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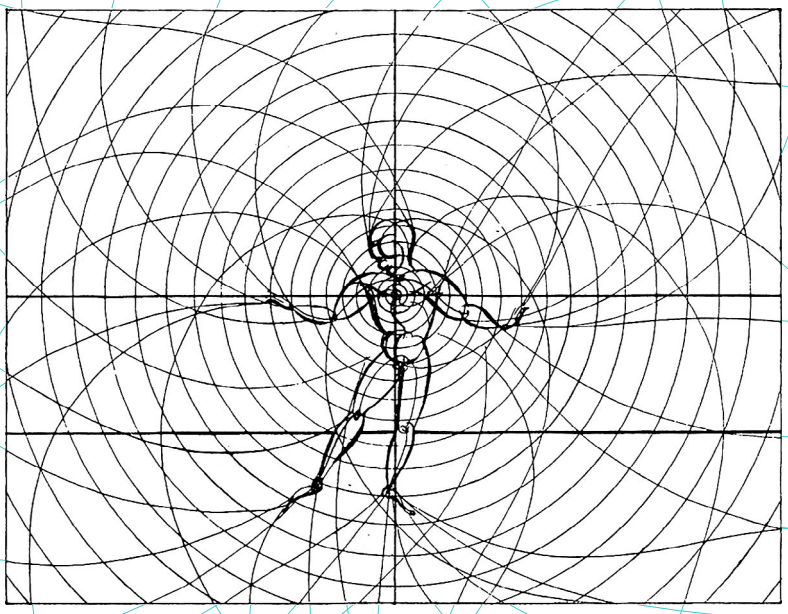

Colophon

diid
disegno industriale
industrial design
No. 74 — 2021

Year
XIX

diid is an open access peer-reviewed scientific design journal

diid is published three times a year

Registration at Tribunale di Roma 86/2002 (6th of March 2002)

www.diid.it

Print subscription (3 issues)
Euro 60,00
Subscription office
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Publisher

Bononia University Press

Bononia University Press
Via Saragozza 10
40123 Bologna
Tel. (+39) 051 232 882
Fax (+39) 051 221 019
www.buponline.com
info@buponline.com

ISSN
1594-8528

ISSN Online
2785-2245

DOI
10.30682/diid7421

ISBN
978-88-6923-960-1

ISBN Online
978-88-6923-961-8

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(published by Langen München, 1925)

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The protagonist of the Open Debate section of issue No. 74 is the human body. We are interested in exploring the relationship between the human and artificial body through design cultures and practices. Within this field where human and machine merge, we are interested in achieving the interaction between human beings through machines and artifacts.

As Advanced Design Unit of the Università di Bologna, we have been exploring this area by organizing the *Future Design Human Body Interaction* international Symposium, which featured the main scientific event in June 2021. The project has established an observatory, fully accessible online, where it is available a significant archive of projects, created in collaboration with forty reporters; they allowed us to process and file three hundred case studies that were debated in the Symposium by authoritative colleagues from the research and production areas that operate on the border of contemporary design-driven innovation.

A boundary that shifts constantly and rapidly because the relationship at issue is overwhelmed by digital revolution, dematerialization, and the rupture of the dimensions of space and time.

A boundary that moves quickly also because contemporary society has given up many things, especially during the Pandemic, but has contributed to increase exponentially people's attention to the transformation of body and mind (empowerment and embodiment) in what B. Joseph Pine and James H. Gilmore over twenty years ago already called “the phase of transformativity”. And in this transformative process, the designer is revealed to be an actor not only in the design of the artificial, but also of the organic. Thus, if until recently, we could separate the organic from the artificial, the person from the machine, and believe that the interaction lived in the middle ground between these two fronts, today, and in the near future, we can no longer do so.

Let me highlight that the international contributions of authoritative articles submitted to the editorial office in the last four months has been astonishing. The Designrama section is enriched with interesting contributions, in increasing quality and quantity, that should provide an analysis of the research potential that the world of knowledge is able to offer.

A special thanks goes to all the staff: in a few months they have set up the management machine and functional processes that, in the case of a scientific journal, also represent the structure that guarantees scientificity and authority.

Flaviano Celaschi
Editor-in-chief

Open Debate

This Open Debate section has the aim of describing a renewed focus on the body as a design field and opens issue No. 74. The questions about physical, psychological and perceptual aspects associated with networking, both in its dynamic and symbolic relationship between body and artifacts, play a fundamental role in the design of contemporary products and services. The emerging technological developments make full inclusion of the body more and more real, and the design recognizes this and begins to move towards conscious dialogical horizons.

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Human Body Interaction From the Imaginary to Contemporaneity

Anticipation Design Processes

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Abstract
Interfaces and prostheses, whether physical, visual, or virtual, are more and more characterized by an ever-increasing level of complexity. In this designing scenario, the relationship with cognitive sciences, ergonomics, semiotics, and the contribution of enabling technologies is transforming the field of product design into that of the design of complex systems that interface the relationship between human and machine.

This paper, starting from the analysis of fiction, scientific literature, and state of the art, analyses the imaginary vision of man-cyborg and the transformation of his body by integrating and becoming dependent on technology to open a debate on a new design relationship between the body and digital artifacts. A new scenario focuses on re-discovering the human body as a design field, paving the way towards a post-human area of application in which artifact and prosthesis are balanced. The research tries to address the transformation of the relationship between the human and the machine through the evolution of Key Enabling Technologies.

Keywords
Human Body Design
Interaction
Prothesis
Homo Saluber

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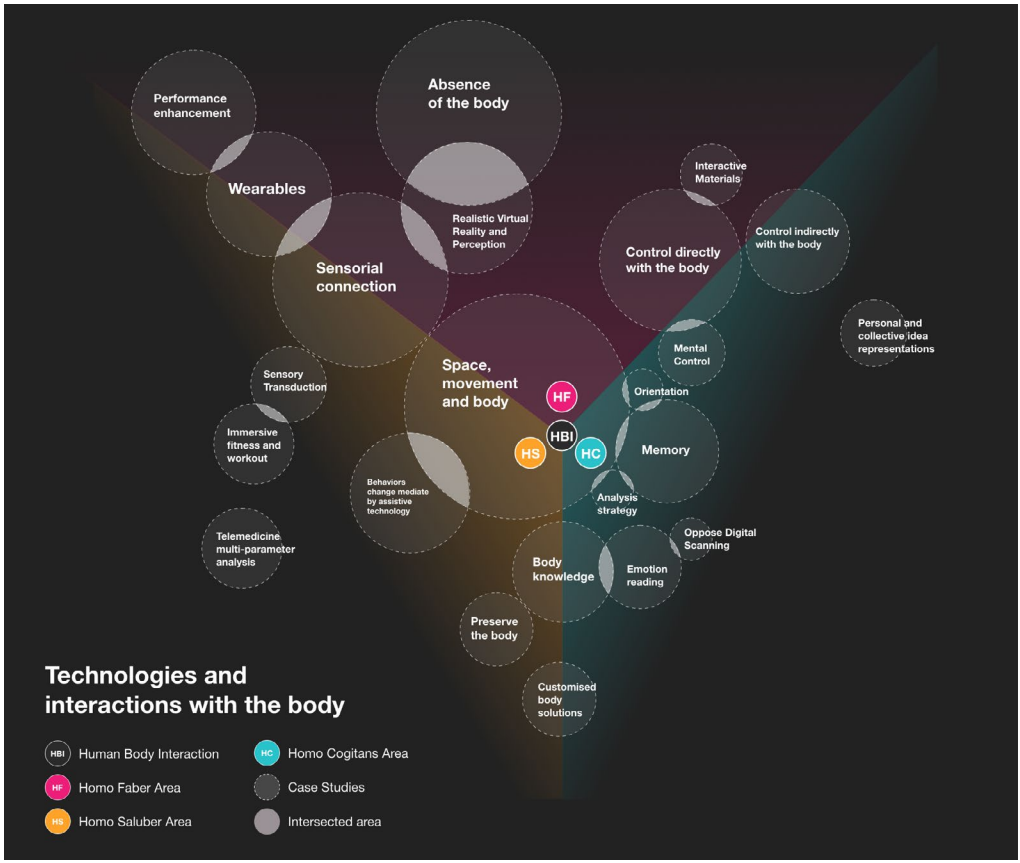

Fig. 1
Technologies and interactions with the body, by Michele Zannoni, Giorgio Dall'Osso and Marco Pezzi.

> [...] any organism is held together in this action by the possession of means for the acquisition, use, retention, and transmission of information. (Wiener, 1948, p. 161)

Introduction

The aim of this research was to investigate how the broader concept of interaction between human / machine / artefact is becoming, in its contemporary form, a set of interactive flows, both real and virtual, and not only the physical and motorial actions of our limbs but the entirety of our mind, body in motion, and cognitive system.

Interfaces and prostheses, whether physical, visual, or virtual, are characterized by an increasing level of complexity and designers who have been working in this field for several time have found guidance in cognitive, ergonomic, and semiotic sciences to discuss and support their project choices. This continuous evolution of interaction tools brings with it processes of dematerialization of artifacts that gradually turn into complex socio-technical systems.

1
The paper was conceived, written and reviewed jointly by the authors. Andreas Sicklinger produced "A vision of future in the body design from novels to reality". Michele Zannoni is responsible for "The origin of the scientific debate" and Marco Pezzi is responsible for "The research and the results". The discussion section and the conclusions were jointly written.

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Doi: 10.30682/diid7421a

The relationship between body and product is becoming dematerialized, losing the gestural nature between the physical relationship and the awareness of action, relegating the experience of "making" to a process of interaction provided by the machine (Marchis, 2005, p. 322).

This investigation wants to explore innovative products, discover new systems and case studies of relationships between human, machine, and objects. The methodology presented has developed a double channel to analyze the research results in relation to the futuristic storytelling occurred in historical fiction from 1800 onwards, in which the prosthetic man anticipates the vision of the cyborg man (Hayles, 1999; Mitchell, 2010), who becomes dependent on technology with his transformed body, until the current state of the art of contemporary real projects that have reached a level of maturity and are already applied.

This inspirational and anticipatory dimension, which is now contemporary and growing fast, re-proposes the body as a design field where the integration with technology and the non-natural abilities that can be activated, leads us towards a post-human design scenario in which the subtle balance between artifact and prosthesis is integrated into new objects in a continuous relationship with the body.

A Vision of Future in the Body Design From Novels to Reality

The wish to improve through technical innovations, but at the same time the fear to lose humanity, goes back in the arts to the beginnings of industrialization. To start with, Mary Shelley's novel *Frankenstein or The Modern Prometheus*. It appeared already in 1818 as a settlement with scientific hubris in the guise of horror romance. Human Body sciences, after a thousand year of medieval reclusion by the Church, during Renaissance starts to gain slowly terrain; however, it takes hundreds of years and brave surgeons to understand more about the body. A body that slowly is understood as a machine, and the old school of Hippocrates, which analyzes the body only through external symptoms and excretion is abandoned (Sicklinger, 2020, p. 32-36). Leonardo's genius was needed to explore the human body as an interconnected system. Still today, his anatomical studies fascinate the observer by accuracy when looking at hyper realistic representations of upper limb or hand anatomy. But the more impressive sketches are the ones where Leonardo transforms the human joints in mechanical pieces, drawing the heart as a two-chamber oven or compares a neck with a ship mast to move the head. However, the fascination of technology, steam, mechanics, and movement also accelerate the interaction with the human body as an object of research and analysis. Many diseases brought by the bad work and life condition during Industrialization drew the attention of some brilliant surgeons like Charles Turner Thackrah (1795-1833) on working conditions, gaining both the increase of health condition of workers for a higher benefit of the factory owners (Sicklinger, 2020, p. 54-57).

After 1900, some art movements took the side of engineering: "Le's prepare the imminent and inevitable merging of man with the engine", proclaimed Filippo Tommaso Marinetti in 1911, a self-proclaimed pioneer of the Italian Futurists. His call for self-abolition was premature, but it produced rousing works of art. The dynamism of new beginnings and the intoxication of speed have probably never been celebrated more euphorically than in the pictures and sculptures with swirling lines of force by Giacomo Balla or Umberto Boccioni. Especially in the cities, new types of conditions emerged, increasingly characterized by the mechanization of all areas of life. On the one hand, they brought with them a variety of environmental problems such as the pollution of water, air, and soil, but also a variety of forward-looking innovations. Municipal water, gas and electricity companies provided artificial light and flowing water not only in public life, but soon also in the private sector, while electric trams accelerated public transport. Subways were added to the big cities and the first automobiles began to liven up the streets. The technological metropolitan culture became the basis for diverse visions optimistic about progress, but also for experiences of loss of natural life contexts and for novel clinical pictures. The nerves of many people seemed to be no longer able to cope with the increasing speed, the noise and the hectic pace of industrialized society, the neurasthenia disease spread and became the hallmark of an "age of nervousness" (Radkau, 1998). Still in 1923, Le Corbusier proclaims "Une maison est un machine à habiter" enlarging this idea of city life into the personal living space, visually made famous through the epic film *Metropolis* by Fritz Lang in 1927.

What was originally understood as the integration of the machine with the human being as an innovation, since the machine can surpass human abilities (especially strength) by a thousand times, has become more and more detached over time and the human body itself becomes a "machine", regarded as the place of mechanical-biological elements. With the advance of medicine, what Mary Shelley portrays in a horror novel becomes increasingly reality: transplantations, repairs, improvements to human organs and the skills associated with them. Frankenstein will not accept himself and his body: similar, but opposite in result, is the idea of the exceptional soldier and worker that fires the imagination of ideologies, especially those based on anticapitalism: the example of Aleksej Grigor'evič Stachanov. Exceeding the workload expectations, becomes a hero of the social parties but eventually fails by not standing the new glory. The social dimension of the phenomenon becomes immediately visible. Dealing with an almost superhuman ability is of particular importance on a socially responsible level, which cinema wants us to believe in the idealized forms of the superheroes by Marvel's Superman, Spiderman, Batman etc. And by the end, the term Stakhanovism today represents not the, from the socialists' Party desired success for work improvement, but an insane attitude of work exaggeration, often leading to workaholism[2].

The spirit of time of *Human (as) Engines*, highly performant, powerful and perhaps indestructible, was alimented by philosophical ideas like the *Übermensch*, which has been translated as "Beyond-Man", "Superman", "Overman", "Uberman", or "Superhuman". This superhuman is an "ideal person" who has outgrown ordinary

2
Voice of "stacanovismo" (o "stachanovismo") in *Dizionario di Economia e Finanza*. https://www.treccani.it

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life of a person who is considered normal and mostly negative. But the scientific progress went much further than the hypothesis of the most famous *Übermensch* by Friedrich Nietzsche, who can perform better through an *above-average health*. According to Nietzsche, the future person will first and foremost need one thing, *great health* — something which one not only has, but also constantly acquires and has to acquire, because one must give it away again and again (Virilio, 1996, p. 118). In *Thus spoke Zarathustra*, for Nietzsche the consequence of these statements is well known:

> this brings healthier people, dangerously healthy people, or rather *Übermenschen*, whose reward is to have a yet unknown country in front of you, the borders of which no one has yet ignored, a beyond all previous countries... (Virilio, 1996, p. 119)

It sounds like the end sequence of the 1992 film *Blade Runner*, when the Android declares "I have seen things you people wouldn't believe", pointing out the impossibility of human bodies to face certain environments, that needs stronger bodies: it becomes his claim for the right to live. Paul Virilio calls this the *Planet Man*, a universally adapted body prepared for interstellar travels. But eventually he finds in his book *The Conquer of the Body,* that the new frontiers of science are no longer to be sought in the large dimension of the universe, but in the extremely small dimension of nanotechnology and, connected with this, the effects and interventions on and especially in the human body (Virilio, 1996, p. 120). This is the new front of modern science. Instead of the bite of a spider or the breath of an Egyptian Cat that generates a superhero, we ought to think that what is closer to a real future vision of *Übermenschen* is the fictional character Molly Millions from Gibson's *Neuromancer* from 1984: a cyborg with advanced features which augment body senses and enhance defence capabilities in order to be superior to the adversary. We ourselves, humans, become the interface of advanced technology to improve limited body performance.

The Origin of the Scientific Debate

The evolution of systems of interaction between the body and artifacts, the relationship between function, usability and continuous geometric-formal research are the elements that characterize man's striving to expand and modify his body over the centuries. Contemporary design praxis shows us how the balance between form and function has been broken down in recent decades, by abstracting the tool and its consequent virtualization in which the interface has taken on a central role in the relationship between body, mind, and artifact. From that point on, these artifacts mediating the relationship between man and tool and the machine became increasingly invisible towards the fusion with the interface object (Bonsiepe, 1995).

If we can consider the first chipped flints the first projects of man (Marchis, 2005, p. 6), from the point of view of anthropological studies on the evolution of man, the modification of his own body is considered the first tool created by the primitive being (Mumford, 1967; Celaschi, 2016). He voluntarily altered his phys-

icality by increasing his ability to interact with the environmental system, assigning his upper limbs more and more precision roles and relegating the lower ones to other functions mainly related to displacement. In this, on body transformations centered, evolution, the role of the interface was mediating the relationship with the prosthetic artifacts, which from being extensions of the body gradually became an integral part of it (Zannoni, 2018). Starting from the assumption that every artifact used by man can be considered as a prosthesis (Maldonado, 1997, p. 141), the relationship between man and objects represents an interactive process based on artifacts that replace or extend his capabilities. Extending this assumption to the probably more extreme position[3] of Marshall McLuhan (1964) in which even the media could be considered as a translation of ourselves, it helps us to understand how the immaterial element of two-way information transmission becomes the essence of an interface project that is configured as an element of relationship with a prosthetic body. Maldonado already in 1992 proposed (p. 13) to start considering this prosthetic dimension as a "technology of thought" citing Allen Newell and Nobel prize winner Herbert Simon who first moved the debate on artifacts, interaction, and technology to the level of dialectics and information exchange.

The theoretical discussion that gave rise to design thinking about interface design can be found in various writings emerged in the mid-twentieth century after the end of the Second World War. In relation to this, several theoretical positions, now historicized, show up that allow us to examine the scientific debate, in which the interface is understood as an instrument of control and dialogue between different biological, physical and virtual entities. We can try to highlight some main lines of thought: among the first ones, certain theories draw a methodological approach from the principles of cybernetics, a discipline theorized by Norbert Wiener in 1948, in which control, computation, and feedback are fundamental elements of a new design approach based on multidisciplinary and collaboration between sciences. The aim of cybernetics was to reduce the distance between the biological and cultural dimensions of man and the communication process, and the evolution of this discipline would condition cognitive studies and interface design, which is based on the same concept of feedback as formulated by Wiener in the 1950s.

With respect to cognitive studies on the relationship between man, artifacts, and the environment, opposing positions can be distinguished with respect to some fundamental elements of interaction design. On the one hand, the ecological psychology theory of James Gibson (1979) and on the other hand the theoretical position of Donald Norman (1988; 2007; 2013) focused on the design and the perception of the users that confronted in time the role of the semiotics of the project of visual communication (de Souza, 2005). In the Italian context, Sebastiano Bagnara's, Gui Bonsiepe's and Giovanni Anceschi's (1993) points of view emerge, which show how developing usable and natural interfaces gives value and meaning to the user experience. The criticality that emerged at the end of the 20th century in the transition from analog to digital (Cooper, 1998) gradually opened to more and more precise studies on interaction processes and on the physical,

3
"Since all media are extensions of ourselves, or translations of some part of us into various materials, any study of one medium helps us to understand all the others" (McLuhan, 1964).

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formal and perceptive aspects of artifacts. The increase in the responsiveness of interfaces is making it possible to reproduce the communicative flow between our bodies, objects, and spaces in a more real and natural way.

The Research and the Results

The research stems from the need to analyze and question the state of the art of technological processes and design in relation to the human body that has emerged with the development of systems and devices increasingly in contact with humans (Casoni & Celaschi, 2020).

This survey aimed to bring out the most contemporary and significant designs for innovation processes, starting from an analysis of the current context to tell and anticipate new future trends and technological and design developments.

After a year of work that began in 2020, a reflection emerged on three main anthropologies of the human being: the creation and construction of tools (Homo Faber), the inspiration for the incessant search for well-being (Homo Saluber), and the knowledge of one's own body in relation to others and the environment based on the use of data and information systems (Homo Cogitans). The research gave rise to a structured mapping which, by taking these three areas into consideration, opens a debate on the centrality of the relationship between interface and body.
To activate a reflection on design in the field of interface design, it was decided that the research results emerging in the project could form an ongoing observatory on interface design issues.

This method based on a participatory survey tested in previous symposia organized by the Advance Design Unit of the Università di Bologna and refined in following years (Celaschi et al., 2021, p. 16), is part of the consolidated Future Design framework aiming to integrate knowledge, models, and networks from the micro to the macro scale of research by collecting case studies. Three hundred projects were listed and reported by forty reporters. The process of analysing and mapping the case studies proved essential for the launch in 2021 of the ongoing observatory on the themes of interaction design and design of the body.

The development of a taxonomy for cataloguing was one of the main points that characterized the development of the repository, helping to bring out the characteristics of the projects in relation to the themes of production processes, technological maturity, and methodologies with a design-oriented approach Fig. 1.

This repository was built thanks to a systematic collection of data of the projects catalogued, giving rise to a relational database of case studies, people, and companies in relation to the three anthropological macro-areas of reference; thanks to the semantic mapping in relation to the senses of man and technology, areas emerged in which to deepen the research in the continuation of the project. This work of structured analysis will continue to evolve over time with the aim of progressively restoring the state of the art and future emerging trends in the context of human-computer interfaces.

Following the structuring of the observatory, the evolution of cataloguing taxonomies by integrating a more systematic approach to technologies and complementing the five traditional senses with proprioception according to Charles Sherrington's 1913 scientific position that indicates it as the ability to perceive and recognize the position of one's body in space in relation to the totality of the body and the contracture of its muscles (Tuthill & Azim, 2018) is found to be essential. This evolution of the semantic cataloguing keys of the case studies is an open process that in the long term will characterize the observatory and allow the evolution of the analysing tools with the aim of developing increasingly structured readings of the data.

4 https://www.ultraleap.com

5 https://teslasuit.io

Discussion

The Human Body Interaction Symposium followed the aim to activate a debate, with the result of focusing on three main fields of application: learning from human, interacting on body surfaces and feedback in immersive virtualization.

The first research field shows two ways of Human-Machine relationship, that are emerging: the one is the traditional human control on machine, while research is moving to an inverse model in which the machine learns from human. The setup of neural networks, capable of interpreting human movement in an increasingly precise manner is gradually becoming a stable reality that can be implemented in design processes. Low-cost technologies give rise to complex systems of relationships between sensors and humans. Google's experiments with the TensorFlow open-source library focus on the use of low computing power hardware to track human behaviors and thus show a specific direction to integrate Artificial Intelligence (AI) in everyday things.

The second field is related to investigations that recognize the entire psychological state of the body. After a pioneering phase that defined the main aspects of affective computing (Picard, 1997), these technologies have significantly grown in flexibility and availability, to the extend to be deeply embedded in interface design. Neuroscience literature confirms that the emotional state or its arousal are connected to cognitive load, attentional distribution and operational choices.

In the last field of interaction with artefact, the last twenty years have been characterized by always more precise construction of high performing screens. Still, the rigid and planar configurations of screens limit the real touch experience. Recent projects show a new frontier of tactile interaction, that will lead to new interactive systems: they will connect the human and machine through a deep control.

It is of growing interest to make the haptic feedback channel active and reconfigurable as communication channel for interaction. Companies like Ultraleap[4] and Teslasuit[5] are working on projects that aim to make possible haptic feedback in space or reproduce tactile and sensorimotor responses to physical actions with programmable interaction. Both are potentially precious aids to add reliability and verisimilitude to immersive visual interaction. The exclusive interaction experiences on digital platform erases the

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real three-dimensional experience in two dimensions: what can be accepted generally however opens to a critical reflection on the limitation of the perceptive process of the complete immersion of interrelation. Interpersonal communication is based also on empathic and emotional, body driven messages, which are erased by digital tools. The result is a flow of communication lacking whole fundamental parts of body language that reduces the physical component associated with sound and words. The absence of the body limits the transfer of emotions in the relationship, in the art and in all the learning processes that involve the body in its entire physical and psychological aspects.

Last reflection raised by this research relates to the role of technology in transformative processes of humans. From early experiments, like the Neil Harbisson's Cyborg, which tried to compensate the lack of part of their chromatic spectrum vision, to more recent research shows important potential towards an increasingly hybrid sensorial communication. The replacement of missing or deficient parts of our bodies and the theme of prosthetics has acquired maturity. The functional fruition and replacement give way to "sensory transduction" in which the lack of one sense is transferred to another through technologies that commutate the signals in different representation. Times seem to be ready to transfer medical knowledge of body repairing to the empowering human body design.

Conclusions

The design directions that we have been highlighted, discovering only a few paths between the three macro-areas which we had set out to investigate. The evidence of the cases analyzed shows that it is now necessary to open a structured multidisciplinary debate on these themes, which until now have only been analyzed through the emerging technologies and their potential to construct products and services, but now they could open a new age of transformative artefacts for woman and man and their bodies.

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The investigation carried out on the three macro areas Homo Faber, Homo Saluber and Homo Cogitans in the first research phase opens to further investigations involving additional characteristics of human, possibly the Homo Ludens (Huizinga, 1938), Homo Creator (Di Rupo, 2018) and others. This is only the start of understanding the new relationship between design and the body, which has been approached according to the logic of product and market, but which is now changing towards a dimension of design for the well-being of the individual and communities. This well-being, a holistic approach to the body from a physical and cognitive point of view opens up to amplify traditional research fields such as physical and cognitive ergonomics, melting the disciplines into a new way of dealing with the body. What has been anticipated by technology and medicine, now reaches design related applications to the human body, giving inedited opportunities to specialized professionals to investigate on medicine, sports and labor by raising performance, self-consciousness and well-being. It will be a design practice built on knowledge of technologies and biosciences.

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diid No. 74 — 2021
Doi: 10.30682/diid7421a

The protagonist of the Open Debate section of issue No. 74 is the human body. We are interested in exploring the relationship between the human and artificial body through design cultures and practices. Within this field where human and machine merge, we are interested in achieving the interaction between human beings through machines and artifacts.

As Advanced Design Unit of the Università di Bologna, we have been exploring this area by organizing the *Future Design Human Body Interaction* international Symposium, which featured the main scientific event in June 2021.

Flaviano Celaschi

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No. 74 — 2021
Anno XIX
ISSN 1594-8528
ISSN Online 2785-2245

Bononia University Press

Euro 27,00

ISBN 978-88-6923-825-3