Metaphors and Embodiment in Virtual Reality Systems

Ana Carol Pontes de França(✉) and Marcelo Márcio Soares

Federal University of Pernambuco, Recife, Brazil
acpsicologa@gmail.com, soaresmm@gmail.com

Abstract. The dissemination and development of digital technology over the years allowed people to integrate products and computer systems to everyday life. These technologies, in turn, enables communication and human interaction and can be employed for many purposes, such as education, entertainment and entrepreneurial. In this scenario, the interface occupies a prominent place, allowing the user to be related with the system itself and interact with others in cyberspace. In such situations, there is an expansion of the user's consciousness that manifests expectations, desires, likes and interests through avatars. Although presented as a sign, the user takes the physical body as a reference with which he/she coordinate his/her actions in the virtual environment. In this sense, this paper aims to discuss the representation of the body in Virtual Reality (VR) systems considering the relationship between information, communication, culture and technology by the theorical and conceptual framework of Ergonomics and Human Factors Psychology, Informational Design, Cultural Psychology and Semiotics.

Keywords: Virtual reality · Semiotics · Metaphor · Interface

1 Introduction

The early years of the computers' history were characterized by its use by experts, like programmers, engineers, mathematicians and physicists, and by the design focused on technology. However, over time, computers have been incorporated into many products, becoming more accessible to a wide range of users, transforming both: work and social relations.

Due the increased demand for cognitive effort while performing a task with computacional devices, it became increasingly necessary to understand the characteristics, skills and human limitations of perception, learning, memory and problem solving in computational systems.

Consequently, the cognitive approach of the users characteristics and performance in these systems has become a key to the design and analysis of interfaces, which shifted the focus of technology-centered design for user-centered design[1].

[1] https://www.nngroup.com/articles-want-human-centered-development-reorganize/.

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Based on this principle, to be designed for human use, an object, system or environment must be adapted to the physical and mental characteristics of the user, so that the product be better integrated into the task context [1].

Adopting such considerations as a starting point, this study invites the reader to think how the cyberculture, with its technological artifacts and languages, mediates the communication and human interaction so that fiction and non-fiction become intertwined and take shape in images, virtual beings and parallel worlds in Virtual Reality systems.

2 Ergonomics and Informational Design

Considered a scientific discipline, Ergonomics takes a systemic approach to matters related to human activity. To do this, it employs scientific methods and techniques seeking to adapt the work to the physical and psychological characteristics of the human component in order to adapt the work to the worker, as well as the product to the user [1].

In this sense, it seeks to investigate, evaluate, weaving recommendations and ergonomic interventions in order to design environments, products and systems more compatible to support the users' needs, limitations and abilities.

According to Moraes and Mont'Alvão [1], based on the systemic and informational approaches, ergonomics, as an operative technology, sets to projects and products, workstations, control systems, information systems, computerized dialogue, labor organizations, task implementation and instructional programs, the following parameters: interfacial, instrumental, informational, actional, communication, cognitive, movimentation, spatial/architectural, physical-environmental, chemical-environmental, security, operational, organizational, instructional, urban and psychosocial.

That is, through methods, techniques and procedures, Ergonomics proposes tailor the presentation of the information to the users' mental model in order to understand how users search and organize information and solve problems while performing tasks in computational systems.

In addition, the ergonomics also seeks to understand how the objective and subjective experiences interfere with the users' strategies and how these strategies change with practice and with context changes.

According to Quintão and Triska [2], the Brazilian Society of Informational Design defines informational design as a graphical design area that aims to equate the syntactic, semantic and pragmatic aspects involving information systems through contextualization, planning, production and graphical user interface information along to your target audience. Its basic principle is to optimize the information acquisition process performed in analogic and digital communication systems.

In this sense, meet the ergonomic requirements enables maximize comfort, satisfaction and well-being, ensure safety, minimize constraints, human costs and cognitive load, optimize task performance, labor income and productivity of the human-machine system [1].

Thus, Ergonomics and Informational Design, focusing on the interface design optimization, are related to the users' mental models and to the reduction of the psychic and cognitive load which arise from the user experience.

3 Paralel Worlds and Virtual Beings in VR Systems

The Encyclopedia Britannica defines Virtual Reality as the use of computer modeling and simulation so that the person is able to interact with an artificial three-dimensional environment or any other sensory environment. In virtual reality applications the user is immersed in an environment generated by computer that simulates reality through the use of interactive devices that send and receive information and are used as goggles, gloves, headphones or clothing. Typically, a virtual reality user wearing a helmet with a stereoscopic screen see animated images of a simulated environment [3].

Consequently, Virtual Reality could be understood as part of a continuum: at one extreme we would have a picture or painting, which transports the reader or the viewer to the context of the story or image. At the other extreme we would have the ultimate display that according to Sutherland, its creator, would be a room in which the computer would control the existence of matter, so that in such room, a chair would be good enough to sit, handcuffs displayed in this room could arrest us and a bullet triggered in this room would be fatal [3].

As França and Soares [4] suggest, Virtual Reality (VR) is an advanced human-computer interface technology, which aims to recreate, with the highest degree of reliability as possible, the sense of reality, so that a person adopts this environment and the interactions occurring in it as one reality circumstantially plausible.

It's a synthetic environment with graphic simulation of fictitious and non-fictitious situations, computer generated, which can be constructed with a higher degree of accuracy by comparing with other grafic interfaces, such as multimedia, for example.

In this context, the (re)construction of daily life by technology allows us to think about the human condition in VR systems, so that, environments and devices, by principle considered products, be adopted as ludic elements and symbolic representation.

Think about the symbolic representation of the human in the virtual environment requires thinking about the physical body and how we consciously and unconsciously use it in our everyday life of screens: when we are in virtual environments we can enter, leave, perceive the environment, be located, interact, look, focus attention, gesturing, set the mood, to communicate, to talk about a point of view, shape the environment and create whatever it is from everything we know about the physical world, from everything that is familiar for us [5].

These representations of the self incorporate customized and anthropomorphic virtual bodies, the avatars, which are semiotic structures that visually communicate and replicate aspects of our identity and how we would like the others to realize us.

In this perspective, the avatars in virtual environments not only allow the representation of the subject in the virtual environment as well as enable human interaction through body movements and nonverbal communication (semiotic interactions) between the users.

In other words, while transiting the parallel worlds, the user adapts him/herself to the context changes assuming new perspectives and positions ("I" positionings in the digital world) which in turn is not independent of the "I" positionings manifested in the physical world [6].

In such situations, identities and digital lifestyles express how the users manifest their corporeality through digital culture. The virtual experience, subjective, multiple, fluid and complex, expands the user's notion about his own body (sense of presence) in ways that he/she can feel the simulated sensations by VR as his/her own sensations.

For Johnson [7], "an easy way to build a consistent interface is to follow the codes and conventions of the real world." In this sense, the characters created by the users present themselves looking like humans (anthropomorphism) in ways that they communicate, look, move, dress and gesture, not only to be more convincing and credible, favoring a greater appreciation and enjoyment of users [8], but also enabling the orchestration of the visual-motor aspects (physical body) and the semiotic mediation (metaphors on the screen), which helps the user to build a sense of self and of the environment that allows to act in and update the synthetic world [5].

Thus, the customization of the virtual environment, the avatar's creation, the playfulness and the narrative power of the digital world not only awaken the subject to an aesthetic experience (manipulating and creating virtual elements) but also invites him/her to inhabit the virtual environment, experiencing the sensations simulated by technology.

4 Interface and Interaction in Virtual Environments

Virtual reality allows the user to view three-dimensional environments, move in them and manipulate virtual objects which, in turn, can be animated, with autonomous behaviors or triggered by events [9].

In Virtual Reality, interaction is a fundamental concept and at the interface it is related to the computer's ability to detect and react to user actions. When interacting with a realistic three-dimensional virtual environment, the user can change the cenary, making a richest and most natural interaction, which leads to more engagement and efficiency while performing the task [9] (Fig. 1).

Fig. 1. A 3D realistic VR environment (source: https://www.youtube.com/watch?v=cML814JD09g&feature=youtu.be)

By engaging him/herself in a process of interaction in a virtual reality system, the user seeks to achieve a goal in a given context of use. For Barbosa and Silva [10], the context of use is characterized by all relevant situation for the user interaction with the system, which includes both the moment of use as well as the physical, social and cultural environment in which the interaction occurs.

In this scenario, the cognitive research began to emphasize the interaction, communication and machine-mediated dialogue [6, 11], instead of the traditional operation of machines, as shown, for example, since the beginning of Ergonomics [10, 12].

From a conceptual point of view, it is necessary to distinguish both the simplest and the complex VR interactions. In the simplest interactions, the user navigates jogging in 2D space, making use of devices such as mouse, keyboard and microphone, seeing the others users' point of view about the scenery, also marking the scene with his/her own point of view. An example of this type of navigation would be the *facebook*[2], in which the user can not only view and explore, but can also manipulate and transform the environment.

However, the more complex interactions will require from the user a higher level of immersion provided by the multimodal[3] devices and by the stereoscopic[4] effects available in virtual reality systems.

Through these devices and the system itself, the senses and abilities of people are magnified in intensity in time and space [13] so that people not only dip into an illusion but to perceive contextually the experience by even the sensation of physical involvement [4, 5, 14, 15].

That is, while interact, the users manipulate and transform the virtual environment, activating or changing the virtual objects, as well as he/she actively uses the imagination and the senses, activating the motor areas of the brain responsible for the body movement, in ways that allows the user to react in a virtual environment similarly what he/she would do in the physical world.

Developed to support interaction, the interface connects the virtual world to our bodies, immersed, that while act and interact, update the environment [5].

This allows the user to command and coordinate his/her actions in the virtual environment in order to be able to develop skills and knowledge from the semiotic interactions experienced in the synthetic environment.

For this reason we should conceive the interface ultimately as a synthetic way, in both senses of the word. It is a kind of hoax, a "false" landscape passing by the "real" thing, and - perhaps most important - is a form that works in the service of synthesis, bringing together disparate elements into a cohesive whole [7].

As Johnson suggests, our interfaces are histories we tell ourselves to ward off the meaninglessness: memory palaces built of silicon and light. They will continue to

[2] https://www.facebook.com.

[3] Visual, audible, tactile and kinesthetic that provides users with multiple informational inputs and outputs and hence a greater degree of immersion, presence, involvement and interaction in the system.

[4] The process by which two pictures of the same object taken at slightly different angles, are viewed together, creating a sense of depth and solidity. Available in: www.soundidea.co.za/home/Sound_Idea_3D-755.html.

transform the way we imagine the information, and in doing so will transform us too. - for better and for worse" [7].

Thus, this study considers the interface as the means of contact between a computer system and the human component of the system, whereby a person comes in physical, perceptual and conceptual contact, in order to explore, manipulate and change the environment virtual and him/herself.

5 The Tension Between Metaphor and Simulation

One aspect that calls Virtual Reality users' attention is that the higher level of immersion guaranteed by technology, provides people with a degree of involvement to the point of them feel present in the virtual environment, acting and interacting integrated to the context.

In this sense, the concepts of immersion, presence, interaction and involvement are fundamental to the study of virtual reality and are relevant to the physical and psychological understanding of users in these systems [3–5].

Although the 'presence' occurs when the brain processes, interpretes and understands multimodal stimulations (images, sound, etc.) as consistent environments, where is possible to the user to act and interact, the sense of presence is subjective [3–5].

This subjective aspect, however, is related to our experiences in the physical world, about the way our body feels and measures the world. In this sense Domingues [16] states that although we measure objectively the space in inches, feet, meters, our presence in the world is more subjective. It depends on the body as a measurement base for everything and sets our standards of scale and suitability. Just waiting so some feelings that they become transparent to us: the pressure on our feet when we walk, the sun on our heads, the horizon uniting earth and sky. Deviations from these expectations cause us discomfort and anxiety. Naturally we accept these standards, which are our guarantee that the world is in order.

Thus, the user perceives the virtual environment instead of his/her physical location and the necessary conditions to experience this presence are the involvement and immersion [3, 4].

However, our relationship with the physical world is not restricted to objects and environments. It also involves our relationship to each other. Similarly, while presents him/herself in the virtual environment, the user adopts as a reference the forms of life that he/she knows about the physical world, so that he/she can integrate the physical world to the imagination and fiction. In this sense, this study assumes that in the virtual environment, body and message are intertwined and constitute an event in which the subject is presented as a sign [11, 15].

Accordingly, on the cognitive point of view, the metaphor would be the link between the physical and mental worlds. Given that the virtual environment is symbolic, its contents use the physicality to acquire substance, since they have no own content effectively [16]. Thus, the user is able to establish connections, similarity relations and association of concepts in order to understand and grasp the new, the novelty [17].

In the book entitled 'Culture of Interface", Johnson [7] already warned us to the fact that our digital age belongs to the graphical interface, and it's time to recognize the work of the imagination that creation requires, and to prepare ourselves for the imagination's revolutions to come.

In this sense, virtual reality, since its inception, is revealed as an exciting and challenging technology that integrates devices, products and situations of the physical world to the users' fiction, imagination and creativity.

However, as a technology that requires edge devices, VR designers need, among other things, be attentive to the concept of affordance, which is considered essential to the analysis and development of interfaces. About that, Barbosa and Silva [10] state that the physical characteristics of a product provide evidence on what to do with it and how to use it. Similarly, the user interface keeps a set of features and operations that are important to guide the user about what the system is able to do and how he/she can handle the interface to do so.

With its origins in Psychology, the term affordance, adopted by Norman and adapted to HCI (Human Computer Interaction) area, corresponds to the set of characteristics of a product or system which are capable of revealing the operations and manipulations that the users can do with this system or product.

In a graphical user interface, for example, the affordances of a command button is the possibility to press it using the mouse or keyboard and thus trigger an operation in the system [10].

According to Preece, Rogers and Sharp [8], one design mistake is to try to design a metaphor interface in ways that it looks like and behave literally as the physical entity that it represents - which ultimately neutralizing the advantages of developing interface metaphors. As noted above, they are used to map the familiar with the unfamiliar knowledge, allowing users to understand and learn the new domain. Design interface's metaphors only like literal models of what is being used in comparison has been criticized, which is perfectly understandable.

According to Johnson [7], in interface design, as in modern art and pulp fiction, realism can sometimes be a vulnerability. In order to avoid restricting the user reasoning, it is necessary that the interface designers develop metaphors that combine the knowledge that people have about the physical world with the new features of the system.

About metaphor, Johnson [7] states that if the user has to relearn the language interface for each new project, the power of this unique metaphor will be seriously compromised. In other words, although what is being represented in the interface be something fictional, the user only understands and recognizes it as a realistic thing based on everything you that he/she knows from the physical world. Thus, while he/she interacts and interprets, the user recognizes the system responses in ways that he/she can plan the next steps of his/her interaction.

Thus, the metaphor fulfill its function since it would transport the meaning from one side to another between the materiality and abstraction [16] both in social and psychological levels.

6 Discussion

Over the years, several factors have contributed to the development of Virtual Reality products and systems. Among them, we can mention the researches' development, languages' development and applications as well as the availability of devices and products at increasingly acessible prices.

The evolution and greater accuracy of technological devices, in turn, provided a higher quality of the visual, facial and motor tracking, greatly improving the user's perception as part of the system. In this sense, the user do not only moves him/herself on the virtual environment, but he/she also grab, move, manipulate and feel virtual objects, that provide to users, in turn, more complex interactions.

Beyond these, other system attributes are also required so that these interactions can occur: the ability to reproduce the natural movements of the user (to point, select and manipulate objects), and the control through metaphors available in the interface or even through the user thoughts, as we have now seen in brain-computer interfaces.

These new possibilities of use focuses on the people in a more dynamic and creative way, making them more able to cope with challenges, solve complex problems and propose solutions.

However, in fictional environments, the novelty facing the unkown can cause discomfort to the user, as well as the need for adaptation and training to technology in some cases.

Whereas the virtual environment is fundamentally symbolic, based on metaphors, it is essential to understand how occur the relationships between the physical and the symbolic, between fiction and non-fiction, between virtual and physical "self", in order to better clarify how virtual reality can actually contribute to a better performance and human improvement.

In addition to its potential it is also necessary to identify the possible limitations of products and systems in order to offer ergonomic recommendations, improvements as well as better and new products and systems.

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