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THE HUMAN BODY IS THE INTERFACE

*Michele Zannoni**

In the interaction design fields, we have often considered the interface a tool between the human body and another entity, regardless of whether the entity is another living organism, an object, a machine, or a system.

In the Italian context I have trained in, the form of the interface has been – for many years – a topic of discussion that has seen different points of view (Anceschi, 1993; Bonsiepe, 1995; Maldonado, 1997; Bagnara & Pozzi, 2011) but now more than ever, this design context – understood as a control instrument for something external to our body – is dissolving and vanishing into the artifacts, just like the concept of machine or computer is slowly becoming physically and culturally invisible (Norman, 1998). Sebastiano Bagnara and Simone Pozzi (2011) had already envisaged this moment of transformation in the past, but the reflection I present today as a conclusion of a years-long research path leads me to claim that the design discussion on the body has returned to the front stage, and the artifacts we identify in our sector as *interfaces* are gradually integrating with the same.

This design scenario is not a recent event but has already been the subject of multiple experimentations in art and media studies in the past. The exhaustingly quoted claim by Marshall McLuhan, who stated that even media may be considered an extension of man (1964), helps us understand how relationship and communication tools may be a single entity composed of mind, body, and interface. About this position, considering the contemporary technological debate and keeping in mind that most adults in the more developed countries daily use a smartphone to communicate and connect to the web, it is fair to claim that such devices are also extensions of our bodies we cannot do without if we wish to relate to the system we live in.

This symbiosis in the communication system becomes evident from the moment we culturally *hooked up* to the web and its servic-

* *Dipartimento di Architettura, Alma Mater Studiorum - Università di Bologna, Italy*

es that sped up long-distance communication (Bauman, 2000) and demanded a part of our brain to focus on such devices (Flusser, 1990; Bannon, 2006; Bagnara, 2006; Zannoni, 2018).

To assert the above, I believe it is necessary to review – through several analyses – some of the innovation processes emerging in the past few years in the Human Body Design context, defining as a problematic field the technological implications that growingly contaminate the artifacts and the forms of interaction that humans may adopt in using them.

In this reasoning, it is not simple to set a limit and classify the designs currently identified as wearable devices, but it is important to consider how these may be, first of all, the result of a gradual size reduction of existing objects external to the boundaries of the body. We may, instead, identify a second class of designs born, in relation to the human and the body itself and configured as prostheses (Maldonado, 1997). This second kind of object is a quite promising design path in which innovation processes are forming new scenarios where the body may integrate daily and harmonically with such instruments.

The instruments of humans

If we reconstruct the steps that humans have taken to design their instruments, a meaningful reflection on the design implications on the body and its artifacts has emerged in anthropological research. We have acknowledged that in terms of the construction of everyday interface tools, the signs of humans' approach to the construction of artifacts with a focus on ergonomic demands already existed in ancient times. The relationship between humans and tools was primary, and the units of measure were based on the body itself. The transformation of the being into *Homo faber* – a craftsman who uses tools and machines – was a fundamental moment when humans separated from his instruments and placed them in a workplace (Marchis, 2005, p. 6). The relationship with machines that took shape over the centuries mutated and definitively matured in the Fordist age, becoming a process of mechanization whereby the machine helps humans in high-precision operations and amplifies their strength. In the mid-1900s, following several experiments including Alan Turing's research on mechanical intelligence (Turing

& Ince, 1992) and Norbert Wiener's work on Cybernetics (1948), the age of automation reached a maturity in which machines control themselves by running programs defined by man. This operational ability – derived from the increase in the computational force of machines and the progressive evolution of sensors – would pave the way to mass production and the definitive loss of the relationship between the body and the act of production. In the first twenty years of the 21st century we are witnessing, instead, a gradual inversion of the human-machine relationship that is defined *heteromation* (Ekbia & Nardi, 2014): a different relationship where it is the human being that helps the IT instrument perform its tasks through choice processes that cannot be automated. These simple, everyday actions applied by humans to digital systems are a set of small, invisible activities – such as choices made online – supporting an Artificial Intelligence that needs to learn to act independently.

US anthropologist Levis Mumford (1967) – and, later, Flaviano Celaschi (2016) – stated that in their evolution, humans have constantly transformed their bodies to adapt to their environment. They improved the specialization of their upper limbs, using them more and more for high-precision actions compared to the lower limbs, which were dedicated to motion. This attitude was then conveyed to objects, with the first forms of prostheses, where clothing was added to the skin and tools were added to the upper limbs.

This process has never stopped. If, on one hand, we may consider these elements as systems of protection from the environment, we may underline, on the other hand, a continuous tendency to shift the primary functions of our social, communication, and working lives to the body in a new form of digital nomadism (Rifkin, 2000, p. 43; Saffer, 2006, p. 213; Zannoni, 2018, p. 74).

New and ancient human anthropologies

In humans' physical, social, cultural, and artistic transformation, we face multiple anthropologies that define them and describe their facets – for instance, in opposition to the figure of *Homo faber* we may consider the other component of human nature identified as *Homo ludens* by Johan Huizinga (1938) in his 1930s treatise establishing the theoretical and philosophical foundations of the role of play in the sphere of human relationship systems.

The human dimension of the playing man and the productive man show us two systems of interaction that in their often antagonistic nature involve human existence in a constant challenge – on one hand against the environment that we emancipate from through artifacts and, on the other hand, against ourselves and others whom we search for as antagonists in a relationship dictated by written or implicit rules.

In the work described in this book and brought forward with the research on Human Body Interaction topics, we have tried to introduce two more specific anthropologies that define the mind-body relationship with a more contemporary view: *Homo saluber*, whereby humans lie in a system of search for wellness, and *Homo cogitans*, whereby self-consciousness in relation to physiological data becomes an interpretation and prediction tool.

Given this interpretation of the human spheres and, more specifically, the way they use and relate to their body, we may affirm that the body-instrument relationship has been mediated by physical and semantic interfaces, gradually conditioning their design in the direction of a formal abstraction of control elements and consequent virtualization (with the rise of digital systems). The design of such artifacts that mediate the human-tool relationship has sought growingly natural forms and ways to replicate interaction processes, gradually pushing (growingly invisible) machines towards the fusion between object and interface (Bonsiepe, 1995).

Towards the body interface

Giving a contemporary definition of interface is not easy, and there is extensive literature on the topic including two very important texts along with the aforementioned ones: *Designing the user interface: strategies for effective human-computer-interaction* by Ben Shneiderman (1987), updated and renewed in different editions over the years, and *The Art of Human-Computer Interface Design* (1990), a comprehensive discussion by Brenda Laurel and S. Joy Mountford in which the two authors open the debate with the question: "What is an interface?". In Computer Science, the term *interface* indicates all the situations in which human beings interact with computers, but in reality, this term embeds a deeper meaning.

Upon analyzing the different texts emerging halfway through the past century – in the second Postwar period – the now historical theories clearly highlighted how control instruments have become communication media between different biological, physical, and virtual entities. Such scientific studies show the effects of the cybernetics principles introduced by Norbert Wiener in 1948, highlighting a new design approach in which control, computation, and feedback are fundamental components placing communication processes at the center of the human-machine relationship.

The importance of Wiener's theoretical research also prevailingly affected design education: Tomás Maldonado introduced cybernetics at the Ulm School of Design in the late-'50s (Maldonado & Riccini, 2019), clearly stressing the importance of feedback in the communication process. Cognitive sciences have also built on the concept of feedback starting from Wiener's research and defining a series of principles articulated by Donald Norman (1988) on the design of digital artifacts. In this framework, the expressions of such guidelines for the development of user-friendly interfaces have given life to numerous theoretical contributions to the field of interaction design (Tognazzini, 1991; Moggridge, 2007; Preece et al., 2004; Kolko, 2011; Tognazzini, 2014). Such theories have consolidated in time and set the basis for the contemporary design of interactive artifacts we use daily through our devices.

In the contemporary discussion on interfaces, the perspectives developed by those who have attempted to define a research scope have originated a series of scientific formulations in the different disciplines and fields that researchers and designers worked in.

If we apply the concept of an interface to the body and not as an element inserted between a man and an object, the discussion is even more complex. In my previous book (2018), I tried to develop a taxonomy of prosthetics based on an arrangement described by Maldonado in *Critica della ragione informatica* (1997), introducing the topic of passive/interactive prostheses or wearable appendices. The subtle distinction between prostheses and wearable devices depends on the type of interface created with the body, with the interface's control becoming so natural it shifts human limits beyond their physical potential. Artistic experiments by Stelarc (Dunne, 2005, p. 31) and scientific works by Kevin Warwick (Barfield, 2016, p. 5) have abundantly confirmed the overcoming of such perceptive and motor limitations.

The topic of limits or boundaries becomes interesting when we see the human skin as the ideal biological container for the first element of interaction with external artifacts, going beyond its obsolete *holiness* and breaking ground for numerous technological experimentations.

The body interface becomes a point of connection and links the human with a network of objects. William Mitchell confirmed this by forewarning a design scenario in which humans are connected with their devices. He introduced a neologism – *Bodynet* – along with a personal interpretation of the controversial topic of cyborgs (Mitchell, 2010). We are experiencing a historic moment in which the human-artifact connection is no longer limited to the cognitive sphere but becomes a physical extension of the human. This will be the basis of future designs in which neurosciences and design will combine to make the relationship between such symbiotic products we are designing more natural (Biondi et al., 2009; Casoni & Celaschi, 2020).

The design of an interface is growingly more a field that straddles the cognitive and bodily spheres in which the elements are slowly moving from the currently dominant visual/tactile dimension to the physical/perceptive dimension, invading our bodies from head to toe. Although cognitive sciences had begun to enunciate interface design theories ever since the early-1900s, more specific studies have emerged in the past 30 years in which perception, visual attention, and memory aspects have been assessed in relation to artifacts for control and interaction with objects, machines, and systems.

In the early approaches, the interface design topic was associated with the topic of machine control or in the IT field as a way to exchange information between different systems, but as mentioned this is an oversimplification that does not consider all of the implications involving humans and their bodies. If we analyze the etymology of the term *interface*, we find that it includes the connotation of a *face-to-face* relationship between two entities. In this sense, which is focused on the physical relationship between the bodies of human and nonhuman entities, the interface migrates from a physical/tactile dimension to an intangible/ephemeral dimension based on formal and semantic aspects. In this nature in which it becomes a growingly thin and digital layer (Zannoni, 2014), corporeality has atrophied on small screens, relegating the interaction process to mainly visual aspects.

This control system through a screen is increasingly dominant and marginalizes the design research on forms of machine-body integration and the multisensory aspects that our perception mechanisms may provide to the interaction processes. It is safe to say that such tendency to reduce the interaction mainly to visual screens is not yet configured as a *path dependence*, and the interface design possibilities are still open enough that the role of the body is not destined to remain on the fringes of such design debate.

Contemporary design scenarios of body interfaces

Given the experience gained in the past 20 years and based on literature, we may consider the graphic interface design context mature by now. The innovation processes that may be applied in this field are mostly incremental, and the implementation of possible disruptive innovations is unlikely. Desktop and mobile systems themselves have remained substantially unchanged in the past few years in terms of the conceptual models behind their design.

There is a currently open debate on the topic of responsive behavior of elements that leads to a reflection on minimum screen areas mostly designed for wearable devices and machines with control systems on their surfaces.

Such real-time control systems have evolved in parallel with the technology, and have turned from small and simple LCD screens to growingly accurate screens in terms of graphics and in the qualitative response to designer demands. The integration with the body has gained demand initially in the field of wearable devices for sports and, currently, everyday objects boasting functions dedicated to the generation of an individual's physiological data in the scope of personal well-being.

Whilst the control system has found a development on the body, achieving great versatility thanks to capacitive and tactile systems, the aspects related to feedback have not evolved, with the full range of haptic feedback relegated to vibration. On this topic, the field of natural stimuli (Dall'Osso, 2021, p. 43) is one of the most promising design scenarios for body-machine integration, although the rhythm and haptic feedback still remain insufficiently explored in literature and in design in general.

We have provided a wide range of experimentations on the topic in this book, and I shall only mention a few particularly interesting case studies. As far as the haptic feedback of touch in the absence of tangible elements, the work by Ultraleap[1] is a cutting-edge project whereby the human body perceives virtual shapes and objects through ultrasound (Romanus et al., 2019). On the other hand, the work done by Teslasuit[2] on feedback systems on the body is innovative and already marketed.

If, on one hand, the systems focused on communication methods through wearables and the body are rather promising, sensors and computer vision processes have, on the other hand, growingly evolved in the scope of tracking humans and their movements.

It comes as no surprise that nowadays we may use computer vision to track emotions very accurately. It offers the opportunity to design objects or systems allowing them to interface with man through a more comprehensive approach than their static geometry (Mengoni et al., 2021).

The broader topic of artificial intelligence is a primary research field in the evolution of human movement interaction and interpretation systems (Hayashi et al., 2021) that, depending on the tracking sensor type, allow the machine to hone its ability to interpret human movement in a new way. Little by little, machines are learning how to understand humans through their bodies and develop neural networks that embed the same more accurately.

While the machine is growingly able to observe us and understand us, it is tracking of the human body's vital signs that has become an impressive cultural phenomenon in the first twenty years of the 21st century. It has gained relevance in contemporary society and was studied in numerous projects related to the theme of the *quantified self* – a growingly popular personal awareness praxis from 2010 on.

This transformation in the way we understand our body, monitoring it with devices and analyzing the data it produces, has led us to gradually develop new data visualization tools to make the information collected by the sensors – currently affordable and accessible – visible.

Wearable devices can collect a wide range of vital parameters and such data, in most cases, show small variations that may only be understood when contextualized in a wider time inter-

val. This initiated a design discussion on how to represent corporeal data and how to help individuals understand the same.

The representation of human anatomy and proportions began with Fidia and Hellenistic art and continued with the search for muscular perfection in the Renaissance, with the rediscovery of the geometrical proportions of the *Vitruvian Man* by Leonardo da Vinci and the research by Leon Battista Alberti, which appeared as descriptive and comprehensive representations of human nature. This technical evolution in the iconography of the human body found its maximum expression in anatomy publications that exposed the body's fragile envelope and represented each of its parts in detail. The flap-book *De humani corporis fabrica libri septem* by Andreas Vesalius (1543) was an interactive tool for anatomy students that – by means of the overlapping illustrations – allowed them to understand the position and relationship between organs.

According to Maldonado, it was at that historical time that the human eye violated the body's holiness and new scenarios for the awareness of the human body had birth (1994).

Such works had reached such a high level of description of the human body that they were unchallenged until photography was used for anatomopathological purposes and later the modern medical imaging techniques. I hereby report the beautiful initiative by Anders Ynnerman for the British Museum in 2014, where the scientist promoted and made accessible the vast majority of the Egyptian mummy collection through CAT scans viewable by the museum visitors on multitouch screens (Ynnerman et al., 2016).

A true paradigm shift in the representation of humans in relation to their proportions in architectural spaces occurred when the first-ever ergonomic and functional products were designed in the mid-20th century, with the first *Modulor* anthropometric scales of proportion by Le Corbusier (1950) and the anthropometric charts in *Designing for People* by Henry Dreyfuss (1955).

The complexity of the human's contemporary visual representation and the multitude of related data becomes central from the moment they acquire a primary role in body-machine communication that – in a setting of interaction with data – becomes the only tool to represent the infinitesimal variations in our self.

Today, we experience a technological addiction to smartphones that – in just over a decade – have blown away every other possible

interaction tool. Nonetheless, this is not a definitive scenario: contexts in which we can design new, wearable devices in contrast with the totalitarianism of mobile devices may open up. Such technologies have been studied by numerous researchers and designers for decades and are reaching a suitable technical and formal maturity to enter the everyday markets and lives of people.

With the risk of homogenizing interface systems, pushing towards a mobile-first use is not the appropriate way to build interaction processes. It is evident that standardization helps to guarantee the usability of artifacts, but does not make the experience of humans seeking a gradual evolution new or alive.

Today we already have several kinds of wearable and augmented reality devices that are slowly undergoing miniaturization and integration with the body that will make them acceptable and suitable for daily use.

Such designs shall permeate the entire spectrum of human senses by pairing with sight, hearing, and touch. Experimentation concerning the vibration and communication aspects has only just begun.

Notes

[1] Ultraleap Ltd., https://www.ultraleap.com.
[2] Teslasuit, VR Electronics Ltd., https://teslasuit.io.

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