# Improving Humans

## Enhancing the complex sociological being with the virtual

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## ABSTRACT

In this paper, we argue in favour of using an immersive Virtual Environment (VE) in order to improve human capabilities. We develop this idea in order to advance the potential of VEs in enhancing humans. Training with VEs has proven in some cases to be more efficient than training in real world situations in terms of the reduction of time consumption, risk reduction, easily presenting specific simulation realism, all of which improve learning capabilities. The VE would be an environment for extending human capabilities, the goal being to increase experiences. This last affirmation could renew the scope of action for AH research: acquiring new needed capabilities from the virtual world that would be usable in both worlds, real and virtual.

## CCS CONCEPTS

• Human-centered computer • Hardware • Computer systems and organization • Social and professional topics

## KEYWORDS

Virtual Environment, Augmented Human, Complex System, Novel therapeutic discovery, Knowledge Transfer.

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## 1 Preamble

Throughout history, the force of genetic mutation and human evolution has always intrigued people. In the 1970's, we began to imagine human beings or sub-species of humanity endowed with special "powers" making them "homo superiors" rather than *homo sapiens*.

The first references of augmented human were brought to the public through comics and fictions (e.g. The Bionic Man, Wonder Woman, Superman, X-men, Spider-Man…). Pop culture has been responsible for introducing original ideas for possible future states of humans. Full feature films and series extended the ideas previously put forth. One may perhaps remember these well-known examples: Steve Austin was made to be an enhanced astronaut after an accident in the television series *The 6 Million Dollar Man*; Christopher Reeve had the role of civilian Clark Kent as *Superman* in four films from 1978 to 1987, as well as; Peter Parker in *Spiderman* in the form of cartoons and numerous films over that last 50 years. These ideas all spring forth from the *human virtual environment*, the mind. In what follows, we will discuss existent and possible VE's for the brain, body and the mind.

## 2 Introduction

The scientists brought the idea of augmented humans within the realm of the possible since then, combining humans and technology, both to allow people with impairments to progress in autonomy, and on the other hand, to allow humans to surpass their own capabilities. In this way, VEs could be seen as technologies allowing man to surpass himself.

How is a VE defined nowadays? A VE is an interactive smart computer-based system that provides a three-dimensional virtual world. The virtual world may be imaginary, symbolic or a simulation of an aspect of the real world. The user in the VE can interact through his virtual self with the virtual world and the other users represented by avatars. A VE may be perceived as a technology and a tool created and controlled by humans to construct knowledge. For instance insomuch, in the field of psychology, VEs have contributed to progress in therapy studies for patients suffering from phobias, stress or anxiety disorders [2]. In addition, other learning-based VEs have contributed to train students in psychology thanks to simulated sessions with virtual patients [17]. Training with VEs is adopted by those working in other fields such as military [9], medicine [10, 23], culture [8] and education [7]. Training in VEs has proven in some cases to be more efficient than training in real world situations [4] in terms of reduction of time consumption, risk reduction, easily presenting specific simulation realism, all of which improve learning experiences and capabilities.

Complex whole body activities and outside activities may be a challenge to simulate in VEs. However, in sports, skiing, a complex full-body activity that depends on mental concentration, physical relaxation and emotional well-being can be acquired in a simulated environment [14]. Moreover, being close to a snow-laden mountain every day is not always possible. According to this last study, simulation is effective in acquiring the complex whole-body skills and control necessary for effective action in skiing activity [14]. By introducing technology into sports to enhance human capabilities, the first Augmented Human conference in Megève in 2010 has contributed to thinning the boundaries between sports and virtual/augmented reality technologies. Since then, projects such as the European Project 3D-live in 2014 ([15,16]), have tele-immersed users into mixed realities (virtual reality CAVE, augmented reality glasses, 3D display) in sports contexts (skiing, jogging, golfing), thus creating more enjoyable experiences. One of the most interesting inputs with VE is that these experiences can be transferred into the real world.

Knowledge transfer from the virtual context to the real context is the criterion for the effectiveness of training in VEs. The transfer process is the experience in VE that affects learning and performance in the real environment. Positive transfer from virtual to real environments occurs in a highly realistic VE or a virtual surrogate of the actual real context [1]. Subjects' mental states seem to be an important factor for an effective transfer process, both depending on the environmental conditions. Measuring the users' experiences may determine the quality of users' mental states [20] related to their activity. Analogously, in the past this has particularly proven to be the case of users of all digital and robotics products, and it is still the case [18]. However, in order to create an optimal user experience and thus an optimal knowledge transfer, the evaluator seems to be the main actor, since he controls the environmental conditions influencing the knowledge transfer.

The knowledge transfer process is a complex subject according to the cognitive psychologists. This process is dealt with in psychological theories (behaviourism, cognitivism, and constructivism). In virtual context, scientists have divergent results about the important factors in VE that encourage the transfer process. The issue of transfer has been widely studied in the past 20 years by educational and cognitive psychologists. We do not wish to address this matter in this paper.

In view of these previous elements, we choose to argue in favor of using a learning VE in order to enhance a human. According to our point of view, the means one is surrounded with cease to be means. Any means at one's disposal become part and whole of the human condition, making the environment part of human. As a general definition, environments are a set of physical, chemical, biological and sociological conditions within which living beings evolve. The human evolves in the natural environment and in the human-built environment spontaneously originating from his own activity. The technological environment as part of the built environment changes along with human needs. This ever-changing relationship can be defined as a "techno-social" or hybrid complex system being part of a complex social system (The community). The technological environment is therefore an integral part of human beings. Consequently, VEs is an integral part of human beings allowing them to enhance their learning experiences and capabilities.

## 3 The Birth of Human Augmented Virtual Environments

### 3.1 Transforming Human's Spatial Skills

VEs seem to allow the user to acquire, in an effective way, spatial knowledge, complex whole body activities or critical skills. Spatial knowledge is needed for everyday activity such as driving or walking from one place to another. Several studies have been carried out to help visual impaired people acquire spatial knowledge easier and faster in an acoustically simulated environment. This acquisition is supposed to alleviate the stress and allow an easier displacement in the real world. Other similar studies have been done for full-sighted people in simulated environments. The spatial knowledge may allow users to be familiar with an environment they never really evolved in, just through VEs. A Peruch, Vercher and Gauthier's study on "acquisition of spatial knowledge" [13] compares spatial knowledge gained through different conditions while visually exploring a simulated environment. It appears that space characteristics are better integrated into a cognitive-map from active spatial exploration rather than passive forms of doing so. This shows the importance of active motor behavior combined with active perception to extract invariants in the environment [22].

The user in a VE seems to learn better from his proper interactions, movements and actions in a self-controlled virtual world. In these conditions, training to acquire spatial knowledge in VEs can surpass training to acquire spatial knowledge in the real world [21].

### 3.2 The Super Human in Sports

Complex whole body activities are common in the context of sports. VEs for sports are used as a tool not only for strategic decisions or for entertainment but to improve sensorialmotor skills as well, that is to say the ability to analyze sensory inputs and produce an appropriate motor response (motor outputs). Enough studies have come to agree that the improvement of motor skills in VEs for ball sports simulation can be possible [11]. Thanks to the quickly and randomly changing environment in VEs, users may face different scenarios in a short time and each scenario would match with a specific situation designed to cover one of several aspects of the user's needs. The user is thus able to practice a wide range of skills. Nevertheless, improving such complex capabilities in sports with VE will depend on the characteristics of the available technology.

### 3.3 The Power if Virtual Environments in Acquiring Critical Skills

Critical and complex skills such as surgical interventions require significant repeated training sessions to increase and acquire experienced surgeon's skills. Surgical simulations with immersive VE such as VEs for training critical skills in laparoscopic surgery [5] offer all important aspects of a proper minimally invasive surgical procedure. Such an environment allows the surgeon to view a body in many different situations and from different viewpoints including point of views that would be impossible in the real world without excessive or hazardous manipulation of the organs.

Other traditional training methods such as learning with animal anatomy, observation of experienced surgeons or training in the operating room seems to be less effective for students and novice surgeons in needs of more practical, self-controlled and realistic experiences. Furthermore, it would be a pity to put patients at greater risk than necessary.

Training sessions using a VE improve students, novice and experienced surgeons to enhance their overall surgical experience, knowledge and skills: spatial orientation knowledge of the organs, spatial reasoning and perceptual motor skills are necessary to manipulate surgical tools such as a laparoscope. The ability to create three-dimensional mental models and plans while viewing two-dimensional images depends on having the aforementioned knowledge and skills.

### 3.4 The Virtual Environment Potential

Simulation in VEs seems to have many potential advantages. Firstly, it could reduce the time needed to bring together the appropriate conditions and design specific scenarios to enhance skills (i.e. have greater knowledge) and the learning experience (i.e. obtain knowledge faster). Once the scenario is designed it can be replayed an unlimited number of times. Secondly, VE could reduce the risk of hazardous consequences due to training in real situations. Indeed, most professional skills need to be acquired in very realistic conditions. Sometimes these conditions turn out to be a beginner in front of a real patient or in a high-risk environment, thus increasing the risk of beginner's mistakes. Consequently, one can suppose that treating with very realistic virtual agents is a better alternative ([6, 10]). Finally, VEs could allow one to easily design a very realistic rendering of the most specific and complex situations in the real world: discovering, learning and evolving from the ocean's depths, outer space, brain cells, chemical reactions at a molecular level, energy transformation...

## 4 The Augmented Humanity

### 4.1 What is an Augmented Human?

In this part we propose an argument for considering a human in VE as an augmented human. The previous part reveals the enhanced skills and learning experiences a human may acquire while training in a VE. Knowing this positive impact of such environments on human capabilities could be a first point that will give weight to our argument, however we still need to understand how the VE is related to humans.

In the field of Augmented Human, a human may be augmented both corporally and/or cognitively and the augmentation technologies have in common the fact that most of these technologies are transplanted into the person's body or worn by the person, thus being part of that human. VEs could be seen as wearable human technologies as there exist several types of Head Mounted Display (HMD) that are wearable and quite famous in the Virtual Reality scientific communities and the public (specifically gamers). However, not all VE technologies are wearable. Most wearable technologies today have evolved from a non-wearable state to fully wearable ones nowadays (e.g. phones can now be worn on the wrist [24]) thanks to technological advances. Therefore, we can imagine in a close future having more Extended Reality (XR) solutions, that is to say technologies that bring together the real *and* the virtual in environments generated by computer graphics and wearable entities.

## 4.2 Technological Environment Improving Human Life

We shall now focus on the relationship between humans and the environments. We want to be able to establish the fact that the human is part of the technological environment, and in turn, the environment at some point becomes part of the human. We assume that a VE is an environment and more specifically part of a technological environment. There is an ever-changing relationship between humankind and technological environment, humans' needs and technological progression [19]. The human evolves in the environment he creates. Therefore, his needs have an impact on his environment, making him part of the environment.

Humans produce the technological environment, which in turn, shapes human life. In other words, scientists and technology assessors make technological environments that will be adopted in human's everyday life. Therefore, technological environment shapes the human environment, habitat, and life and by extension himself (the way we use and see our technological environment today differs from the past): Robotics, artificial intelligence, and trans-humanistic innovation movements are significantly interesting illustrations. Thus, the technological environment could be seen as a parameter modifying the human's equation. VEs as much as augmentation technologies are tools, means, and techniques from the technological environment, which, from our point of view, cease to be means and become a full part of the humans' condition. At this point, our first statement could be confirmed in considering human users of VE's to be people integrating a technological environment able to augment them.

## 4.3 The Complex Human System

To finalize our reasoning, we will focus on an additional theory explaining how humans can represent a complex system. The world consists of a variety of complex systems ranging from our bodies to our ecosystems or our economic systems. Therefore, we suppose that humans represent a built complex system while being part of it. The goal of the Science of complex systems is to study the collective behaviors resulting from the interaction of a big number of entities, to finally, be able to model, simulate and reconstruct the behaviors for a better description of how existing organizations function [3]. Complex systems can contribute to evolutionary theories: by "contributing to methods of mathematical and computational modelling that aid our understanding of emergent behaviors" and by "elaborating ideas from that are relevant to ecologies and evolution" [12]. A complex system understanding and analysis is carried out in a global perspective: by either *reductionism*, in which the properties of the whole system are explained in terms of its parts, or *holism*, for which the whole system cannot be explained by its components alone. For this latter, the system as a whole determines how the parts behave. The relations people have with one another and with their environment represent a complex system, as it is difficult to foresee the behavior, the tendency or the momentum. Just as it is for the human, the environment is also part of this complex system that we may name the complex human system. This final statement reinforces the idea that the environment is part of humans.

## 5. CONCLUSION

Throughout this paper, we expose the way in which humans in VE can be considered as augmented. We develop this idea to advance the potential of VEs with regards to enhancing humans. First of all, we put forward the capabilities a human can gain training in a VE: enhanced skills and enhanced learning experiences. Human training in a VE comes out from this experience with something more. VEs not only contribute to better learning, they also seem to contribute to a greater and more enjoyable experience, hence their success with the public.

Secondly, we place human users in VE on the same level as people using augmentation technologies. This analogy allows us to construct step by step the idea that the human in a VE is an augmented human. Indeed, both can use a wearable virtual or augmentation technology to enhance their capabilities and experiences. However, as VE is also seen as an environment, we propose a reflection aiming to develop the idea that the environment is part of the human. In this way, VE can be seen as part of human, the same way augmentation technology is part of human.

Finally, we define what we consider humans are: a complex system we choose to name the Complex Human*s* System. New behaviors, ecologies and evolutionary theories are human issues the Science of Complex Systems help to better understand. Especially as new concerns grow in our minds on the relation of humans with immerging, and somewhat intrusive, technologies in the future; concerns about the kind of nature towards which augmented humans and their environment evolve or the impact of upcoming technologies on human definition.

These matters and others such as the knowledge transfer from virtual to real world, the user experience in VE in order to enhance capabilities are several worthwhile matters we did not fully address in this paper. Indeed, the positive transfer of knowledge in the real world and the optimal user experience in the VE measures the actual effectiveness of a VE. One may wonder what factors create a positive knowledge transfer and a positive user experience. Moreover, what will the consequences of such effectiveness be on the relationship humans experience with emergent technologies? Will their environments be affected? What level of attractiveness could the real and *limited* world have compared to a virtual and *unlimited* world? Papers on transfer process in VE [1], user experience in VE [20] and Complex System [12] would be a starting place to answer these questions.

We finally would like to recollect upon the fact that, even if the VE technology do not fully allow for an exact surrogate of the real world today (especially in terms of interactions and image rendering), we nevertheless reach significant contributions in the Virtual Reality field in order to reconsider our learning methods. Activities with VEs are still gaining in sophistication and are evolving toward an unknown but near future.

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