterated in distorted feedback loops (Gitelman, 2013). This is easily found in *Weapons of Math Destruction* (O’Neil, 2016), which showcases the social impact of biased AI: from correlations between urban areas, crime rates and social relationships exposing subjects to the risk of being arrested, to medium-calculations and projections affecting the ranking of American universities, causing tuition fees to rise by over 500% in less than a decade.

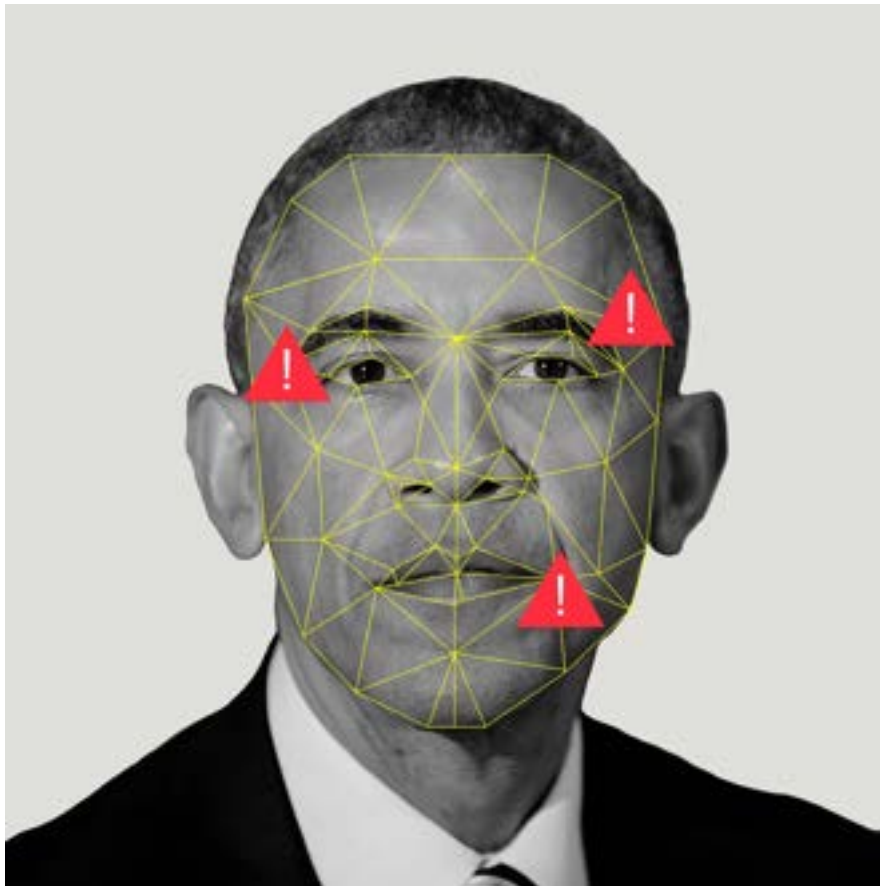


Figure 1. Deepfake programs pull in lots of images drawn from facial recognition datasets. Alyssa Foote. Photo by: Olivier Douliery/Getty Images.

Algorithms outputs impact political and social values, revealing the lack of nuance or contextual understanding that such processes often do not accommodate, in fact:

As an instrument of knowledge, machine learning is composed of an object to be observed – training dataset – an instrument of observation – learning algorithm – and a final representation – statistical model. The assemblage of these three elements is proposed here as a spurious and baroque diagram of machine learning [...] the information flow of machine learning is like a light beam that is projected by the training data, compressed by the algorithm and diffracted towards the world by the lens of the statistical model. (Pasquinelli, Joler, 2021, p. 1265).

In this sense, AI is not open to outside inquiry, in a way that, as Willson (2017) puts it, “only its products or outputs can be addressed”. As a result, AI suffers from the black box effect: even though it is “an actual issue of deep neural networks [... as they] filter information so much that their chain of reasoning cannot be reversed” (Pasquinelli, Joler, 2021), it is also the natural status of any experimental machine at the early stage of development. By not falling for the black box rhetoric, it is possible to counter conspiracy narratives and see AI through the lens of critical understanding. Here, the work from Crawford and Joler (2018) helps us open the black box, by mapping an “Anatomy of an AI” with its hidden layers of human labor, data and planetary resources. Taking the home assistant Amazon Echo as an example of black box, the large-scale map reconstructs its design and the relations of each component with planetary ecology and economy. Despite the aspect of a plain domestic tool, authors argue how common knowledge about those hidden structures is limited: these aspects respond to extensive data and material extraction processes, whose costs are not calculable. In this sense, “Anatomy of an AI” is, indeed, a relevant contribution, raising awareness on a hardly problematic matter through design means.

These case studies pose urgent challenges for researchers, who are trying to understand algorithms and their ways to affect the everyday. This is relevant to designers themselves, who might open spaces of negotiation to fuel debate around the impacts of digital technologies, understood not only as mere tools, but as a global phenomenon shaping new ways of living. One of the most urgent challenges may be embodied by the need to manage unavoidable biases when the origin, outcomes, instructions and implementation of algorithms are not open to scrutiny. Addressing such issue will require further interdisciplinary efforts, since, as Willson (2017) discusses, the issue doesn't lie only "in the proprietary nature of many algorithms, their multiplicity and complexity, [...] but also in the requirement for technical knowledge or literacy that many people lack when dealing with often complex mathematical and technical systems".

Open Materiality and Design Responsibility

Arguments built so far help us understand how crucial it is to dispose of theoretical and practical means to handle algorithms and their concerning opacity, to the point that researchers and designers are working at "new ways to make algorithmic processes visible, to render algorithms accountable, and to find within the algorithmic process some opportunity for external review and examination" (Pasquale, 2015). In fact, the growing complexity of datasets made algorithms turn from procedures which deliver predictable results to entities capable of producing unknowns (Dourish, 2017): "more accurately, they produce analyses of data that are known and understood in some terms – in terms of the formal properties of the dataset, its patterns and regularities – but unknowable in other ones". In this sense, aligned with the concept of indeterminacy and unpredictability, algorithmic knowledge can no more be understood as a programmed determination of routine execution (Pasquale, 2015), but rather it is the result of a complex relationality, which is an inherent feature of the digital domain.

EXPLORING TOMÁS MALDONADO

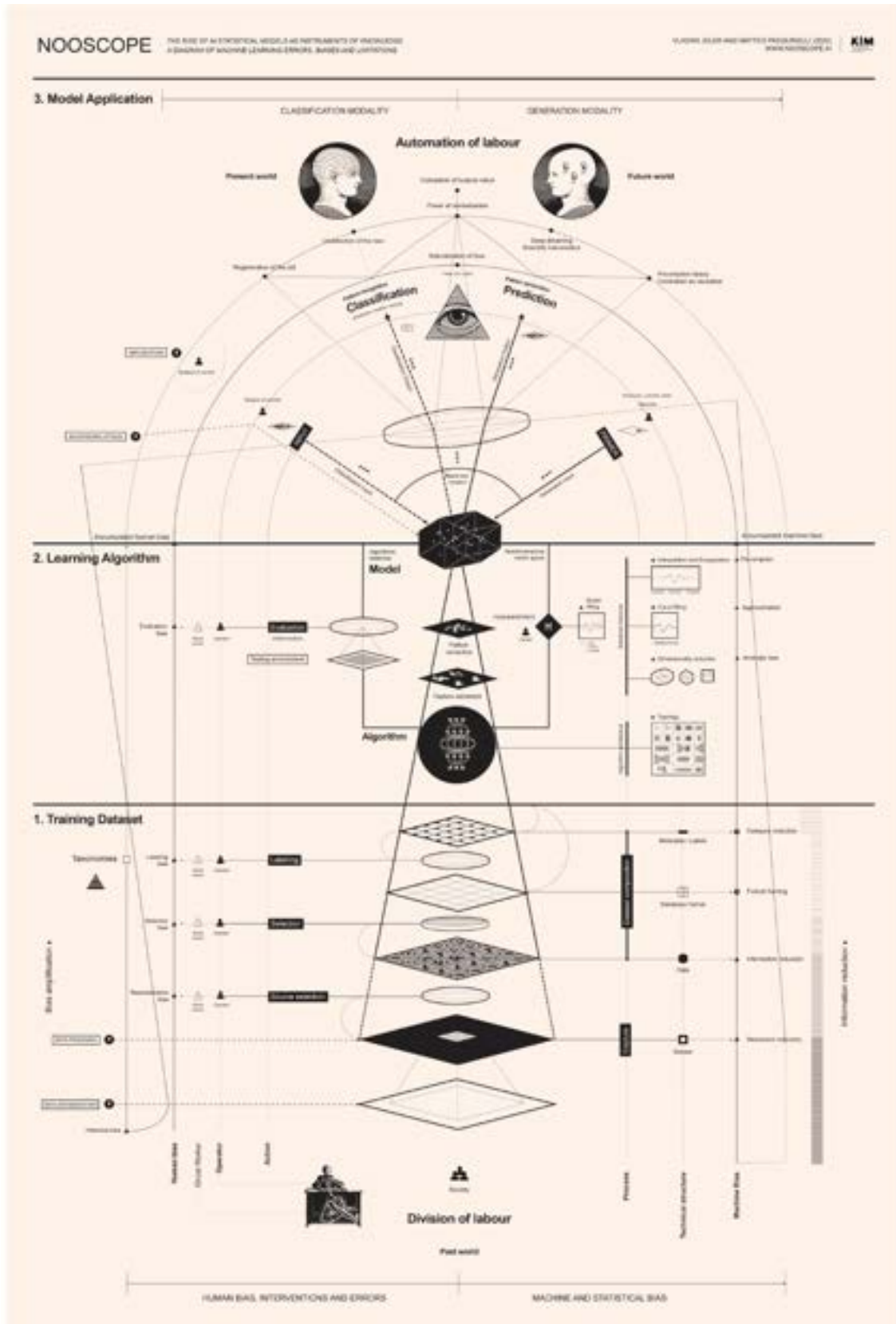


Figure 2. The Nooscope (diagram) by Matteo Pasquinelli and Vladan Joler. From: <https://nooscope.ai/>

According to Hui's (2015) analysis, the digital era is the time of "the concretisation of relations in terms of data and metadata": data, understood as the elemental digital component, could be thought of as the new material medium of operation. Moreover, even though data are experienced as the most immaterial element available to humans, they embody the main vector through which subjects in social assemblages communicate with each other. Thus relations are established through data exchange. If data need to be mediated, to be grasped by a subject, then data can be understood as relations themselves: as a result, they are both content and vector of content (Hui, 2015; Dourish, 2017). Such a framework lets us intercept its new opportunities and limitations.

The case studies presented above provide clear examples of the relationality inherent to digital materiality, capable of building new power structures: both Gender Shades and Amazon Echo help us understand how such relational material had been handled to establish certain relations, which eventually led to the definition of new forms of power. Thus, the concept of digital materiality follows the modernist concept of matter, which has been traditionally considered something to be mastered, dominated and controlled. This calls for a challenging perspective to design which, as design theorist Tony Fry (2010) puts it, "expresses power materiality in ways that shape how people interact and ontologically prefigure their material culture and economy". Drawing from the relationality inherent to the digital domain, it appears that designers deal today with materials that are not only inert tools, functional to shape structures and objects, but relational, mediating tools.

Here design, the mediator of knowledge and processes, exerts its catalyzing action to establish osmotic relations between subject-nodes, while weaving structures with(in) the fabric of digital materiality. As a result, designers will be working in new spaces made of open materialities, understood as temporal assemblages of designing intelligence and artificial intelligence, capable of sparking highly relevant knowledge and value. This strongly recalls what Maldonado (1970) discussed

about design as the most solid link between man, reality and history. Designers have historically been asked to conceive the “new material asset of society” (Maldonado, 2010), so that, today, they might need to embrace the new, digital and open materiality to make their contributions meaningful and relevant.

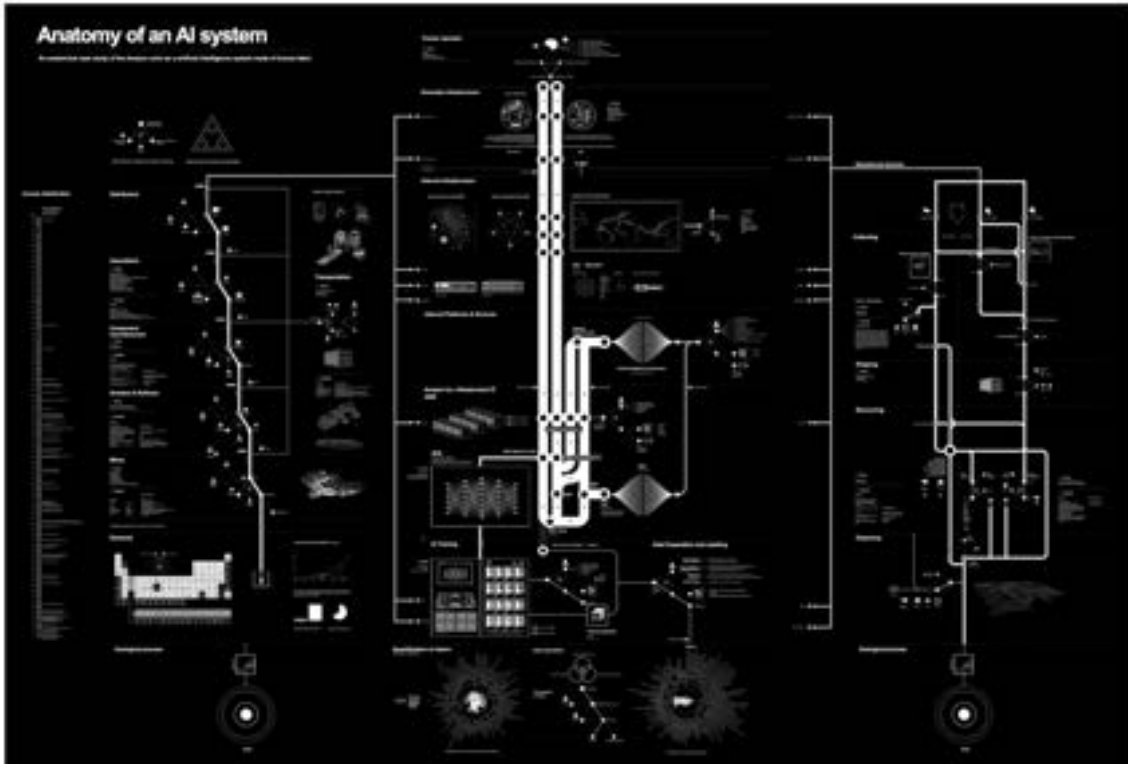


Figure 3. Visual map of Anatomy of an AI system by Kate Crawford and Vladan Joler. From: <https://anatomyof.ai/>

As Maldonado reminds us with emphasis, “interdisciplinarity and transdisciplinarity not only respond to a more urgent need of disciplinary cooperation, but most importantly to an inescapable, universal vocation to knowledge” (Translated by the authors). In a society that has a speleological approach to knowledge, it appears crucial to nurture the “third culture”, namely the one capable of building bridges between hard and soft sciences (Maldonado, 2010). In order to do this, designers might start from “thinking with materials” (Bratteteig, 2010), working with concrete abstractions of structures and processes, at different levels of concretizations as well as across them. This suggests

that designers might understand their new designing space, a place that enables them to move between different layers of abstraction and concretization for the actual design process and outcome. Again, open materiality seems to be something that needs to become embedded in design practice, to imagine and build desirable futures (Maldonado, 1970; Fry, 2010; Escobar, 2018).

So, if designers do not grasp the inevitability of working in the field of open materiality and understand it, the risk is to act without shouldering the social responsibility of design itself. In this sense, today more than ever, design is a political act.

Today, designing means revealing the power structures intrinsic to the medium itself, since they prove to be far more dangerous and impactful by producing effects that are perceptually and physically distant in both space and time. Without any interventions, this could end up in building permanent control systems inside experiences and product-service systems fed by algorithms, which co-evolve with us in a continuous present. The openness linked to this new materiality leads to the digital dimension of matter. However, it should not be interpreted as limited to the inherent relationality discussed above, since there is also an operational feature regarding the criteria linked to the accessibility of systems. If from one side, researchers and activists are contributing to the assessment of AI-based systems (Krafft, et al., 2021), design needs its own epistemology about new sociotechnical assemblages to be relevant in this space. Moreover, this could not be enough, since design could need new operational tools and models, allowing an upstream configuration, through which managing possible biases and incorporating auto-control systems. Therefore, the digital side of design needs to be open, integrated and interoperable in its relational dimension, but also accessible, inspectionable and open to a continuous adaptation to the physical context within which it is called to operate. This means making it susceptible to variations based on the needs of the local territory, community and social systems.

The responsibility of the designer is, then, inevitable in the design process. Thus, thinking from a digital perspective means addressing

several factors that ultimately affect cultural production. Maldonado (2005) warns us about how “cultural production often reflects the glaring ambivalence of information technology”, always reminding us of the essential benefits derived from technological progress. As the ability to “make” and “design” is uniquely human, Maldonado (1970) invites us to embrace the political responsibility associated with design practice, leaving behind “any celebratory enthusiasm”. Design and its inherent responsibility are experienced in the concrete projection: a dialectical process of mutual formation and conditioning that affects the human condition and the human surroundings.

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Interfaces as a Space of Interaction

Stefano Gabbatore, Barbara Pizzicato, Nicoletta Sorrentino

Introduction

Among the multitude of studies addressed by Tomás Maldonado during his long career, stands out the field of information technologies and digitization, of which Maldonado himself lived the birth and experienced as a pioneer the extraordinary progress.

He repeatedly confronted them, as an artist and teacher, considering their practical implications, but never neglecting the attempt to give a philosophical interpretation of their horizon of meaning and of the deep transformations that because of them affected the development in the Western world.

The relationship between man (be he producer, designer, user) and technology is one of the pillars of his reflections, and one of critical importance, with the second understanding not as an intangible entity and “immanent” in the world, independent of human activities; rather as a set of instruments never neutral, capable of activating, positively or not, profound changes in man and society.

Particularly significant to the subject that will be here discussed also deserves to be mentioned the system of signs that as a designer Maldonado developed in 1959 for the calculator Olivetti Elea 9003, together with his pupil Gui Bonsiepe.

Willing to compete on the international market, Olivetti decided not to translate the Italian abbreviations on the console but entrusted Maldonado with the study and development of a visual language for human-computer interaction, which could be learned by any operator, regardless of their native language.

Maldonado and Bonsiepe designed a system of logograms, corresponding to nouns, verbs and adjectives, with grammar and syntax. (Figure 1)

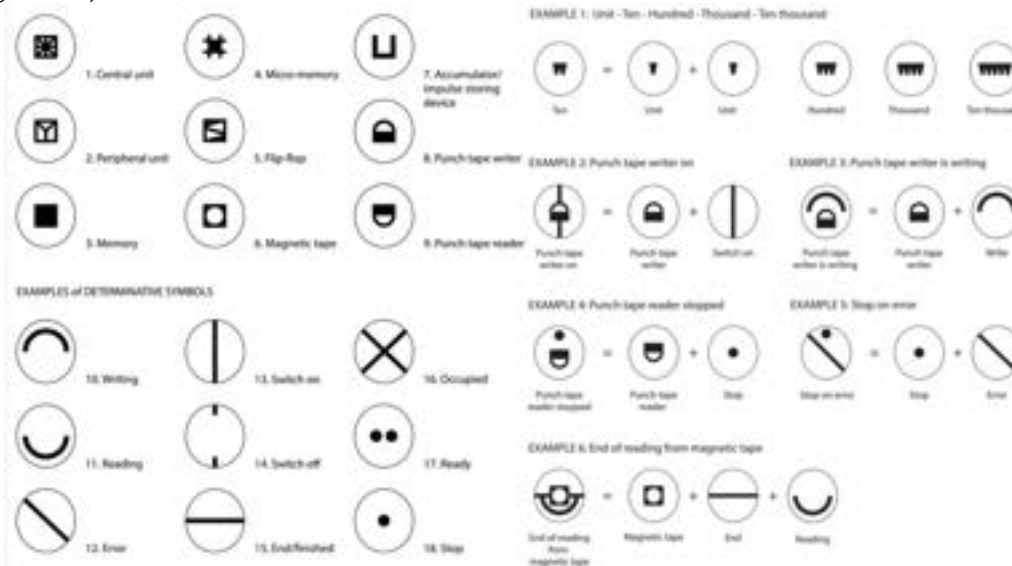


Figure 1. Symbols for the electronic calculator Olivetti Elea 9003, Tomás Maldonado and Gui Bonsiepe, 1960-61. Source: Elisabetta Mori, 2020.

In the transition from keyboard input systems to graphic systems, their work is innovative in at least two aspects, which would later become fundamental in industrial design in general: ergonomics and human-machine interaction – through the application of semiotics, psychology, cognitive sciences and theories of perception and learning – to improve the interaction between operators, engineers and computers.

Despite the sign system being never implemented, it still represents a significant contribution to the study of human-machine interaction, as well as anticipating the modern use of icons in graphical interfaces and laying the foundations of interface design, long before it was recognized as a discipline (Mori, 2020).

Therefore, moving from the theme of the relationship between humans and technology as interpreted by Maldonado, and from the inevitable mediation between them, represented by the interfaces, the reflections conducted in this essay examine several of the most recent ways of possible interaction, in the broad sense, highlighting the impressive modernity of Maldonado's thought.

Humans and Technology in Maldonado's Thought

Although specific allusions to the subject of "interfaces" are rarely found in his books, as briefly mentioned above the relationship between humans and technology is crucial to the thinking and design of Tomás Maldonado.

In his book *Critica della ragione informatica*, for instance, we find many of the critical nodes of this relationship: the risk of poor involvement, if not just the passivity of the user; the illusory freedom of access to everything and everyone through the network, the decrease in the dialectic between virtual communities and within them, control and democracy, personal identity in the relationship between online life and offline life, language, advantages and criticality of dematerialization especially in relation to work, to teaching and learning.

In *Reale e Virtuale*, just about the latter problem, while appreciating the progress made so far in the development of computer science, Maldonado opens the question of the need to operate binary, which inevitably ended up affecting the relationship between user and computer. It can be interpreted as an allusion that, implicitly, can be associated to the question of whether and how the use of the same type of technology can have different effects, depending on the changing of the operational interface (Maldonado, 1997).

Further in *Reale e virtuale*, addressing the topic of virtual modelling, the production of synthetic images and, more generally, of what at the time was the status quo of technological development, Maldonado writes:

Therefore, in the future it will depend on us whether, in the name of an ideology of an all-embracing dematerialization, we want to make an alienating use of such tools, or rather, as I believe it should, a use that makes the most of the formidable potential of man's cognitive, design and creative interface with the world. Not a fuga mundi, but a creatio mundi (Maldonado, 2015, p. 78. Translated by the authors).

This last quote well summarizes the personal vision of Tomás Maldonado, appreciable also in numerous other texts, both previous and subsequent, and that is characterized as a real methodological approach in the observation of the world and its phenomena.

A definitely different perspective, one might say “lateral” in the cultural context of the time, very critical of both then-dominant positions: the first, a sort of renewed Luddism, that considered emerging technologies as cause of aberrations and alienation, both for designers and users, particularly popular among the French intellectuals of the last decade of the twentieth century.

The other opinion, embodied in those years by MIT and the rising companies of Silicon Valley, the so-called cyber-hippies capitalists remembered by Maldonado himself (Maldonado, 1997), overly enthusiastic about the potential of new technologies and tending to minimize, if not even to hide, any negative effects that a not fully aware use of them could have on man and society.

As Maldonado himself points out still in *Critica della ragione informatica*, it is two opposite positions, but imbued with the same technological determinism, “prone to hastily give individual technologies the responsibility, for good or ill, for social (and even political) highly complex phenomena” (Maldonado, 1997, p. 15. Translated by the authors) and which considers technology as an autonomous force, inde-

pendent of the will of humans, views from which Maldonado repeatedly and explicitly departs.

The most recent is in the book-interview *Arte e artefatti* in which, answering to H. U. Obrist who precisely asks him about the “trend... to believe that all cultural changes can be explained in terms of technological innovations”, he states that in his opinion “it is society itself that, through technological innovations, changes society. Technological developments are never autonomous. It is, therefore, wrong to believe that social (and cultural) changes are to be attributed only, and exclusively, to the advent of new technologies” (Maldonado, 2010. Translated by the authors).

Then, distancing himself from those who believe in technological utopia, but without encroaching on techno-skepticism, Maldonado always adopted an extremely critical point of view, intended to a continuous process of reviewing the social impact, political and cultural technology, careful to grasp both the possible risks and the extraordinary potential.

In the preface to *Critica della ragione informatica*, we read:

This is not a book against new computer science technologies, nor is it against the expectation of a strongly computerized society. It should not be misleading whether I bluntly distance myself not only from an obtuse conformism but also from the elated triumphalism, nowadays widespread, about those technologies and their potential impact on society. Nothing is more foreign to me than a prejudicial distrust of the role of technology. [...] it is my deep conviction that, if we want to preserve the innovative power of technologies, they must always remain open to debate of ideas; willing to recurrently review not only their foundational assumptions but also, and perhaps primarily, their relationships with the dynamics of society.

But, everyone knows, all that openly clashes with the interests of those who do not want to disturb the peace of the computerized garden. Those who oppose have to keep silent, as sentenced by

the thought cyber-police (Maldonado, 1997, p. 7. Translated by authors).

The last few lines highlight a particular aspect – that Maldonado seemed to perceive – in the attitude of the most enthusiastic, as perhaps even more problematic, if not dangerous, than the rejection *a priori* of new technologies by skeptics.

It is the willingness to censure any voice that, like the author's one, is not inclined to declare itself tout court in favor, uncritically accepting the technical and scientific progress.

On the contrary, the approach that Maldonado hoped for, ideally open to any novelty, considers the unceasing re-examination not only of technologies themselves but also of their connection to their contexts the main way for profitable use of technologies, that takes due account of all the issues at stake, not least the ethical dimension.

Less than ten years later, during which such instances were more clearly outlined, and were made more explicit the new challenges posed by the rising of always new technological facilities, along with the historical context marked by the terrorist emergency in the early 2000s, in *Memoria e Conoscenza* Maldonado examines again the new information and communication technologies and their social, cultural and political implications, among all the issues related to the protection of privacy and the mechanisms of social control.

Regarding their all-pervasive use, he forewarned: these technologies, while helping us to increase the number of our interpersonal relationships and to facilitate many of our daily tasks, at the same time actually contribute to weaken, and sometimes to frustrate, those mechanisms that in the past have allowed relative protection of our privacy.

Protection which concerned (and now as then) the defence of one of the founding values of democracy: respect for the autonomy – objective and subjective – of the personal sphere (Maldonado, 2005). From this brief digression, which naturally does not claim to be exhaustive, it has thus been evident that even twenty, thirty years later and

without considering any historical developments then unpredictable, almost all the questions addressed at the time by Maldonado, with a somehow “prophetic” vision, are still extremely relevant in the current debate about mediation between humans and technology.

Technological Mediation and the Role of the Designer in the Project of the Interaction

Technological artefacts cannot be considered neutral intermediaries but have an active role in determining how individuals are present in the world.

This process, defined by Verbeek (2006) as technological mediation not only concerns the aspects of perception but also those of action. In fact, technology is able to shape the experience of individuals, increasing, reducing, or altering the perception of certain aspects of reality; at the same time, technology can define and influence the actions of an individual, preventing some, enabling, or fostering others. Akrich (1992) and Latour (1992) describe the relationship between technology and human actions in terms of scripts: technological products contain instructions such that they suggest to users how these artefacts can be used or how to behave in a certain context. However, not always scripts correspond to explicit indications, on the contrary in most cases they influence users indirectly.

Every time a new technology is introduced, it comes with several challenges and raises issues that can have potential drawbacks on the users or even the whole society. In particular, the introduction of new types of interface and new ways of interaction urge new reflections, for example concerning users’ privacy or the issue of accessibility; others, instead, such as the so-called recently experimented brain-computer interfaces, raised issues about potential dangers related to loss of identity or detachment of the individual from reality. Identifying such dangers, however, might be a hard task, since it is not easy to foresee the unpredictable ways of application of technology in a particular context of use.

Considering as valid the idea of technological mediation, the designer has a relevant responsibility in designing interactions. As a producer of scripts, a designer can delegate certain responsibilities to technological artifacts (Latour, 1992) and so influence, at least to a certain extent, the user's behaviour. Hence, at the very beginning of the design process, a designer needs to anticipate and analyse the whole range of possible interactions of the user with the artefact in a particular context of use. This reflection is particularly relevant if applied to the field of the design of interfaces, which are the first point of contact between man and technology as well as the fundamental space in which the designed aspects of experience emerge (Bollini, 2020).

Technological innovation has brought profound changes in the way of conceiving and designing interfaces, here considered as “the metaphoric osmotic membrane that separates the object and the user” (Anceschi, 1993. Translated by the authors), raising new questions and challenges for designers.

Back in the '80s, in parallel with a progressive integration of digital technologies in daily artefacts, the definition of user interface design was already considered too limiting about the new role of the designer, so it was necessary to adopt the new expression interaction design, attributed to Bill Moggridge and Bill Verplank (Chiappini, Rigamonti, 2010).

Already in those years, a new scenery – not so far from the contemporary – was taking form. In this sense, the vision of Mark Weiser, head of the Computer Science Laboratory at the Xerox Palo Alto Research Center, was emblematic. He imagined a world where technology could disappear in the background, integrated into the fabric of everyday life (Weiser, 1991), foreseeing clear advantages for humanity but still well aware of the potential dangers.

Nowadays, in a more and more defined perspective of ubiquitous computing, the standard paradigm of human-computer interaction, represented by the graphical user interface (GUI) is challenged by the introduction of new typologies of interfaces, where “action and reciprocal exchange” (Botta, 2006) between user and artefact is now free

from the bonds of the two-dimensional medium, including new ways of interaction, according to a logic that goes towards a direct and less mediated action (Tolino, et al., 2020). This is the case of the tangible user interface (TUI), the vocal user interface (VUI) or the robotic user interface (RUI).

The present discussion, on the other hand, will not take into account all those technological wearable devices, that can be more properly considered as prostheses of the human body and where technology is not perceived by the subject but rather included in the same perceptive process, in an interaction that can be described as embodiment relation (Ihde, 1990).

The tangible user interfaces (TUI) aim at giving physical shape to digital information, making it directly manipulable using the body. In fact, even though GUI represented a considerable improvement in terms of usability if compared to the previous command line interfaces and offered the possibility to graphically emulate a number of media, they are not coherent with the way men perceive and act in the physical world, taking advantage of the skills acquired over the years (Ishii, 2008). (Figure 2)



Figure 2. Transform, Tangible Media Group, Milano Design Week, 2014. From: https://www.wired.com/2014/04/mit-whizzes-invent-magical-transforming-furniture/?mbid=synd_digg#slide-id-719221/slide-id-719221

On the contrary, vocal user interfaces (VUI) are based on conversation and therefore on the absolute lack of physical interaction. This kind of interface, that will be afterwards analysed more in-depth as a

case study, represents a clear example of the research of more naturalness in the interaction of man and technological artefacts in a perspective of calm technology (Weiser, Brown, 1996).

Lastly, the robotic user interfaces (RUI) are more complex and can be considered as a medium in motion, not necessarily humanoid, able to involve almost all sensory channels (Fornari, 2021).

In a landscape of transition like the present one, the growing complexity and the progressive introduction of new ways of interaction – such as the ones based on manipulation or language – suggest stressing the central role of designer as well as the need of integrating into the design process considerations concerning the technological mediation. This can be done both restricting or preventing certain behaviours or actions of the user, or developing new desirable forms of mediation.

A significant Example: the Case Study of Voice Interfaces

Voice assistants are now our companions in everyday life. They turn the lights on and off, they tell us what the weather will be like. Indeed, when we do not find the remote control, they even turn on the television. These small objects that listen to us, always ready to satisfy our requests, are a technological innovation now present in the homes of many people. There is more and more talk of smart homes, as a consequence of the spread of artificial intelligence and home automation.

The advantages are significant from several points of view: convenience, speed, efficiency, economic side, and aspect of environmental sustainability. But how many times opening Facebook or Instagram have we found the products we were talking about with a friend or advertisements of the places we fantasized about. At this point, the question that arises spontaneously about voice assistants is: “how does artificial intelligence know us?”.

Does this mean that the big 5 (Amazon, Google, Microsoft, Apple, and Facebook) listen to us 24 hours a day? No! Artificial intelligence and machine learning, tools that are the basis of these home automa-

tion devices, are unable to process our language. And if you are wondering why, the reason lies in the fact that the language is changeable, organic. The result of singular experiences. And for the moment we are still far from an Orwellian scenario.

In the name of safety the goal, which also includes the role of the designer, is to create reliable artificial intelligence that we can trust. It is, therefore, necessary to think about alternative design scenarios to have responsible AI. In this sense, it is essential to take the time to reflect on what these systems should do and to ensure that ethical issues are addressed to build systems that have the common good of humanity in mind.

One of the ethical issues that struck us most is that relating to the voice of voice assistants. Among the settings of the assistants to date it is possible to choose between a female or a male voice, but at first many devices had only one voice option, the female one, a choice made following market research which showed that users felt more at ease with a more ringing voice.

In the same way, the decision regarding the names was a precise one, launched starting from 2011, the year of the first diffusion of these technologies. Although invented (Alexa, Cortana, Siri), they recall what a woman might have, characterizing the object with a gender.

Initially, the risk could be that the association of female name – female voice – welfare function made the idea of a woman's voice, and therefore of the woman herself, coincide with that of a vocal assistance product, i.e. without an own will and always available for any request. Given that the use of these voice technologies is more and more daily, it can risk penalizing women in real life when they do not behave as a voice assistant would do. But what could be an alternative to avoid reinforcing the gender gap?

Having realized this problem, UNESCO first denounced the risk of sexism and then acted concretely by coordinating an international study and experimentation operation for a new device. In collaboration with the Anglo-American creative network Virtue Worldwide,

Copenhagen Pride, and Danish researcher Anna Jorgensen, he created Q: the first voice assistance device with a neutral timbre. (Figure 3)



Figure 3. Q, Genderless Voice, 2019. From: www.wired.it/attualita/tech/2019/03/21/assistente-vocale-genderless-uomo-donna

The need from which the project started was to be able to expand the idea of gender beyond binarism, beyond the dualism of man/woman, so that one does not have to choose which voice to give to the product, but the device can have a totally new voice. The experiment combined the vocal frequencies of thousands of people to create a neutral timbre, which oscillates around 145 Hz, between the 80 Hz of a male voice and the 220 Hz of a female voice.

The aim of the project is above all to raise awareness of consumers on the issue and companies to take a position of social protection corresponding to the cultural influence that their products exert, to make the world more equitable thanks to technology.

We have seen that the role of companies is fundamental in spreading a culture that is respectful in the digital environment, but not only: they must become workplaces with a balanced percentage of men and women, to promote a future that can be built in a way more equitable and shared.

Furthermore, involving the customer in the design, development, and implementation of responsible AI allows interested parties to be

involved in ethical issues, in the assessment of the social impact and undesirable consequences of future innovations in a given sector. The responsibility of research is to pay attention to the concerns of stakeholders and to report so that innovation processes can be made transparent and responsive to the needs of society (Owen, 2013).

Conclusions

The readings of Maldonado's texts and the considerations that emerged from the deepening of the case study outline some interesting focus that, placed under the lens of the same critical approach used by Maldonado, have highlighted four most problematic issues, summarized in the four key concepts of privacy, due to the waiver of more or less confidentiality that their use involves; of illusoriness, in some case for the type of experience, in others for the intrinsic features of the interface, that make it to hide up to almost "disappear", completely disguising itself; ownership, when, for instance, the device fully integrates with the body of someone; lastly identity, when the interaction with the machine becomes deceptively similar to the one with another human being, or when the user, who can act freely only thanks to the interface support, ends up identifying with it.

Therefore, concerning them, some questions remain open, one above all: is it fair that the designer anticipates the mediating role of technology, somehow guiding the user to behave a certain way? Is it or not a restriction of freedom?

The analysis of the example of the vocal interface would induce us to answer affirmatively; the same example, however, supports the reasoning, that we cannot neglect, that the mode of interaction adopted by the user is equally essential. So, alongside the responsibility of the designer, there is also one of the user, who is called to actively collaborate in the redefinition of the project as it takes shape in use.

Then, this leads us back to what Tomás Maldonado wrote in *Il futuro della Modernità*, quoting the epistemologist Mario Bunge: "[He] supported the thesis that there's a single and indivisible responsibil-

ity of individuals towards society. Liability cannot be broken down into different types of liability ascribable to different individuals. [...] Everyone, in essence, must feel responsible for everything. And it is only this feeling of omnipresent responsibility that can at least allow us, and that is no small thing, to exercise an omnipresent vigilance towards new technologies. This does not necessarily mean opposing them, but being able to know, with a reasonable approximation, which ones are compatible with the public interest and to regulate, consequently, our conduct in this regard” (Maldonado, 1987, p. 14. Translated by the authors).

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Stereotypes and Visual Emblems in Contemporary Cultural Systems between Simplification and Banalization

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Maldonado and Semiotics Studies: an Introduction

The essay aims to investigate Tomás Maldonado's thought regarding the thematic area of philosophy of language, linguistics and semiotics. Indeed, he was one of the first thinkers to introduce the teaching of subjects such as semiotics, ergonomics and communication science in the education programme of the designer. Maldonado experienced this approach when he headed the School of Ulm (Hochschule für Gestaltung) between 1954 and 1967 and examined it in his critical contribution to semiotics theory, which is identified as the theory of signs (Morris, 1939, 1946) that studies signs and symbols as significant part of communication. The theory identifies three areas of investigation: semantics, which studies the relation between sign and signified; syntax, which concerns the relation between signs; pragmatics, the relation between sign and interpretation (Maldonado, 1959).

The results presented in this paper are the synthesis of a plural and synergic work that starts from the individuation and the discussion of specific topics in the field of social communication design until the

selection of cases of interest useful to explain the contemporary of Maldonado's thought.

This research was developed through a qualitative methodological process, subdivided into three main steps: the first is related to the critical reading and the interpretation of Maldonado's thought by the analysis of his written works; the second step concerns the categorization and actualization of themes, identified through the use of collaborative digital tools; the third phase relates to the selection and analysis of communication design projects, developing a taxonomy of case studies in the specific fields of data visualisation and new media.

The research focuses on the study of Maldonado's writings from the 1950s to the early 2000s, from which a strong connection emerges with the current themes such as the evolution of languages within new media, the spread of alternative communication codes, the tools for simplifying reality and also the attribution of a social and educational role to communication.

The analysis aims to bring these themes to a contemporary dimension, through the identification of some examples and projects of interest that allow reflecting on the boundary between simplification and "semantic banalization" (Maldonado, 1959).

From the analysed texts, three main levels are identified through which signs and signifiers act: logical-cognitive, visual and multi-sensorial. These levels allowed exploring themes in different fields and led to considerations about communicative language and the capacity of design to act on social meanings and to generate knowledge.

In particular, this paper adopts a logical-cognitive¹ interpretation to relate semantics with translation processes (Baule, Caratti, 2016) and attributions of meaning used by the design discipline. On one hand, these processes lead to uncritical thinking made of stereotypes and emblems, based on common beliefs. On the other hand, they attribute an interpretative dialogical ability to the design culture able to simpli-

1 *Logico-cognitive* refers to the processes involved in knowledge-perception, imagination, memory and all forms of thinking.

fy and spread messages to a wider audience. The purpose of the paper is to critically analyse this ability and to illustrate, through the identification of effective or weak case studies, the guidelines currently adopted in visual communication and new media fields.

Semiotic Reflections in the Field of Communication Design

The reflections developed from Maldonado's writings create a critical connection between the growing complexity of reality – supported and mediated by the improvement of digital technologies, especially those concerning hypertextual and multimedia production – and the need to simplify and make fragmented and substantial contents more accessible.

This complexity of reality underlies mechanisms of cognitive simplification that the designer implements to make the message decodable and incisive. As Maldonado states: “The visual communication specialist knows he is responsible for everything that is offered to the sight of the common man. [...] Nobody can ignore that his mission is to produce ideologies or to actively participate in their demolition” (Maldonado, 1953, p. 35. Translated by the authors).

Simplifying is essential in the process of knowledge and translation of complexity, but the risk is to banalize through a process of oversimplification. Therefore relying on excessively reductionistic or rigidly deterministic definitions and conceptualizations of a complex reality. The consequences are a flattening of conceptual differences and subtleties, and an emptying of representations aimed at developing a critical awareness of the relationships between symbols and things (Bennett, 1985).

Maldonado, therefore, focuses on the risk of oversimplification and stereotyping of communication languages, which leads to a semantic emptying and what he defines as the communication crisis,² which

² Based on the thinking of Karl Jaspers, Maldonado states: “[...] nowadays, an information crisis is already beginning. Today, communication has been replaced at all

leads in the long term to no longer being able to read and critically analyse reality, as well as semantic and relational drying up.

The issue of the reduction of complexity becomes more and more central in the post-industrial debate in relation to its complex technological meaning. The Web has given everyone the opportunity to transform a fact into news and there is a widespread – and partly institutionalised – trend towards the progressive dissolution of the boundaries between information and entertainment (Morcellini, 2011). Today, more than ever, communication processes and ethics are therefore highly topical issues and objects of interest by numerous researchers (Makau, 2009; Panchevski, et al., 2011; Fabris, 2014) since they deeply affect our life.

The filter – that the evolution of communication media imposes on our perception of reality – changes transforming the patterns, times and spaces of relationships between people. Indeed, McLuhan observes that:

Once transmuted into software, anything and everything becomes malleable, fluid, interchangeable. Each new medium is a new culture and each demands a new spin on identity; it is urgent that we begin to study all of the forms of knowing, now called literacies. Multimedia means simply compound literacies. As discourse shifts from page to screen and, more significantly, to a networked environment; that is, as discourse decentralizes, the established definitions and relations automatically undergo substantial change. The shift in our world view from individual to network brings with it a radical reconfiguration in culture (McLuhan, 2009, p. 12).

But the new media are not neutral and their intrinsic structure produces an influence on the recipients of the message, which goes beyond the specific content they convey. And it is for this reason that digital

levels by chatter. Chatter that is not only verbal, but also visual” (Maldonado, 1953, p. 31. Translated by the authors).

media fit so effectively into the political-cultural debate, in which forms of conceptual simplification are as essential as risky, given their ease in falling back into forms of intentional mediocrity (Maldonado, 1961) and of creating dangerous stereotypes in the critical elaboration of more complex concepts.

Maldonado himself often argued, almost prophetically, on the doubts linked to the communicative dimension of digital media, on the language adopted – which he defines as cyber-slang – and on the “[...] threat, in a similar type of jargon, to favour, in the short or medium term, a generalised stereotyping of language” (Maldonado, 2005, p. 240. Translated by the authors). His scruples were strictly connected to the peculiarity of this communication method of spreading worldwide thanks to the all-pervasive nature of the technologies at its disposal.

The Information Crisis, a Critical Interpretation

The topics raised from Maldonado’s works are in a relationship of continuity with current issues and constituted the basis to implement a work of critical re-interpretation and actualization. This analysis required the use of conceptual tools that enabled to provide an overall and contextualised picture of the processes that today lead to what Maldonado referred to as the information crisis or the death of information. The schematization (Figure 1) of these processes is therefore the result of a systematic cross-comparison between Maldonado’s written works from the contemporary context. The process of synthesis and schematization allowed to highlight part of the mechanisms that define today’s cultural systems, according to Maldonado’s perspective that connects culture and communication, communication and ideology (Maldonado, 1953).

The purpose of the following reflection is therefore based on the above-mentioned dichotomy regarding the ever-increasing hyper-complexity of reality (Morin, 2017) that characterises society as a whole and the need, on behalf of the media, to simplify information

in order to be effective. In following the process that, according to this critical interpretation, would lead to the crisis of information, the starting point – the concepts of multiplicity and complexity – is fixed at the top, opposed on the same level to the need for simplification, which implies not only a simpler comprehension of the message, but also a greater incisiveness of the communication.

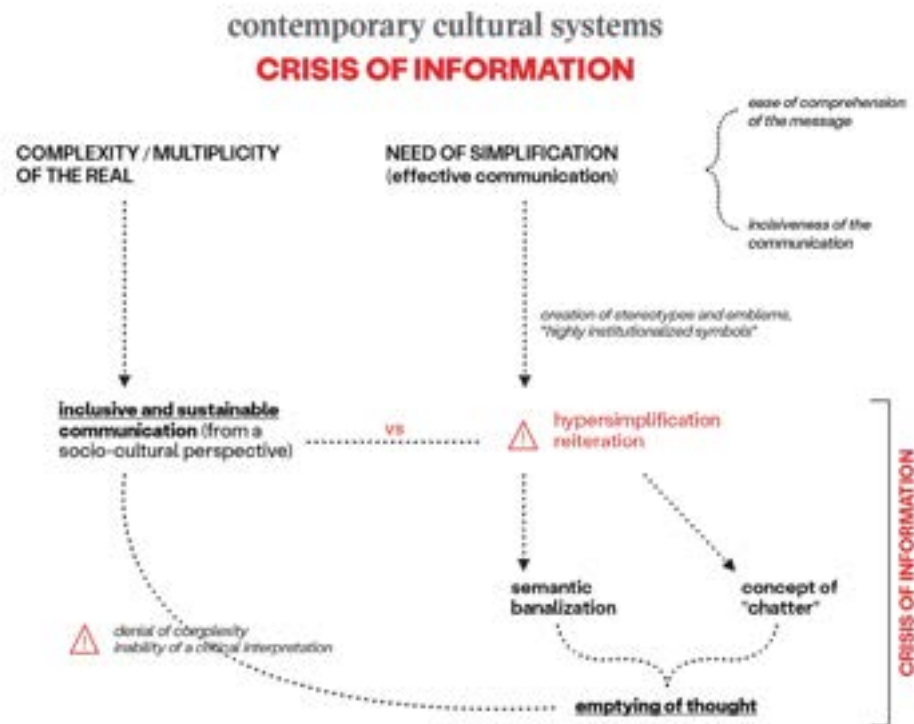


Figure 1. Graphical scheme representing how the information crisis appears in present cultural systems.

Therefore, if on the one hand there is the complexity of reality and the consequent urgency of a communication design that is representative of this multiplicity, in order to be inclusive and sustainable from a socio-cultural point of view, on the other hand the need for simplification inevitably results in the enactment of semiosis processes – where semiosis is defined as translation processes of meaning production (Baule, Caratti, 2016) – that lead to the formation and consolidation of stereotypes and emblems.

According to the definition of Zingale (2012), the stereotype is an ideologically oriented connotation, which implies firstly a high degree

of simplification and generalisation – the particular is arbitrarily elevated to the general – and a social sharing that sanctions its institutional and normative status. The thinking that Maldonado articulates in *Communication and Semiotics* as early as 1959 concerns precisely the tendency of some universes of discourse (e.g. cyber-slang) to excessively reducing the repertoire of signs, leading to the consequent generation of visual and verbal emblems. He states that “The higher the degree of emblemization of a symbol is, that is, the higher the degree of its semantic banalization is, the lower its communicative incisiveness. The more intrusive is its institutional meaning, the less is its functional meaning” (Maldonado, 1959, p. 71. Translated by the authors).

The increasing simplification of the message, up to hypersimplification, then coincides with the elevation of the degree of semantic banalization, which brings with it both the impoverishment of content and a distortion of the meaning produced since, being the stereotype ideological connotation, “whatever object it means, it means it by contaminating it with other meanings” (Zingale, 2012, p. 101. Translated by the authors).

Here the paradox of the serial image (Baule, 2012) comes into play, generating a short-circuit of meaning. The stereotype is technically necessary for communication, but at the same time, it impoverishes its content and distorts its meanings.

We live in an increasingly dense and overcrowded semiosphere (Lotman, 2005; Mirzoeff, 2015), characterised by the serial reiteration of hyper-simplified messages devoid of meaningful content. It is precisely what Maldonado identifies as chatter. Furthermore, based on the thinking of Robert Venturi, Maldonado states: “Epidermic communication, without any density and thickness: in short, a fictitious communication, a simulacrum of communication, just chatter, just noise” (Maldonado, 1970, p. 123. Translated by authors).

The result is therefore a “semiotic pollution” (Manzini, 1992) that well highlights a damaged system of production and reproduction of images that are worthless. These images are ubiquitous and pervasive

and are disseminated at such a rate that they inhibit our ability to see and critically understand most of them. If ubiquitous images are worthless, however, it is a profound mistake to assume that they do not have power and influence over society. This system generates a sort of paradox of worthless images, which is powerful and has several consequences:

Firstly, as Smargiassi (2012) argues, the overproduction of images means that we are overwhelmed by an iconogenic surplus. This surplus is incongruent with the image's ability to create differences and oppositions because it is not content oriented as Volli (2008) argues. This surplus transforms the audience into a *tabula rasa*, sensitive and receptive to media communication, but largely unaware of content beyond the moments of transmission and reception (Caratti, Roxburgh, 2018, p. 3).

It also follows that “the group of words or images that still retains some original force is always received with distrust by the users of that expressive régime [the chatter]” (Maldonado, 1953, p. 31. Translated by the authors), generating a self-feeding loop. This vicious circle primarily causes the emptying of thought, ending in the denial of complexity and the inability to critically read not only media messages but reality as a whole.

In a historical moment characterised by the democratisation of the media that enable anyone not only to have free access to information, but to produce new information by fueling the proliferation and circulation of opinions, too often the ability to grasp the difference between fact and opinion is lost, as well as the ability to understand that between reality and its media transposition there is precisely a mediation, a semantic cross-section. Reality thus tends to be blurred by what is said or represented about reality.

Simplification and Banalization: a Case Study Analysis

The analysis has moved to an empirical level, seeking projects of simplification and banalization of communicative languages within contemporary cultural systems. The analytical approach is inspired by the critical analysis that Maldonado makes in *La speranza progettuale* concerning the city of Las Vegas, which is proposed as an equivocal space, saturated from a sensorial perspective and subject to the continuous search for eidetic stimuli, that create new phenomena of ambiguity (deprivation – satiation) (Maldonado, 1970). The collection of case studies constitutes a state of the art of selected practises in reference to the socially oriented communication design.

The research method used to collect and organise the case studies is contextual to the complexity of the identified problem, as it allows the development of a transcalar (macroscopic and microscopic) qualitative investigation of contemporary communication phenomena, demonstrating the relevance of the topics examined. Resuming the duality between *richness of meaning and clarity of meaning*³ (Maldonado, 1970), the analysis leads to the concepts of simplification or banalization of the contents conveyed in artefacts of the cultural industry of contemporary society.

Through a synthesis operation, twenty cases of interest were selected on the basis of criteria such as: the impact on the media, longevity of the project, type of information flow conveyed. The method for the classification and the critical analysis takes its cue from the semiotic square (Floch, 1983; Felluga, 2015) also known as Greimas square, a conceptual matrix that was considered a suitable tool to represent the contrast of the concepts of simplification and banalization.

The analytical matrix develops along two Cartesian axes. The horizontal axis puts in relation the concepts of simplification and banalization. The vertical axis, on the other hand, puts in relation the ease

3 Reflection that Maldonado assumes from Robert Venturi, *Complexity and Contradiction in Architecture*, The Museum of Modern Art, New York 1966, p. 23.

of comprehension of the message and the incisiveness of the communication. Their position generates four taxonomic quadrants in which the projects analysed have been classified.

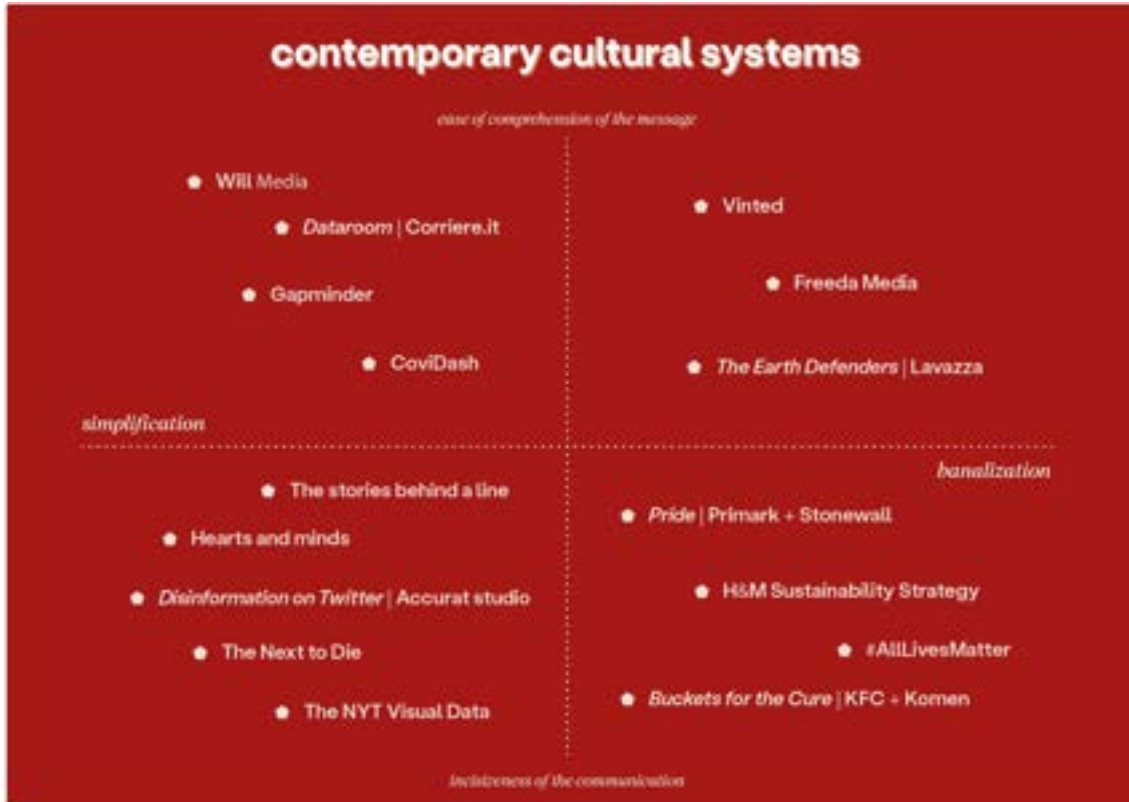


Figure 2. Graphical representation of the semiotic square, main tool for the analysis of case studies.

Simplification – Ease of comprehension of the message

The first quadrant includes communication projects in which the need to simplify a multiple and complex flow of information produces effective, inclusive and sustainable communication systems from a socio-cultural point of view. Specifically, Will Media is an editorial project with the aim of being a point of reference for a large community that shares values and interests. Launched in early 2020, it uses Instagram and TikTok as privileged media channels through which to convey and organise the flow of information. The narrative modes of the covered topics, ranging from economics to politics, denote an

approach based on the simplification of complex phenomena through effective communication strategies. The user can select the topics of interest independently, continuing along a path that offers heterogeneous contents in terms of density, format and language. This project presents an effective communication system for the dissemination strategies adopted, for the clarity of presentation and the ability to synthesise the communicative artefacts produced and shared in the respective social medium.

Simplification – Incisiveness of the communication

The second quadrant reports communicative artefacts that use data visualisation to simplify large quantities of data and information, thus allowing incisive, immediate and dense communication of semantic references. Hearts and minds is a project supported by an interactive digital platform that explores the perception of the migration phenomenon in the European socio-cultural context. Through the communicative potential of data, the aim is to tell from an empathic perspective the impact of migratory flows and the behaviours recorded towards refugees and other migrants. In this case, the use of data visualisation takes place as a multilevel tool that allows the fruition of heterogeneous information, organised in different scales of deepening. The methods of visual restitution of data require an ability to interpret and decode the information and it presupposes a high level of media literacy; the visualisations produced are in fact addressed to an audience sensitive to the topics covered. Unlike the previous case, the designer's attention is focused on the definition of new codes and visual languages that allow a translation of complexity without any loss of content.

Banalization – Incisiveness of the communication

The third quadrant refers to deceptive communication strategies, which banalize the topic addressed through “an abusive use of the mass media, thus emptying it of its disruptive charge and reducing it

to a seasonal fashion like many others” (Maldonado, 1990, p. 65. Translated by the authors). The communication strategy of brands such as H&M⁴ offers an equivocal image, albeit immediate, aimed at transferring values such as environmental, social and economic sustainability, which clashes with the complaints made by numerous activists about greenwashing⁵ practises. The accusations of greenwashing have also been added to those of social washing, in reference to the precarious working conditions of those who work in the company’s offices located in developing countries, as well as their low economic remuneration. The image proposed in the advertising campaigns conveys a positive but generalised and stereotyped message, which hides a non-transparent attitude in relation to the production processes and ethical principles of the brand.

Banalization – Ease of comprehension of the message

The fourth quadrant includes examples of oversimplification, leading to a banalization and impoverishment of the messages conveyed. Freeda is an editorial project born in 2017, which aims to become a platform for “a new generation of people who want to transform the world into a better place”. The landing page of the site refers to its social profiles (Facebook, Instagram, TikTok), used as privileged vectors of information. The multimedia contents and articles produced are in fact designed as instant articles⁶ to be enjoyed in a direct and immedi-

4 In recent years, the fast fashion company H&M, as well as many others, has directed its marketing strategy towards sustainability in its multiple ecological, socio-cultural and economic meanings. On the official website, in fact, a section has been activated dedicated to the story of the company’s sustainable actions to ensure a fashion that is more attentive to the environment, fair and inclusive.

5 The term *greenwashing* indicates that particular “façade ecologism” of some companies, organisations or political institutions that adopt a communication strategy aimed at building an equivocally positive self-image in terms of environmental impact, in order to divert the attention of public opinion from the harmful effects on the environment due to their activities or products. Negative effects not only at the environmental level, but also at the socio-economic level.

6 The *instant article* is a multimedia content present within the Facebook mobile app and viewable only to registered users. These are tools designed to optimise and make storytelling functionality more interactive.

ate mode. Most of the themes concern feminism and LGBTQ+ rights addressed through a generalized stereotyping of contemporary customs and traditions. Communication takes place mainly in the form of a pill, resorting to clichés and stereotyped images that reduce gender issues to simplistic slogans. The semantic and plastic banalization proposed in the published multimedia content is directly attributable to the phenomenon of pinkwashing.⁷ Despite the poverty of in-depth content, the channel manages to collect a great success becoming today the leading Italian media company.⁸

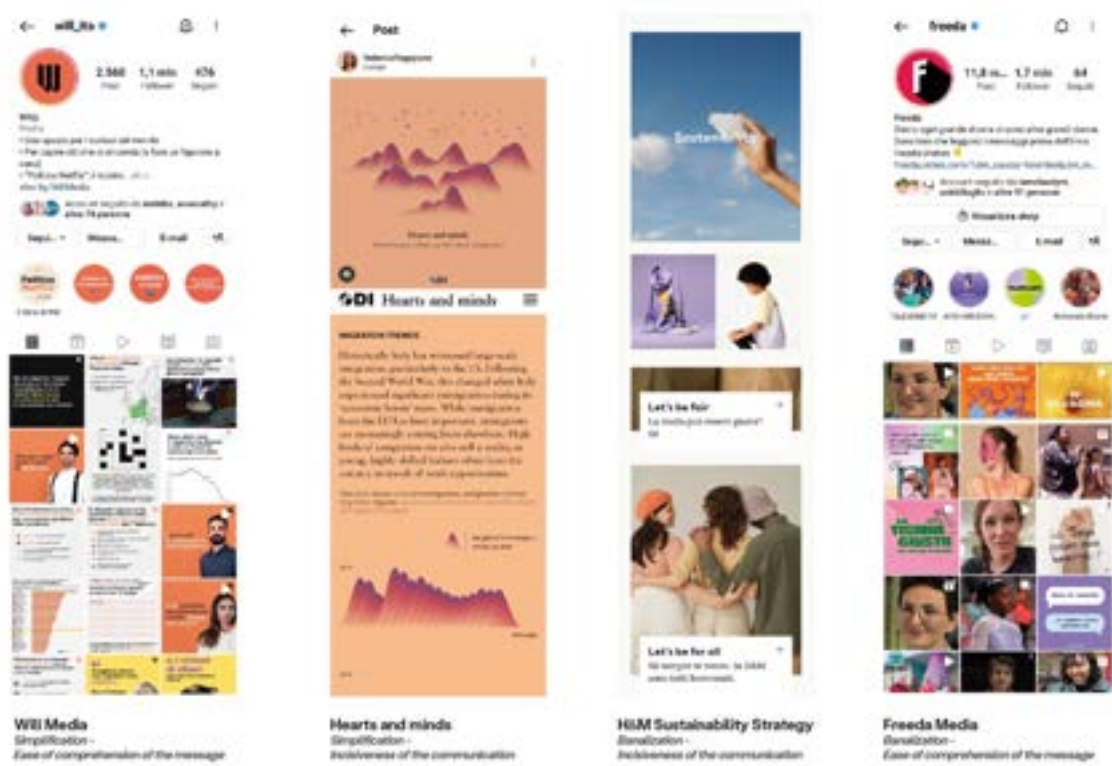


Figure 3. Case studies. In the figures four case studies are reported: Will Media, Hearts and minds, H&M Sustainability Strategy, Freeda Media.

7 *Pinkwashing* is a term coined to indicate advertising campaigns and marketing strategies that promote a product or entity through an apparent attitude of openness towards women’s empowerment or the LGBTQ+ community.

8 <https://www.panorama.it/Tecnologia/social-network/freeda-leade-media-company> (Last consultation February 22, 2022).

Conclusions

The communicative opulence (Maldonado, 1961), produced by social media and the spread of digital communication platforms, imposes itself on traditional channels generating, on the one hand, a greater dissemination of knowledge on current topics, and on the other hand a proliferation of messages and opinions that feed disinformation and ambiguity. The emerged scenario shows that the case studies reported within the four areas which are closest to the concept of banalization feature a reduced complexity of thought, with a marked preference for a stereotyped and stereotypical informative dimension, which does not encourage curiosity for a more in-depth examination of the issues.

The high degree of generalisation of information leads to the apparently exhaustive nature of the same, reducing the stimulus to further critical exploration by the user.

On the contrary, the case studies referring to the concept of simplification, foster a translation of complexity based on the use of accessible languages and tools that facilitate the transfer of knowledge, while preserving the density of the content conveyed.

If the “ethical dimension of Communication Design [...] directs the value, the meaning and the content of communicative artefacts and their impact in the social context” (Baule, Caratti, 2016, p. 23. Translated by the authors), the perspective for the elaboration of such artefacts is a democratic and constructive exchange of knowledge oriented to overcome the proliferation of generalised and oversimplified opinions, raising awareness towards a conscious deepening.

Nowadays, the tools for producing and disseminating content and information are extremely accessible and their visibility is independent of their quality. Is it possible to imagine the diffusion of a communication ethics external to the culture of the project that democratically involves any content creator?

This contribution aims to foster a design reflection on which strategies and tools can be useful to stop the tendency of digital communication towards poverty of thought and the death of information.

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Human-Robot Interaction

Face Stereotypes in Anthropomorphic Robotic Systems

*Niccolò Colafemmina, Paride Duello,
Fabrizio Formati*

Introduction

The relationship between man and machine has long been the focus of studies and research from different scientific areas. Since the Industrial Revolution, man finds himself having to interact and collaborate with machines and wonders, in this sense, on the best way to communicate with them. The mechanical machine has always been considered the machine par excellence, a man substitute in performing physical activities. In fact, initially man was involved in mechanical applications to produce goods, this was followed by, in addition to the previous functions, the transmission of information and therefore the definition of a new form of communication.

This is how a qualitative evolution of the functions of machines is configured: the concept of feedback emerges which implies a reaction of the machine to an action generated by man (Bonsiepe, 1963). With the use of advanced technologies and new robot features, this relationship has become complicated, up to the point where, in some cases, the hierarchy between man and machine has become very unstable.

Today, the potential of robots makes it possible to use new communication channels to improve interaction with them and make it more intuitive and natural. In fact, the multimodal information provided by both the robot and the user ensures reduced communication times and is very effective as the presence of variable noise and lighting conditions can lead to a reduction in the communication channel and invalidate the interaction itself. An effective interaction, in fact, involves the user through his posture, face and gesture. In literature, there are different coding systems of facial expressions such as Ekman's FACS or the classification of facial expressions by El Kaliouby and Robinson: the first one is organized on the identification of the movements of the face and head; the second one is based on the combination of sequences identified through a dynamic Bayesian network as regards facial expression. The latter system detects the user's moods that are fundamental in the collaboration between man and robot (Ekman et al., 2002; El Kaliouby, Robinson, 2005).

The purpose of the essay is to investigate the theme of communicative language understood as a human-robot interaction code. It is therefore essential to focus attention on the concept of face stereotyping, in this case of the robotic face, and on how it affects the interaction with the user. Starting from Tomás Maldonado's research and thinking, the fundamental elements in the communication between man and the robotic machine will be analyzed. Subsequently, will be highlighted the aspects that, with the evolution of technologies and the introduction of robotics, have revolutionized this relationship, introducing new fundamental elements that could contradict the theories that Maldonado hypothesized while projecting into the future.

Maldonado's Influence

Communication is the central topic of those who are responsible for developing, inventing or putting into circulation the signs or symbols that make it possible (Maldonado, 1953).

Tomás Maldonado's thinking on communication and then on man-machine language has been of fundamental importance within the scientific debate. In fact, as early as the 1950s, Maldonado introduced the teaching of semiotics at the *Hochschule für Gestaltung* in Ulm, becoming a pioneer of this discipline.

Over the years, Maldonado's interest has moved towards the world of information and communication, also placing attention on cybernetics and, in particular, on how it is essential to connect the computerization process of communication with machines, not only as feedback for use and management, but also as signs and symbols of interaction (Neves et al., 2014).

In fact, in the 1960s, Maldonado in collaboration with Gui Bonsiepe designed an alphabet of signs for the Elea 9003 computer by Olivetti, characterized by elements which, when combined, represent various references. These elements have been identified as basic signs, comparable to language nouns, and definite signs, hence adjectives and verbs. The referents of the basic signs are the functional units of a system, while the referents of the determinatives are mostly the states and processes carried out by the machines such as: "ready", "compare" and "function" (Maldonado, 1963).

In a 1994 interview, Tomás Maldonado, in addition to discussing communication, also addresses the issue of ergonomics, defining it first as "a discipline notoriously aimed at optimizing the product-user relationship" and then as "a system in which psychology, physiology, anatomy, engineering, systems engineering, computer science, anthropology, linguistics, descriptive semiotics and, last but not least, industrial design is involved" (Zingale, 2018).

It is clear to what extent, already in Ulm's time, it had become essential to discuss communication by including machines among the interlocutors.

The issues taken into consideration mainly concern the field of designing the surface of products and services, and therefore the design of interfaces – or the interface between man and machine and the

resulting interactions – requiring the involvement of different disciplines.

From the interview, it emerges how Maldonado contributed to the optimization of the man-machine relationship and to the evolution of the active and communicative behaviors of man with machine. Maldonado specifies that there are two possibilities of interface: the indication devices that are used to communicate visual, acoustic, or tactile information to the operator, and the control devices, mechanical or electromechanical devices through which, with direct action of their limbs, operators generate, interrupt or regulate the actions of the machine.

It is precisely from the analysis of these two categories of interface that Maldonado elaborates an extremely interesting thought around which this essay is built. In fact, starting from objective data that have seen a change over time in the quantitative relationship between indication devices and control devices, with an ever-greater diffusion of the former compared to the latter, he hypothesizes:

It is likely that, in the future, an ever-increasing sophistication of robotics could make the indication devices themselves superfluous (or nearly so). If this happened, we would have reached a particularly critical point in ergonomic studies relating to machines (Zingale, 2018).

The purpose of this essay is to investigate the hypotheses raised by Tomás Maldonado through an inductive approach. From the analysis of some application examples, in fact, the current state of the robot interfaces and interaction codes that facilitate communication with the user are verified.

Interpretation

If signs can be considered the minimum structures at the basis of communication, the code is certainly the periodic table that regulates

their meanings. This is always the case, regardless of the sender and recipient.

The set of codes organizes languages as systems of correspondence between the order of the expression and the order of the content, intended for the transmission of information between an emitter and a receiver through the production and dissemination of messages (Simone, 2005).

Although verbal languages are strongly characterized and diversified due to their socio-cultural roots, the codes of non-verbal language are interesting because they are disconnected from ethnographic contexts, often also overcoming the communicative boundaries between species and orders of living beings.

As reported by Maldonado (2006), already in the 16th century was taken into consideration what is defined as the fourth category of language: communicating and expressing oneself through the actions of the body. The complexity of the code underlying a language is proportional to the complexity of the information to be transmitted through the message.

Communicating and expressing oneself through the actions of the body or gesture has created a causal link between gesture and language and between gesture and non-alphabetic proto-writing, emphasizing how the origins of languages have been changing over time and have their roots in non-verbal communication.

Maldonado (2006) also points out that, already at the turn of the 21st century, the belief had spread that human skills, combined with graphic representation, non-verbal communication (gestures and facial expressions) and the use of different forms of language, had a simultaneous development and therefore a natural co-evolutionary process.

Then, this theory was reinforced by the latest discoveries on mirror neurons by Rizzolatti and Sinigaglia (2006), which highlight how powerful non-verbal communication is (Iacoboni, 2008).

Furthermore, studies on mirror neurons show that in perception, with empathic communication and the recognition of a human form,

brain activity increases, concentrating the interaction activities of individuals towards that image. It explains, for example, the strong bond that is established between patient and assistance robot (Fornari, 2012).

Empathic communication, as a form of knowledge, can be trained to activate empathic behaviors in relation to different situations and social contexts of reference and to create a climate of trust. It is necessary to interface with the end user through sophisticated and intuitive technologies in order to create empathy; to achieve this goal, robots must interact through the language of gestures and expressions, building positive and satisfying relational dynamics.

Empathic robotics takes into consideration the emotional states of the user for the cognitive processing of information. In fact, multi-modal communication is the most used since it transmits a clear and correctly received message.

Facial expressions or voice messages are effective and understandable communication elements used to communicate user's input. Tactile feedback is another form of communication as the user collaborates directly with the system by manipulating a shared object.

Other forms of communication can take place using instruments designed to extract physiological signals from users and provide information on their internal state. In particular, it refers to signals of brain and muscle activity, from heart rate to the galvanic response of the skin, which can inform about the user's stress levels or emotional state. The robot adapts its behavior according to the user's reaction and the degree of trust that is established between them.

Interesting for the development of this study is the morphological classification of robotic systems carried out by Yanco and Drudi in 2004, where it is possible to frame probable interactive situations, thus highlighting an empathic relationship between robot and user since operators react to robotic systems in a different way according to the various physical conformations, creating therefore a series of communication mechanisms and social expectations.

It is important to investigate the different modes of interaction through which humans have the opportunity to interact with the robot (Yanco et al., 2004). The morphological classification in detail is listed by attributing different values to the robotic system: the anthropomorphic value, where the robot assumes the physical conformation of a human being; the zoomorphic value, where the robotic system assumes the appearance of animals; the functional value, in which the robotic machine is not bound to the physical conformation but is linked to the function it performs. The classification just mentioned is interesting because it investigates the relationship between users and robotic systems since the type of relationship greatly affects the human-robot interaction, improving the quality and efficiency of the entire system.

In view of what was said in the first part of the paragraph, to analyze the interaction between man and robot, it's necessary to rely on some studies on non-verbal communication (NVC). In particular, within the classification of Mastronardi (1998) the elements of non-verbal communication are ideally arranged according to a scale that starts from the top and proceeds downwards. This scale involves the elements that most influence this type of communication, including the face and the movement of the head (Table 1).

Classification of non-verbal communication (NVC)

External aspect:

- Body shape
- Clothing

Face:

- Glance and visual contact
- Face expressions

Proxemics:

- Body distance
- Body touch
- Spatial behaviour
- Body orientation
- Posture

Paraverbal signals:

- Tone
- Frequency
- Rhythm
- Silence

Kinesics behaviour:

- Bust and legs movement
- Kinesics behaviour
- Hand gestures
- Head movements

Table 1. Classification of non-verbal communication (NVC), Mastronardi (1998).

Among the non-verbal signals, the face is the most significant area of the body from a communicative and expressive point of view and the one over which the greatest control can be exercised. In fact, the recognition of individuals is most often achieved through their face, where they communicate the most important information (Zeki, 2003).

Face recognition turns out to be a systemic process in which the relationship between the parts of the face acquires a fundamental role in the codification of the face. For this reason, the face has been compared to an artifact with its own dimensional ergonomics that makes it possible to identify any facial configuration as a face that respects it, such as that of a robotic face (Fornari, 2012).

The face can be divided into three areas: upper, middle, and lower (Corman, 1970) (Figure 1). It is possible to associate the seven main emotions (happiness, sadness, surprise, fear, anger, disgust, and contempt), identified by Friesen et al. in 1983, to actions and movements involving some of these areas of the face. The following model was identified for the analysis of the degree of stereotyping of the anthropomorphic robots face (Table 2).

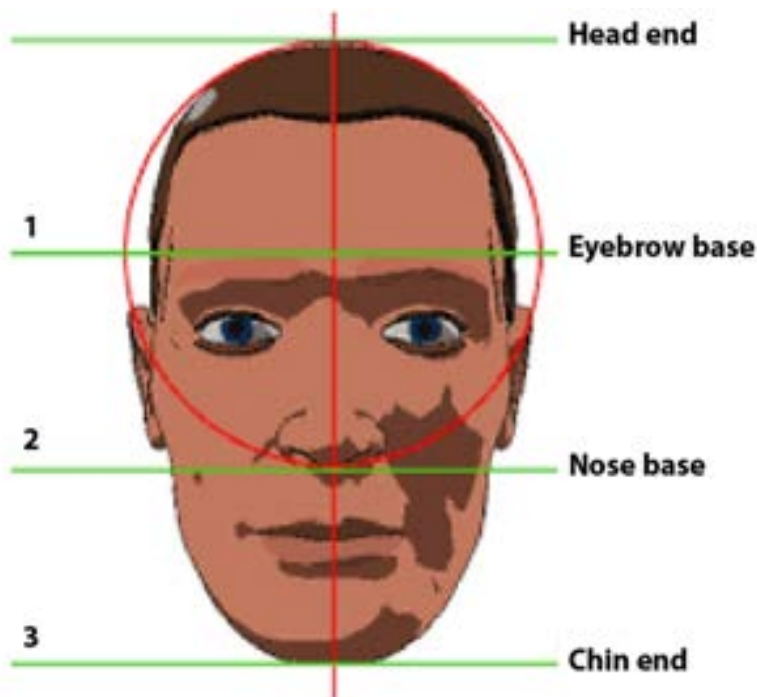


Figure 1. Areas of interest and levels/zones of the face, Friesen and Ekman (1986).

Emotion	Facial actions	Involved areas
Happiness	raise the cheeks, raise the corners of the lips	2+3
Sadness	raise the inner corner of the eyebrows, lower the eyebrows, lower the corners of the lips	1+3
Surprise	raise the inner eyebrow corner, raise the outer eyebrow corner, lift the upper eyelids, open the mouth wide	1+2+3
Fear	raise the inner corner of the eyebrows, raise the outer corner of the eyebrows, contract the forehead, contract the eyelids, widen the mouth, open the mouth wide	1+2+3
Anger	lower eyebrows, lift upper lids, contract eyelids, pursing lips	1+2+3
Disgust	contract the nose, lower the corners of the lips, raise the chin	2+3
Contempt	lift right corner of the lips, squeeze the right cheek	2+3

Table 2. Seven main emotions involving the face, Friesen (1983).

Case Study

Starting from the morphological classification of robots by Yanco and Drudi, a series of robots belonging to each of the three categories (anthropomorphic, zoomorphic, functional) and which, in different ways, communicate information to the user, were identified and analyzed (Table 3).

For the purposes of the research, however, it was considered more appropriate to focus the study only on some examples of applications concerning the class of anthropomorphic robots.

In fact, even though automata and anthropomorphic machines have been received in different ways over time and cultures, the association of technical artifacts with human morphology has led to consider the machine as a living model and has raised a series of questions about the modalities of interaction with it (Fornari, 2012).



Table 3. Morphological classification of reference robotic systems, Yanco and Drudi (2004).

Among the anthropomorphic robots considered, three were selected to carry out an in-depth study. The analysis filing took into consideration seven states of robot activity (shutdown, ignition, stand-by, receiving an input, sending an output, communicating a positive feedback, communicating a negative feedback) and for each of the examples of application were analyzed: the interaction codes, that is the ways in which the robot interacts with humans and sends communicative signals; the stereotypes of the face that represent the degree of expressiveness of the robotic face associated with the human one, according to the Friesen scheme; and finally the indication devices mentioned by Maldonado and on which he questioned about their disappearance in the future.

Robot Pepper

Pepper (Figure 2) is an anthropomorphic robot produced by Soft-Bank Robotics in 2014 and designed with the ability to read emotions. Its ability to recognize emotions is based on the detection and analysis of facial expressions and voice tones. Due to its breadth of interac-

tions, it is used in different contexts such as care, domestic, medical and many others.

An interesting point emerges from Pepper’s analysis: the robot, in fact, maintains a neutral facial expression during all states of activity that can be associated with a happy face. This lack of expressiveness is compensated, however, by a wealth of movements, gestures and indication devices that allow the robot to have a clear communication with man and to be used in different contexts while maintaining an efficacy in communicative terms (Table 4).



Figure 2. Robot Pepper.

Activity states	Interaction codes	Face Stereotype	Indication Devices
Shutdown	Head lowering, eyes and ears light shutdown	Happy	Neck motor, smiling mouth
Power on	Eyes lights power on, intermittent eyes white light, incandescent eyes light (rotating), ears light turning on, head raising, head movement	Happy	Eyes LED, ears LED, neck motor, smiling mouth
Stand-by	Head movement, blinking (preference, on-off-on eyes light)	Happy	Eyes LED, ears LED, neck motor, smiling mouth
Input	Head turning towards the interlocutor, dynamic eyes blue light (rotating), dynamic ears blue light (rotating)	Happy	Eyes LED, ears LED, neck motor, smiling mouth
Output	Head movement, eyes green light	Happy	Eyes LED, neck motor, smiling mouth
Positive Feedback	Head movement, eyes green light	Happy	Eyes LED, neck motor, smiling mouth
Negative Feedback	Head movement, eyes green light	Happy	Eyes LED, neck motor, smiling mouth

Table 4. Pepper anthropomorphic robot analysis.

Robot iCub

iCub (Figure 3) was produced in 2009 by the Italian Institute of Technology and proposed as a direct prototype to a community of Open-Source software developers, for the development of different behavioral models that can be used in multiple advanced functions such as the therapy of patients with autism.

The presence of LEDs used to simulate the eyebrows and the mouth of iCub allow the face of the robot to acquire greater expressiveness, however limited by a smaller presence of interaction codes, resulting in a more arid type of communication compared to the case previously examined (Table 5).



Figure 3. Robot iCub.

Activity states	Interaction codes	Face Stereotype	Indication Devices
Shutdown	Closing eyes	Neutral	Animatronic eyes, eyebrow LED, lips LED
Power on	Opening eyes	Neutral	Animatronic eyes, eyebrow LED, lips LED
Stand-by	Neutral eyebrow, neutral lips	Neutral	Animatronic eyes, eyebrow LED, lips LED
Input	Arched eyebrow, lip corners pulled, double blink	Surprised	Animatronic eyes, eyebrow LED, lips LED
Output	Turn towards the interlocutor, double blink	Happy	Animatronic eyes, eyebrow LED, lips LED, neck motor
Positive Feedback	Turn towards the interlocutor, double blink	Happy	Animatronic eyes, eyebrow LED, lips LED, neck motor
Negative Feedback	Turn towards the interlocutor, arched eyebrow, lip corners relaxed	Sad	Animatronic eyes, eyebrow LED, lips LED, neck motor

Table 5. iCub anthropomorphic robot analysis.

Robot Moxie

Moxie (Figure 4) is a robot designed by the Embodied company in 2020. A companion for children aged five to ten that supports social, emotional, and cognitive development through play-based learning.

Compared to the two previous cases, Moxie uses a different technology: equipped with technologically advanced 3D display, in fact, the presence of indication devices is greatly reduced, limited to the display and the movement of the neck, but increases the expressiveness of the face and the number of interaction codes that the robot uses to communicate with the user (Table 6).



Figure 4. Robot Moxie.

Activity states	Interaction codes	Face Stereotype	Indication Devices
Shutdown	Shutdown animation on 3D display, eyes and mouth closing, head lowering	Neutral	3D display through eyebrows, eyes and mouth graphics, neck motor
Power on	Power on animation on 3D display, eyes opening, yawn, squint, alternate movement of eyebrows, head tilting and shaking	Happy, surprised	3D display through eyebrows, eyes and mouth graphics, various icons, neck motor
Stand-by	Head movement, eyes blink, alternate movement of eyebrows, various facial expressions	Happy, surprised	3D display through eyebrows, eyes and mouth graphics, neck motor
Input	Head turns to the interlocutor, eyes blink, alternate movement of eyebrows, various facial expressions	Happy, surprised	3D display through eyebrows, eyes and mouth graphics
Output	Head movement, eyes blink, alternate movement of eyebrows, mouth moving (speaking), various icons showing, face dimming to show read messages	Happy, surprised, disgusted (wince), angry (wince), sad	3D display through eyebrows, eyes and mouth graphics, various icons
Positive Feedback	Head movement, eyes blink, alternate movement of eyebrows, mouth moving (speaking), glittering graphics	Happy, surprised	3D display through eyebrows, eyes and mouth graphics, various icons
Negative Feedback	Head movement, eyes blink, alternate movement of eyebrows, mouth moving (speaking), various icons shown	Surprised	3D display through eyebrows, eyes and mouth graphics, various icons

Table 6. Moxie anthropomorphic robot analysis.

Conclusions

The aim of the essay was to explore the theme of communication and in particular language as a code of interaction between man and robot. Starting from the thought of Tomás Maldonado who, in 1994, hypothesized that increasing sophistication of robotics could make superfluous some types of interfaces for the exchange of information between man and machine (Zingale, 2018), the research activity was developed with the aim of investigating what are today the predominant features in the communication between man and robotic machine. In fact, the aspects that, thanks to innovative technologies and increasingly interactive robotics, have changed the modes of communication have been highlighted, defining new fundamental elements of interaction that only partially refute the progressive intuitions of Maldonado.

The anthropomorphic robots analyzed in the discussion, in fact, represent a growing trend in both social and industrial robotics, so it is configured in this context, an interaction between man and machine and the sharing of their respective capabilities and potential; humans are entrusted with activities of cognitive value related to intelligence, while the robots are entrusted with activities considered heavy or tiring for the user or tasks that he is unable to perform.

Through the identification and analysis of three reference examples of anthropomorphic robots, the current state of indication devices was verified, analyzing, at the same time, how the degree of facial stereotyping influences the codes of non-verbal interaction between humans and robotic systems in different fields of application.

The data collected from the analysis files of the individual application examples were compared: in particular, as can be seen in Table 7, the relationship between the interaction codes and the indication devices was analyzed, and a ranking of the degree of facial expressiveness was drawn up based on the number of facial expressions of the three cases analyzed.

The degree of facial expressivity does not always affect the expressive complexity of the robot: low facial stereotyping can be supported by interaction codes outside the face, e.g., the Robot Pepper, despite having a low degree of facial expressivity, turns out to be very communicative thanks to the support of arm movements. The relationship between interaction codes and indication devices, therefore, is directly proportional to the degree of complexity of the indication devices. For example, the Robot Moxie has many interaction codes because it uses a display with a very interactive interface.

Therefore, returning to Maldonado's input mentioned above, although the indication devices have evolved over time, using more and more advanced technologies, from the research and analysis of the application examples identified, their use is still necessary in some cases of user's interaction.

The combination of artificial machines with the physiognomy of the human face leads to consider anthropomorphic robots as a living model of interaction that, to date, leaves open many questions about the possible new ways of communication with robots implemented through increasingly innovative and adaptive technologies.

The research activity carried out lays the foundations for future investigations in which it will be necessary to examine how an excessive stereotyping of the face of anthropomorphic robots could lead to the definitive disappearance of the indication devices still present in robotic systems.

The fifth revolutionary wave in industry, Industry 5.0, demonstrates how it is crucial to design interactions in synergy with a growing awareness of the value of humans in symbiosis with advanced machines. It is described how a value design guides on the one hand the identification of user's needs and on the other hand the implementation of specific technological solutions, thus supporting the migration towards a symbiotic Industry 5.0 (Longo et al., 2020).

The figure of the new anthropomorphic robot, in the context just described, will be characterized by the management of complex tasks not only during the performance of production processes but also dur-

ing the performance of daily duties; innovative machines will therefore be able to acquire skills and configure sensory and perceptual interactions with the user.

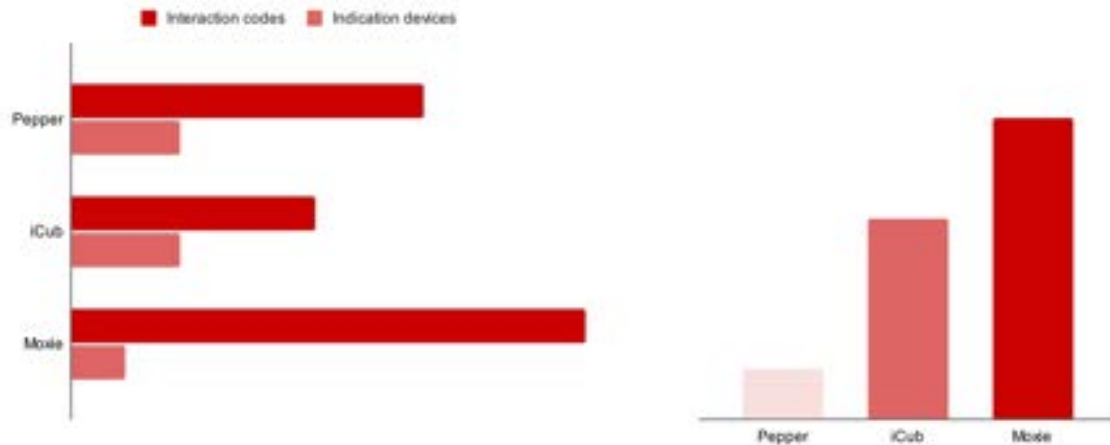


Table 7. Comparison of interaction codes and indication devices; degree of robots facial expressiveness.

In this context, design becomes a fundamental field of study to define and discuss the issue of communication between humans and robotic systems increasingly anthropomorphic in appearance to improve interactions, reduce discomfort and achieve greater satisfaction for user's well-being. But above all, design must become the escape route from what Masahiro Mori (2012) defines as the uncanny valley: a depression of the sense of familiarity with the robot that leads to a feeling of disturbance and that makes its appearance when the degree of similarity with the human being is unthinkingly and excessively increased.

In the near future, the role of designers will be to lead the design of interactions with increasingly high-performance and adaptive robotic systems to create efficient and satisfying environments that are more and more adapted to the needs of the user of the future.

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Maria Claudia Coppola is PhD student in Design at University of Florence, DIDA – Department of Architecture – and member of REI Design Lab – Reverse Engineering & Interaction Design – where she takes part in interdisciplinary design research activities. Digital culture enthusiast, her research develops at the intersection of future studies and policy sciences to foster public value through design. She is currently working with local municipalities and other research institutions to make a designerly contribution to contemporary multi-scale goals, like carbon neutrality and sustainable transition. With Margherita Tufarelli, *Mediated identities: values of fashion in digital culture* (2022); with Elisabetta Cianfanelli, Margherita Tufarelli, *Product Advanced Design: A cultural intermediation between knowledge and information* (2021).

Enrica Cunico, graduated in Product Design at the Iuav University of Venice, has worked as a product and graphic designer in metalworking and jewelry manufacturing companies. In 2018 he worked as a research fellow dealing with issues related to Industry 4.0 and the man-machine relationship in the industrial sector. In 2020 she was teaching assistant in the Fundamentals of product design course at Iuav and is currently a PhD student in Design Sciences at the Iuav University. With Pierfrancesco Califano, Giovanna Nichilò, Filippo Papa, Emilio Patuzzo, Raimonda Riccini, *Il museo-archivio virtuale del Vkhutemas: strumenti per un laboratorio di storia del design* (2022 – in press); with Luca Casarotto, Pietro Costa, *Design, space management and work to-*

ols: enhancing human work in transition to Industry 4.0 (2021), with Luca Casarotto, *Design multidisciplinare nell'Industria 4.0. La progettazione come espressione ed integrazione di saperi e tecnologie* (2020).

Daniela D'Avanzo is PhD candidate in Design at Politecnico di Milano. She has worked for many years in the visual design field, carrying on several projects for national and international clients, never leaving aside her personal interest in the design research. Her work now focuses on wayfinding systems and her doctoral research is aimed at studying the orientation processes in general terms and, in particular, in urban public places. With Salvatore Zingale, Daniela D'Avanzo, *Far sentire il benessere dei luoghi – Progetti di orientamento come esperienza di immersività* (2021).

Chiara De Angelis is a designer and PhD candidate in Innovation Design at the University of Camerino. Her research thesis focuses on design for emergency, in particular it aims to investigate the resilience strategies that industrial design can implement during a deep crisis situation. Previously, she graduated with two honors degrees in Industrial and Environmental Design (2016), then in Computational Design (2020) from the University of Camerino. Simultaneously practicing as a junior designer and participating in international design research workshops, she has consolidated her interests towards issues related to process and product sustainability.

Federica Delprino is PhD student in Design at University of Genova and MSc in Communication Design at Politecnico di Milano. Her research focuses on inclusive design processes and tools, investigating the principles that bring assistive technologies into the mainstream and lead to the normalisation of the former. In particular, she is interested in the use of touchless solutions and design methods based on multi-sensory and multi-modal interactions: broad-spectrum solutions based on a universal design approach. She is subject expert and assistant in Interaction Design for the MSc of Digital Humanities and in Design Fundamental for the BSc in Design; she is a tutor in Service

Design for the MSc in Product and Event Design. As a multi-disciplinary designer and content creator, she is also involved in European projects on topics such as landscape tourism, in research support and in the production and strategy of audiovisual content. *Digital and Physical Margins Pre-Visions for New Interactions in the City in Progress* (2021); with Maria Carola Morozzo della Rocca, Alessandro Bertirotti, *Dalla limitazione dei gesti a nuove possibilità – Modalità di interazione touchless e opportunità* (2021), *Soluzioni touchless tra opportunità e inclusione. Tecnologia a distanza: dalle mani alla voce* (2022 – in press).

Paride Duello is a service and product designer and currently PhD candidate at the Department of Planning, Design and Technology of Architecture of Sapienza University of Rome. His research is focused on the relationship between design and disability and in particular on the concept of Disability led Design: an approach to design that sees the community of people with disabilities as a resource to enhance the design process and make it accessible right from the conception phase. Therefore, his thesis analyzes the benefits of bottom-up design and community-made design also for a greater social integration of marginalised communities within the urban context. He received his bachelor's degree in Industrial Design in 2017 and his master's degree in Product Design in 2019, both from Sapienza University.

Marco D'urzo is a PhD student at the Politecnico di Torino. Since 2018 he has been working on the topics of the Circular Economy, Social-Solidarity Economy and Social Cooperation, that are now his PhD research themes. He is also active in the social inclusion project “Costruire Bellezza”, where designers work with homeless people to foster empowerment and inclusion processes. With Nicolò Di Prima, *Una didattica circolare e “appropriata”: ambiente, tecnologia, società* (2021); with Cristian Campagnaro, *Social Cooperation as a Driver for a Social and Solidarity Focused Approach to the Circular Economy* (2021); with Cristian Campagnaro, Raffaele Passaro, “*Design is one*”, *un canone grafico del progetto di social design; 10 anni di ricerca-azione* (2021).

Dipl.-Des. (Univ.) *Moritz Elbert* MSc. is exhibition maker, independent curator and PhD student in TU Munich and Iuav of Venice. He graduated in Industrial Design, museography and museology at the Politecnico di Milano before moving to Lisbon where he established his atelier specialising in communication strategies for cultural institutions. After a post-graduation in curatorial practices, he begins to research and create exhibitions of design, architecture and contemporary art, expanding the communication practice to museums and cultural institutions. Since 2015 he lives and works between Munich (Germany) and Venice (Italy), developing digital strategies for cultural goods.

Riccardo Fazi is dramaturg and researcher in the field of performing arts, graduated in Anglo-American Languages and Literatures. He is the author of plays, performances, operas and radio programs. After working for four years in New York as assistant to Caden Manson (Big Art Group), in 2006 he founded the company Muta Imago with Claudia Sorace. Since then, he has created the dramaturgy and sound design of all the company's works, which are performed in Italy, Europe and the Middle East. For several years he has been combining his work in the field with a path of investigation and theoretical research on the role of dramaturgy in the performing arts. He teaches sound dramaturgy at the Faculty of Architecture of Sapienza University in Rome and at the DAMS in Lecce. He realizes audio-documentaries for Rai Radio Tre (*Antologia di S.*, 2015; *Le piccole storie*, 2018; *Sparizioni*, 2020) and for Internazionale (*Limoni*, 2021). He is currently working on his doctorate in contemporary dramaturgy.

Fabrizio Formatì received his bachelor's degrees in Mechanical Engineering in 2015 at the Second University of Naples and in Design for Innovation in 2018 at the University of Campania Luigi Vanvitelli. He is a PhD student at the Department DI (Department of Engineering) of the University of Campania Luigi Vanvitelli. In 2018 he started his PhD in Environment Design and Innovation at the University of Campania Luigi Vanvitelli in Aversa. His thesis focuses on the deve-

lopment of methods for the evaluation of human-robot collaboration applications in the manufacturing system of Industry 4.0 in order to improve the design of new collaborative robotic solutions.

Stefano Gabbatore graduated in 2015 in Design and Visual Communication with a thesis entitled *Archetype of a high performance steering wheel* under the supervision of prof. Claudio Germak. He then moved to Florence, where he continued his studies with a master's degree in Design and graduated with a thesis entitled *ErgoTech SmartMove*, supervised by prof. Francesca Tosi. With a background that over the years has turned and consolidated on ergonomics and user experience, he worked as a scholarship holder at the Politecnico di Torino, again under the guidance of prof. Germak, from 2018 to 2020 before starting his PhD in Management, Production and Design in November of the same year. *White X* (2021); with Xavier T. Ferrari, et al., *COMMON SPACES. University scenarios for the return to a-normality* (2021); with Lorenza Abbate, et al., *Here. Human Engagement in Robotics Experience* (2020).

Antonello Garaguso is PhD student at the School of Architecture and Design of Unicam, he is developing a thesis in the Innovation Design curriculum. After completing his master's degree, he started working in the field of communication and graphic design, collaborating in university projects as a scholarship holder and carrying out some support activities for teaching. His PhD research investigates the role of design in the design of digital archives as online devices for the valorisation and promotion of companies' cultural heritage. With Carlo Vinti, *Il design per la valorizzazione del patrimonio aziendale: il caso dei marchi storici Averna e Cynar del Gruppo Campari* (2020); *Symbiotic short circuits* (2019); with Carlo Vinti, *Averna. A Sicilian and Italian story* (2018).

Luca Guerrini is associate professor at Politecnico di Milano where he has worked since 1993. A trained urban designer, he has carried out applied research and projects in the field of transportation and envi-

ronmental design, interior and spatial design, design for cultural heritage. His studies focus on the concept and perception of space in the relationship between design and the arts. He teaches Interior Design and Arts and Languages of the Present at the School of Design. Since 1999 he has been a faculty member of several PhD programmes and is a former Director (2015-2017) of the PhD programme in Design. He is in charge of the joint Politecnico di Milano and Tsinghua University of Beijing degree programme in Design. Since 2018 he is Dean's delegate for admission test of the School of design. He has lectured on MA and PhD Courses in Italy and abroad. Design and architecture exhibition curator, he has acted as consultant to the National Museum of Architecture in Ferrara, Italy (2000-2006), and has taken part in national and international architecture competitions. Author of books, essays, and papers presented in national and international conferences. His current scientific production focuses on design pedagogy, and on design research methodologies. *Students at the centre of the action* (2020); *Towards the future. Insights on research and training* (2019); *New Hospitality: investigating the meaning of hybrid* (2019); with Alice Devecchi, *Empathy for Resilience* (2019); *Envisioning the future: report on a first year design-studio project* (2018); with Paolo Volonté, *Dialogues on Design. Notes on Doctoral Research in Design 2018* (2018).

Alessandro Ianniello is a product designer for Innovation and a PhD student in Design at Politecnico di Milano, where he also works as research fellow and tutor for bachelor and master's degree courses. He is part of the Environmental Design Multisensory Experience (EDME) Interdepartmental Laboratory, dealing with subjects such as extended realities and immersion. He has also been invited as a lecturer in various private universities. His research is focused on imagination, and on its role in fostering transformations towards responsible and just futures. He is also tackling topics such as sustainable and digital tourism, experience design and cultural heritage. With Giuseppe Amoruso, Stefania Palmieri, *Digital Strategy to Enhance Jordanian Tourism Sector: A Post Pandemic Gap Analysis* (2021 – under review); with

Stefania Palmieri, Mario Bisson, Alessio Righi, *A sport project and its future applications: how to implement speculative design to fulfil users needs* (2021); with Stefania Palmieri, Mario Bisson, *Environmental Design Multisensory Experience. Integrated space for simulation activities* (2020).

Ilaria Lombardi is graduated in Architecture with honor at the University of Campania Luigi Vanvitelli, qualified as an architect in 2020, Competent Technician in Environmental Acoustics since 2019 (EN-TECA). PhD student of Environment, Design and Innovation course of the XXXVI CYCLE, at the Department of Engineering of the University of Campania Luigi Vanvitelli, in the area of Industry 4.0 and human-machine interaction. Author of 24 publications in the field of applied acoustics. With Antonella Bevilaqua, Giuseppe Ciaburro, Gino Iannace, Amelia Trematerra, *Acoustic design of a new shell to be placed in the Roman amphitheater located in Santa Maria Capua Vetere* (2022); with Gino Iannace, Amelia Trematerra, *Effects of nightlife noise in a city center* (2021); with Silvana Sukaj, Giuseppe Ciaburro, Gino Iannace, Ilaria Lombardi, Amelia Trematerra, *The Acoustics of the Benevento Roman Theatre* (2021).

Fabiana Marotta is transdisciplinary designer and currently PhD candidate in Design at University of Naples Federico II (Architecture Department). Her current research focuses on the relevance of the political dimension in contemporary design, intercepting the complex relationships that exist between design and politics in order to build new theoretical frameworks in which to reconfigure the social and cultural dynamics of our time. *Diciotto storie per una contro storia della cultura tecnologica del progetto* (2022); with Marina Block and Massimo Perriccioli, *From Emergency to Emergence: re-think design approach in a transitionage* (2021).

Elisa Matteucci is PhD student and a design researcher at the Design for Sustainability Lab in the University of Florence. She has been part of the Design for Sustainability Lab research team since 2019 where

she is a designer and curator. Specifically, she works on several exhibitions in collaboration with MIDA (Mostra dell'Artigianato di Firenze) such as Craft 4.0, new perspectives of making. She mainly deals with communication design and data design. Actually she is working on research projects such TiAmbienta (Tecnologie Intelligenti per gli Ambienti di Vita), Prismamed (Piano Rifiuti e Scarti in Mare da pesca, acquacoltura e diporto nel Mediterraneo) and Robocoop (Realtà aumentata, storytelling evoluto, blockchain nel processo di innovazione di innovazione circolare e tecnologica delle cooperative sociali)

Matilde Molari, MSc in Systemic Design, is a PhD student at the Department of Environmental, Land and Infrastructure Engineering (DIATI) of the Politecnico di Torino (Italy). She carries out research in the Applied Ecology Group, dealing with vertical greenery in outdoor urban contexts. She investigates environmental and social impacts deriving from re-naturalization projects. With Mariangela Francesca Balsamo, *Ri-costruire una natura contemporanea* (2022); with Elena Comino, Laura Dominici, *City that embraces nature. Designing with vertical greenery* (2021).

Giovanna Nichilò is an architect and exhibition designer. Her professional experiences include works in Exhibition Design for scientific museums, fairs and events; Creative Industry; Digital Fabrication and Design of teaching activities for STEAM matters; Grant Research in Inclusive Museum Design at Laboratory of Ergonomics & Design at the University of Florence. Since 2020 she is a PhD student in Science of Design at Iuav University of Venice and investigates aspects of space-user interaction in Exhibition Design with a focus on spatial responsive and interactive applications in medical museums. With Gabriele Pontillo, *Site-Responsive. Critical of the Interactive Environments in Exhibition Design* (2022); with Francesca Tosi, Antonella Serra, Alessia Brischetto, *Asking Users. Questionnaires as Indirect Observation Tools in Human-Centred Design Approach* (2021).

Monica Oddone is PhD student in Management, Production and De-

sign and MSc in Ecodesign at Politecnico di Torino. She complements her research work with the design of honest, human and environmentally friendly products and services, also achieving international recognition and awards. Her PhD research focuses on the definition and development of new products and strategies, suggested by design approach, to enhance cultural value and local excellence, with particular reference to the valorisation of the identity of Politecnico di Torino through merchandising. With Doriana Dal Palù, Beatrice Lerma, Marco Bozzola, *Il wayfinding nei luoghi della cultura. Un progetto per il Castello del Valentino* (2020); with Irene Caputo, Marco Bozzola, *Design and Cultural Sites: new signage methods and languages for fruition, accessibility and storytelling* (2020).

Angela Denise Peri, naval architect, yacht and ship designer. PhD candidate in Naval and Nautical Design, University of Genoa. Her MSc thesis, awarded with honours, is focused on the project of an electric hybrid solar catamaran for passenger transport, with particular attention to issues related to sustainability and accessibility by people with physical disabilities and sensory-perceptual alterations. Her research activity is focused on the definition of design guidelines applicable to cruise ships in the post Covid-19 era, with reference to smart materials and contactless technologies. She is paper author and speaker at international conferences and teacher of a professional education course dedicated to the same topics. She holds management training seminars and is co-lecturer at the courses of Construction Science, Psychology for Design and workshops dedicated to the project of cruise ship units and electric vehicles, one of which is held together with Beijing University of Chemical Technology.

Filippo Petrocchi is product designer and PhD student at the University of Ferrara. He is author of scientific paper and lecturer at national and international conferences regarding inclusive and sustainable design. His areas of expertise include: design for elderly, transportation, UX, UI, HMI. Complete the profile several awards and publications at national and international level. *Awareness, compatibility and equa-*

lity as drivers to resilience in sustainable design research (2021); with Giuseppe Mincoelli, Silvia Imbesi, *How Co-design Leads Mobility Innovation Towards a More Inclusive and Senior-Friendly Transportation System* (2021); with Giuseppe Mincoelli, Michele Marchi, Silvia Imbesi, Gian Andrea Giacobone, *Cittadinanza smart thing: Smart objects al servizio di città più attive e inclusive* (2021).

Valeria Piras is a Design PhD student at the University of Genoa. Interested in the constant relationship between design and politics, her research investigates the role of the current design educational context in relation to actual political and social issues, looking at it through the lens of feminist philosophy. *Intersectionality in Visual Design Education* (2021); *CAPS LOCK. Una panoramica sull'ultimo libro di Ruben Pater* (2021); *Discomfort in Visuality* (2021).

Barbara Pizzicato is currently a PhD student in Environment, Design and Innovation at the University of Campania Luigi Vanvitelli. She took a Bachelor Degree in Design and Communication at Politecnico di Torino and a Master's Degree in Design for Innovation (curriculum Eco-fashion) at Luigi Vanvitelli. Her field of investigation concerns circular and systemic design with a strong focus on innovative processes and technologies for circularity in the textile field. Among her latest publications: with Maria Antonietta Sbordone, et al., *0_Textile. A Design Research applying Circular Economy in the textile field; An Ideal Triangulation in Fashion and Textile: Industry, Academia and Users; Fashion Confronting Unrelated Sectors: The Ideal Model of Manufacturing Symbiosis Between Industrial Systems* (2021).

Gabriele Pontillo is an Italian product designer. In 2019 he obtained a Doctoral Research Fellowship in Environment, Design and Innovation at the University of Campania Luigi Vanvitelli. Main focus of his line of research are parametric design, medical design, and advanced manufacturing – knowledge acquired during his academic path. With Carla Langella, *Fluctuating Intelligence: Bioinspired 3D Printed Design on Textile* (2021); with Carla Langella, Roberta Angari, *Intersection*

Between Design and Science in the Mediterranean Food Landscape (2021).

Raimonda Riccini is full professor at the Iuav University of Venice. She was coordinator of the PhD in Design Sciences (2012-21) and Deputy Director of the Doctoral School (2016-21). In 2013 she conceived and directed *Frid. Fare ricerca in design*, the national forum of PhDs in design. Hers are the project of the Bembo LS Writing Laboratory and the Bembo OE Editorial House, of which she is editorial director. Co-founder and president (2014-18) of the Italian Association of Design Historians, she directed the journal “AIS Design. History and Research” (2013-21). From 2021 she is president of SID Italian Design Society. (Edit by) Tomás Maldonado, *La speranza progettuale. Ambiente e società*, 2022; *I linguaggi dell’interazione: Olivetti e la Scuola di Ulm*, 2021; *Design e innovazione. Una visione critica in tempi di incertezza*, 2021; (edit by) Tomás Maldonado, *Bauhaus*, 2019; (edit by) Frid 2017. *Sul metodo/Sui metodi. Esplorazioni per le identità del design*, 2018; *Gli oggetti della letteratura: il design tra racconto e immagine*, 2017.

Davide Romanella is architect and PhD candidate in Sustainable Urban Planning at the International School of Advanced Studies in the University of Camerino. He is a member of the EcCoItaly company where he has developed a qualified profile on the management of competitive issues and projects in the sector of urban redevelopment and regeneration of open spaces in the technological and environmental fields. He carries out a doctoral research entitled *Post-vernacular architecture, territorial technologies for a distant future* focused on the sustainable aspects of architecture, characterized by the concept of “circularity”. *Light* (2021); with Federica Ottone, *Una “Nuova Archeologia” per la Ricostruzione dei Paesaggi Colpiti dal Sisma* (2020); with Roberta Cocci Grifoni, Anna Bonvini, Graziano Enzo Marchesani, Paola Tassetti, *Nuovo Rinascimento* (2020).

Beatrice Rossato is an Italian fashion designer. She is a PhD student in Design at the Design Department of Politecnico di Milano. Her research focuses on the relationship between jewellery design and digital

technologies, particularly on the dematerialization and virtualization of body equipment and on learning tools to design digital accessories. With Alba Cappellieri, Livia Tenuta, Susanna Testa, *Digital Filters: A New Way to E-Wear Jewellery* (2021); with Livia Tenuta, Susanna Testa, *An Example of Innovative University Teaching and Learning: the Fashion-Tech Model of Integration* (2021).

Jing Ruan is a Design PhD student at the University of Florence. Her research explores sustainable and creative design solutions for enhancing the competitiveness of local agriculture based on innovation projects in China and Italy. Since 2019 she has served as deputy secretary-general of Wuhan Industry Association and Design Committee of Hubei Packaging Federation, responsible for organizing exhibitions, competitions, project cooperation. She has been a teacher in the Visual Communication Design Department of Wuhan Technology and Business University from 2005 to 2018. *Research on value conversion from agricultural products to creative products* (2019); *To explore the Italian city of creative visual design* (2017); *Personality vivid bottle and jar – on the composition of the beauty of Morandi painting* (2015).

Manuel Scortichini is PhD student in Innovation Design at the International School of Advanced Studies, University of Camerino. Since 2018 he has been collaborating in teaching as tutor in university courses, as correlator of three-year theses and in the organization of exhibitions, conferences and educational seminars at the School of Architecture and Design Eduardo Vittoria in Ascoli Piceno. His PhD research explores the relationship between new digital technologies and communication systems in museums, with particular attention to new strategies for interactive exhibition design. With Enrica Lovaglio, *Guerrilla art in the city: Urban and social revitalization* (2021); with Enrica Lovaglio, *La città come opificio sperimentale* (2021); with Giuseppe Losco, Davide Paciotti, Carlo Vinti, *The fifth dimension of interaction design: conversation with Gillian Crampton Smith and Alessandro Maserdotti* (2021).

Elettra Scotucci is visual communication and graphic designer and PhD student at Sapienza University of Rome. Her main research topics are typography and graphic design history, and the relationship between design and new craft in the particular field of the contemporary production of wooden typefaces for letterpress printing. Together with his PhD colleague Andrea Vendetti, she runs a letterpress printing studio in Rome, Slab, which is also a key spot for historical researches, experimentation and educational projects. Currently she is Teaching Assistant to professor Daniele Capo in the Type Design course, both in the English and Italian curricula, at the DCVM master's degree, at Sapienza University. With Andrea Vendetti, *United in isolation. An online letterpress festival* (2021).

Nicoletta Sorrentino graduated in Architecture in 2014 from the University of Genoa. From 2017 she collaborates, first as Cultore della Materia and then as assistant, to the courses of Design History and Fundamentals of Representation for Industrial Design in the Department of Architecture and Design of the same university. Since 2019, she has been enrolled in the Phd Course in Sciences and Technologies of the Sea, developing her thesis on graphics and communication onboard large passenger boats. Among her most recent publications, *Communication, orientation and wayfinding aboard great ships: towards an integrated and user-centred system* (2020); *The Design of Spaces for Young Children and Preschool in Emergency* (2019); with Luisa Chimenz, *For your pleasure only* (2018) and *Known for Unknown. Images from the Past for the Present Future* (2017). She collaborated on research for the book *Handmade in Italy* by Claudio Gambardella (2020).

Giovanna Tagliasco is designer and PhD student in Design at the Department of Architecture and Design of the University of Genoa, Italy. She is researching the effectiveness of tools in design and service design projects. She works on how to visualize processes. *Service design: la co-progettazione nella ricerca che sconfini. Confini e contesti* (2021); with Marialuisa Taddei, *Zoom in e zoom out sui comportamenti: risorse di progetto* (2020); “*Graphicizing*” *Service Design* (2020).

Margherita Vacca is architect, PhD student in Sustainability and Innovation for the Design of the Built Environment and Product System (curriculum Design) at the University of Florence. Her research aims to reflect on the complex system of social realities belonging to the Third sector system, trying to understand how design can exploit its connective and maieutic capacity to promote the exchange and acquisition of necessary skills for the challenges of future scenarios. With Fabio Ballerini, *La cura del Design: nuove forme di inclusione socio-professionale dei migranti. Processi di codesign per la valorizzazione del dialogo interculturale* (2021); with Marco Marseglia, Francesco Cantini, Elisa Matteucci, Alessio Tanzini, Giulia Pistoiesi, *Design con il Mediterraneo. Nuovi metabolismi materiali e immateriali, intrecciando traiettorie tra saperi, miti, mare e racconti* (2022); with Irene Fiesoli, Fabio Ballerini, *Togetherness. Design con le imprese sociali* (2022).

Angelica Vandi is PhD Student in Design and MSc in Design for the Fashion System at Politecnico di Milano. During her career, she took part in the Design Management joint program with Jefferson University, Philadelphia. As a research fellow, she followed the development of the “DigiMood for CCIs” European founded project. Her PhD research focuses on rethinking the ways of modelling, preserving and transferring fashion cultural reservoir making use of new media technologies, understanding how the digital sphere could be employed to augment the tangible and intangible value of fashion heritage. *Fashion Design Education Towards Twin Transition. Developing multidisciplinary skills for future professionals* (2022); with Paola Bertola, *Global Fashion Conference* (2021); with Paola Bertola, *Designing Interactive Narratives for the Fashion System. MOOC and blended learning in a transdisciplinary design module* (2021); with Ilaria Mariani, *Head '21, 7th Educational Conference on Higher Education Advances*.