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ABSTRACT

Virtual Reality (VR) is a new medium which allows total stimulation of one's senses through human/computer interfaces. VR has applications in training simulators, nano-science, medicine, entertainment, electronic technology, and manufacturing. This paper focuses on some current and potential problems of virtual reality and virtual environments that should be studied and resolved before widespread adoption and implementation of this new technology. Issues considered in this paper include: (1) physio-psychological aspects: virtual reality is a spatial and temporal medium in which users can accomplish normally unrealistic or supernatural tasks along with normal tasks, so creators must consider how these events or tasks will be processed mentally and how they will affect the users' emotions; (2) technology transfer: visual perception and information processing in the brain have yet to be fully understood, and virtual reality adds another dimension that must be investigated; (3) technology versus performance: the virtual environment has to be set precisely for each user so it does not cause adverse physical and psychological effects; and (4) entertainment users will make up the largest share of the VR market by the year 2000, so designers should keep in mind that the heavy VR users are likely to have less skill and knowledge in making sophisticated reality judgments, and may "get lost" in the VR environment. (Contains 14 references.) (SWC)

Title:

Virtual Reality: A Dream Come True or a Nightmare

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"The soul never thinks without a picture." Aristotle (390 BC)

Since before recorded history, when people were sitting around, staring into the fire or relating their experiences, their mind would visualize thoughts or stories in terms that could be understood and processed. The human mind has always converted information into visual images to be encoded and stored in long term memory. People have learned primarily through visualizing since the time of evolution (Psotka, 1994).

For instance, when reading or hearing the word "pencil", one creates a mental image of a pencil. With the advent of virtual reality (VR) and virtual environments (VE), images play an even more important role within the realm of visualization by generating and immersing the user in both visual images and auditory messages. Seen through VR, the pencil once visualized, comes "alive" in many different ways, thus the visualization experienced becomes enhanced many times over.

Virtual Reality

Virtual Reality is an exciting new medium based on a concept which allows total stimulation of one's senses through using human/computer interfaces. It already has many applications in training simulators, nano-science, medicine, entertainment, electronic technology, and manufacturing. In the near future, it will have increasingly greater applications which are bound to impact all aspects of life. Its effect on society, through both what is developed through advanced technology and the very essence of Virtual Reality, in and of itself, is likely to cause a cultural change in society as did the motion picture or television industry.

Virtual Reality is still in its infancy and the ideal usability of this technology is sometime in the future. When comparing Virtual Reality with a medium such as television, one has to realize even though TV is only two dimensional and despite its perceived simplicity, it has an extremely strong immersive quality and influence over people, especially adolescence (i.e. the issue of television violence).

Virtual reality is designed to be as close to true three dimensional as possible and its programs require interaction from users, not just immersion. The effects this will have on individuals and society as a whole cannot be totally foreseen at this time. But, the implications of what effects it can have are beginning to surface and should be addressed while the technology is still in its infancy.

It has long been known that we perceive and learn through a variety of different mediums. Aristotle, in 350 BC, wrote about mediums used in perception:

There has to be a naturally attached medium... The following problem might be raised. Let us assume that every body has depth, i.e. has three dimensions, and that if two bodies have a third body between them (environment) they cannot be in contact with one another... The problem, then is: does the perception of all objects of sense take place in the same way, or does it not, e.g. taste and touch requiring contact (as they are commonly thought to do), while all other senses perceive over a distance? The distinction is unsound; We perceive what is hard or soft, as well as objects of hearing, sight, and smell, through a 'medium', only that the latter are perceived over a greater distance than the former; that is why the facts escape our notice. For we do perceive everything through a medium; but in these cases the fact escapes us...we perceive because the medium produces a certain effect on us (Stevenson, 1995).

Thus, if our senses trick us in the real world, how far then can we be additionally "tricked" by this new medium without demonstrating some type adverse reaction to it. An example again would be television. It portrays motion , but in actuality, it is nothing more than a sequence of scanned lines presented in a manner as to create an illusion of motion. Coupled with this, is an illusion of depth by the placement of graphical objects which allows the watcher to feel "presence" or "telepresence" (a sense of being in another place).

The Physio-Psychological Aspects

Virtual reality or virtual environments are oriented primarily as a spatial and temporal medium. Once immersed in it, "our minds construct a closure to create the experience of inclusion" (Bricken and Geoffrey, 1994)". The VR industry is trying to achieve a true four dimensional environment (height, width, depth, and motion) that will assist in the functions of human performance on many levels. Even though touch/feel, sound and smell are being incorporated into this technology, the primary focus is on the visual sense. This dominant visual property of VE's requires the user to learn and to relate through cognitive, psychomotor, and affective processes that are relative to but dissimilar to the processes used in the real world. (i.e.: flying over rooms, walking through walls, lifting objects that are too small or too large, maneuvering in space while repairing equipment, or swimming with fish).

There is greater use of the visual senses in VR than in almost any other form of communication with "signing" being an exception. The very act of signing is truly four dimensional, totally spatial and greatly iconic. Oliver Sacks in his book, *Seeing Voices*, addresses the fact that the hearing impaired who sign have better perception and direction of motion than other people of their same age and abilities. (Sacks, 1989). This is most likely due to the way spatial cues are processed along with experience in processing in this manner.

In the virtual environment a user is able to accomplish normally unrealistic or supernatural tasks along with normal tasks. Uniquely, the larger numbers of these tasks are represented in the form of objects and /or icons, and they are manipulated with the movement of hands and fingers. This presents a similarity between signing and virtual environments. Perhaps the spatial and temporal processes that are used by the hearing impaired can be used assist a user in VR to adapt to uncommon events that, prior to entering the virtual environment, could not or did not exist, how an event or task in a virtual environment processed mentally and, in what manner in which it affects the user's emotions.

Another area of the VE is the spatial process the brain uses to encode and decode visual information received, what signals are actually received, and the response returned. In the Soviet Union it was not an uncommon practice to remove healthy eyes from blind people and use the eyes to restore other people's vision, which seems on the surface to be an acceptable practice. However, over a period of time it was noticed that many of the people who were blind, developed sleep disorders. It was then determined that these people could not see in the normal light wave frequencies, that the brain had been able to determine day and night through other frequencies or mediums being transmitted through the eyes before they had been removed. It could very well be that there are certain optical or near-optical stimuli that are present in VE's that may have less than positive influence on the user's performance.

Technology Transfer

The human brain processes information in a manner we don't fully understand at present. Physiologically we have yet to determine how, as well as where, different information is processed and stored in the brain. Visual cortical neurons that are sensitive to motion direction, vertical axis, horizontal axis, or opposing directions, and the method in which processing of the information occurs are examples of visual perception and processing questions yet to be answered. In the normal world, we orient ourselves to binocularly perceive the size and distance of an object, using pre-established mental conditioning (learned experience). We process this environmental information without consciously realizing what or how we do this. From their research on field of view (FOV) and other related areas, Joseph Psotka, US Army Research Institute, Sharon A. Davison, Catholic University, and Sonya A. Lewis, Howard University describe the problem:

The visual space has to be coordinated with the proprioceptive space of the eyes, head and hands. This has not always coordinated in virtual environments, nor is it easy to engineer, since the psychological cues for these spaces remain complex and poorly understood (Psotka. J., Davison, S., and Lewis, S.A., 1993).

Since virtual reality largely depends on spatial and temporal recognition, the proper positioning of "objects" within a virtual environment is crucial to achieving any degree of reality. In essence, the human mind is being tricked into its perception of the "objects" and their placement within VEs. Any three dimensional "object" is perceived to have six points of reference or centers of origin; i.e. a cube has a front, back, two sides, top and bottom. In order to determine the size and distance, there has to be a seventh point considered to be the "oneegocenter" [or central ego center], "egocenter", or individual view point.

Once all six reference points have been established, then a perceived size and distance can be assigned to that "object". This completed information is then encoded and stored in the appropriate storage area of the brain. From there this

process is repeated with any other "objects" within the VE, one by one until they have all been categorized and stored. At this point the next scenario is processed and repeated until that task is completed.

Three dimensional motion in simulation has the original 6 points of reference that are moveable (front-back, up-down, left-right) as well as yaw (angular rotation on the vertical axis), pitch (movement in distance) and roll (3-dimensional rotation of an object). These are known as the "six degrees of freedom" of movement. The seventh point or the point of observation is also required to perceive and define the object.

Technology vs. Performance

Virtual environments are designed in a way for the user to feel "presence" within that environment. Presence is "...the suspension of disbelief which permits us to share the digital manifestations of fantasy (Bricken & Geoffrey, 1994)." If the VE is not precisely adequate for the user, then there can be adverse effects on the user. For instance, if the binocular balance (equal recognition between both eyes) or the viewing point is not exact, the user may experience motion sickness or other manifestations can occur (Psotka, Davidson, & Lewis, 1993). If the proper balance between the vestibular and visual systems are not met, then the equilibrium of the human autonomic system can produce undesired symptoms such as dizziness, upset stomach, headaches etc. Even certain frequencies of sound can produce undesired effects, with some known to trigger epileptic seizures. Bruce Gil of Viewpoint Datalabs International stated that a warning notice is placed on certain VR arcade games to alert people with epileptic tendencies (personal communication, July 1994).

Among the known affects reported on this new human computer interface medium, is the possibility of flashbacks from certain "flight simulators" using HMD (head mounted displays) that produce strong effects as to cause the restriction on driving or flying for a period of time (Isdale, 1993). In some cases "flashbacks" occurring some hours after spending hours in a simulator have nearly caused fatal automobile accidents (Office of Technology Assessment, 1994). Another study by the Endinburgh Department of Psychology (Endinburgh Virtual Environment Lab), found that after ten minutes of light exercise while wearing HMDs, 20 young adults displayed clear signs of binocular stress. Over half the subjects also reported symptoms of visual stress, such as blurred vision.

Other Problems to Address

It is widely believed by the year 2000, entertainment will dominate the largest share of the virtual reality market (Biocca, 1992). Shapiro and McDonald (1992) express concern that "heavy VR users" with less skills and knowledge in making sophisticated reality judgments, may get lost in the VR environment. The very essence of virtual reality generates responses which in turn stimulates emotions. Jaron Lanier, one of the founders of VPL Research (the company that patented the data glove) relates his view regarding virtual reality games:

Also, there's a problem that it's (VR technology) sort of an enforced form of compulsive behavior. There is no doubt that all of us - and let's say adolescent boys in particular - go through a period where they are interested in killing things and aggression. But I think the point is if they do it in the play ground, it's part of a fluid process which continues to grow and change. But, if they get caught up in an interactive loop, in some sort of a simulation entertainment product, then they get stuck in and relive the same loop again and again (Shapiro and McDonald p. 163-164).

Virtual environments have many similarities to "in depth day dreaming". There is inclusion, immersion, closure and visual images. Comparatively speaking, if day dreaming can be considered as an escape mechanism, how much more intensive and in what manner will the onset of virtual reality "games" with their powerful and unnatural environments affect the participants? In a recent report on virtual reality, Daily, Howard, and Caudell (date unknown) express their concerns that "...we can expect the full potential of virtual reality to be compellingly hypnotic, especially for entertainment (p.23)."

Issues and concerns:

1) Shapiro and McDonald (1992) point out that research has not focused on reality judgments in virtual reality but instead on the media effects. They suggest that "Interacting with such an environment may often tax mental capabilities", and the more real the environment appears, the more likely "it becomes a mental challenge to make judgments about reality (p.104)." Just individual temperamental personality differences determines the extent of immersion an individual person experiences (Psotka, 1994).

Cornell, Bailey, and Bollet (1994) raise concerns related to the well-being of unsuspecting individuals who may experience dramatic and highly-dangerous side effects which impact mental stability. Is there danger to unsuspecting users through immersion in virtual reality and other similar experiences? What effect will immersion in this powerful medium have on those subseptable to schizophrenia, bi-polar disorders, claustrophobia, or other related impairments?

2) There seem to be no published studies in the combining of artificial intelligence (AI) with virtual environments. Already the industry has termed certain AI components as "V-actors", "V-extras", "V-experts", and "V-agents" to be used as separate "beings" capable of changing the environment within VR games (Hamit, 1994). These "entities'" purpose is to "work together to undertake tasks beyond the capability "of the players or any one entity. What effects will "entities" have on the perception and judgment of users in virtual environments?

3) Psotka, Davidson, & Lewis (1993) relate an experience they had with moving a user who was preoccupied in a VR "fish world" chasing a fish. They moved him slightly and his first perception was that it was done by an invisible force. They continue to say that his second confusion was that he could not be moved in VR by the real world. They observed that the subject's momentary confusion and disorientation lasted several seconds before he could orient himself, and this was in a simple scenario. They continue by adding "Could it be, that with practice we could become more adept at holding these two realities intact' synchronically? If anything, our experiences in VR are making it easier and easier to enter VR completely immersed, and easier to forget entirely our real world surroundings" .

What will be the long term effects on "heavy" VR or simulator users in relation to their perception and interaction with a real environment? If just after a few hours of "immersion" in a simulator can cause serious "flashbacks", how much time can one spend in a virtual environment without psychological effects?

4) We must consider the ramifications of Marshal McLuhan's concept of the message being the medium as it would apply to VR and VEs. Virtual Reality (or a virtual environment) is an extremely powerful psychological medium. Is Virtual Reality as a medium so great, that it overwhelms the training or task when it is being presented through virtual environments?

Conclusion

As with any new technology, there are uncertainties of its potential, uses, and control. Virtual reality with all its magnitude is certainly no different. As in other technological advances, problems will arise and will be resolved. However, it was the intention of this paper to focus on some current and potential problems so that they can be studied and resolved. The immersed user of this medium and any undesired effects of the medium should be the primary focus and not the medium.

It is our belief that the end products of VR/VEs are designed to help us. Medicine, psychological treatment for phobias, and simulations that hone one's skills are indeed useful, if not extremely important. However, minimizing the detrimental or unwanted aspects should be considered before releasing an application of technology just for the sake of the technology.

We reiterate, "If the medium...were a membrane separating us from the object...we should be relative to it in the same condition as we are to air or water in which we are immersed (Aristotle, 350 BC)."

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