EDUCATION AND TRAINING IN VIRTUAL ENVIRONMENTS FOR DISASTER MANAGEMENT

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Abstract: Virtual Environments (VE) are currently being developed and evaluated as an alternative for educating and training first responder personnel. The methods being developed offer a more realistic alternative to lectures, manuals, and traditional computer-based training and circumvent the logistic and resource requirements of a full-scale field exercise. In this paper we discuss how lessons learned in the application of VR in medical education, carried out within the University of Queensland's Centre for Online Health, assist to inform a developmental project training first responders in response to weapons of mass destruction. This large-scale project, sponsored by the United States Army's Tank-Automotive and Armaments Command (TACOM), is just underway at the University of Missouri-Rolla. The paper focuses on the current and near-future possibilities for applying VR to education and training in the DM field, focusing on the role of presence and affective intensity.

Introduction

Since the devastating terrorist attacks on September 11, 2001 at the World Trade Center and the Pentagon, Homeland Security (HLS) has become an issue of increasing importance and utmost visibility to the nation. There is great need for developing measures for counter-terrorism and for training of military and civilian personnel engaged in HLS.

A pivotal process of HLS is the development high-level skills in Disaster Management (DM) through formalized education and training. Practical difficulties arise, however, for providing realistic physical disaster environments. Building physical facilities for strategic planning and personnel training in HLS would be time-consuming and costly, and the result would be of only limited utility in planning/training activities, considering that there exist practically endless mission vignettes. In addition, using realistic physical facilities to develop decision-making and operation skills of personnel in counter-terrorism and other HLS missions is potentially dangerous to the participants, hazardous to the surrounding ecosystem, and threatening to local security. These same skills can be gained through training of the personnel in virtual environments (VEs), which represent highly realistic simulations of physical environments, while providing great advantages in increased safety, reduced cost and time, and the ability to produce many vignettes with a minimum expenditure of additional resources.

Virtual Reality and Education

VR has been successfully used in training and education domains outside the research environment for some years (MacPherson & Keppell, 1998). Many of the 'real-world' applications of VR-based education involve modifying human behavior. Most prevalent are flight and driving simulators that allow a hands-on experience without the risks associated with a novice controlling a rapidly moving vehicle (Jang, Kim, Nam, Wiederhold, Wiederhold, Kim, 2002). Goals of educating in VEs include training individuals to operate complex machinery, to respond appropriately to rapidly unfolding events (such as combat decisions), or to function in environments that would otherwise be too expensive or hostile to be used on a day-to-day basis (Tarr & Warren, 2002). Such established uses of VR are becoming both more widespread and more compelling thus the obvious choice to explore VR in DM training.

In addition to education and training, the second highest use of VR has been to modify behavior in the treatment of psychological and mental health disorders. VR, in this field, has been successfully used to enhance human abilities rather than merely modify them (Tarr & Warren, 2002). In mental health research, one of the most important consequences of a concept referred to as 'presence', is that a virtual experience can evoke the same reactions and emotions as a real experience (Schumie et al 2001). Clearly this is important to potential training outcomes in Disaster scenes as trainee's psychological reactions and emotions felt toward simulated environments will impact on both their performance and ability to recognize task requirements.

This sense of 'presence' in the VE has also been shown to be an important variable on the impact on how successfully skills learned, in the VE, will be transferred to the real world. For example, VEs designed for surgical training must realistically represent the real task that is being simulated. Measurement of the simulated performance is likely to assess competence in the real task. However, training packages which present less 'realistic' images can be just as effective in training, for example, in psychiatry education (Tichon, 2002). Riva and Gamberini (2000) report the effectiveness of VR applications in education are, therefore, more strongly dependent on the sense of 'presence' felt by the trainee than the richness of available images.

As it has advanced and costs have declined over the past decade, there has been a steady growth in the use of VR in health education (Riva, 2002). This is due largely to the fact that VEs are highly flexible and programmable. They enable the instructor to present a wide variety of controlled stimuli, and to measure and monitor a wide variety of responses made by the user (Riva & Gamberini, 2000). This flexibility can be used to provide training that optimizes the degree of transfer of training and learning to the person 's real world. Research identifying the psychological impact of VE training environments has enabled a shift from an emphasis on quality of image or graphic perfection of the system to the sense of presence. Understanding how to use immersive VR to support education and training presents a substantial challenge for the designers and users of this technology.

Two current projects currently designing VR software to support education and training are outlined next.

Project One: Centre for online Health (COH)

A significant research project being undertaken for the past twelve months at the University of Queensland's Centre for Online Health and Virtual Visualisation Environment Laboratory (VISAC) has constructed a number of virtual environments that reproduce the phenomena experienced by patients who have psychosis. Symptoms of psychosis reproduced include delusions, hallucinations and thought disorder. The VR environment will allow behavioral, exposure therapies to be conducted with exactly controlled exposure stimuli and an expected reduction in risk of harm.

Development of the VE comprised two main steps. The first step involved creating the model of a psychiatric ward, and models of static elements of the scene (eg. furniture) using a 3D modeling package. The static models of the psychiatric ward were based on photographs of an actual ward in Brisbane and objects were saved as VRML files for inclusion into the main program. The second stage of development

involved writing the main program which loads, positions and displays the static elements, and which implements the dynamic parts of the scene, such as sounds and movements of objects. The software was written in C/C++, in conjunction with an open source, cross platform scene graph technology. This method of implementation was chosen as it will allow us to eventually port the software from the current IRIX platform to a PC platform. This would enable the software to be used, for example, in hospitals and other on-site teaching environments.

The use of VR in medicine is well established but it is the growing recognition that VR can play an important role in clinical psychology particularly impacts on broader scenarios of VR-based education and training. VR provide the opportunity of locating clients in environments that would otherwise be dangerous or inaccessible. VR has addressed this challenge in clinical psychology when treating fear of heights, driving and fear of spiders. The current project presentation will demonstrate those aspects of the world of a person with schizophrenia which have been previously inaccessible and show how recreation in the VE of stimuli reduces physical danger for patients. Exposure of students of psychiatry to this VE has provided valuable feedback on the potential impact of sense of presence on how successfully skills learned in VE can be transferred to the real world of psychiatry and patient interventions. These results will be used to assist to inform the VR software development in Project Two outlined next.

Project Two: First Responder Simulation and Training Environment (FIRSTE)

A virtual reality system is being developed by the University of Missouri-Rolla to help train first responders including police officers, firefighters, hazardous material technicians, emergency medical providers, public works personnel and emergency management officials in dealing with terrorist attacks involving use of weapons of mass destruction (WMD). The main goal of the project is to determine how effective virtual environments can be used for training first responders. The virtual environments would be capable of being programmed to allow first responders to train in numerous scenarios. One objective is to determine how trainees can be fully immersed in a virtual environment that realistically simulates an actual situation. Another objective is to provide an effective and inexpensive method of training first responders to meet the difficult challenges of responding to a WMD event. Further, the project will demonstrate why training in a simulated environment is can be much safer than training in a live environment, where not all elements of the physical environment can be controlled.

An important evolving component of this project is a focused and systematic examination of the basic factors that account for learning within affectively intense learning environments. Affectively intense learning refers to learning in which the task to be learned is to be performed in a highly stressful, emotionally intense environment (such as disaster management). An experimental environment is being developed, based on a virtual model of the University of Missouri – Rolla's Computer science building, adding special affectively intense effects that would be associated with a terrorist attack. This research is based on a model, which posits four important classes of variables as influencing the virtual reality and learning outcome relationship: learner variables; virtual environment factors; perception of presence; and affective intensity. A basic assumption of the model is that the learner's perception of presence will grow in importance with the degree of affective intensity. A graphic depiction of this model is displayed in Figure 1.
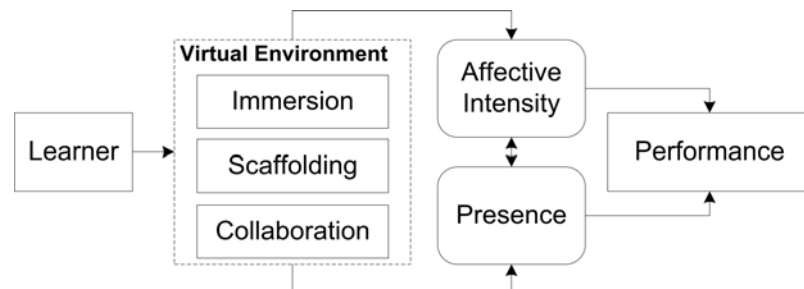

Figure 1. Model for Examination of Affectively Intense Learning

Conclusions

In both of the current projects, and similar VR-based education and training projects to-date, the importance of the concept of presence has been recognised. Some of the drawbacks to previous methods of teaching and learning have been identified as the tendency to stress abstract and logical thinking that requires a high degree of attention. One problem this produces is that people are not good at applying high attention to relevant concepts over a long period, and the mind tends to wander onto other, less demanding, things. Most current VR applications, on the other hand, stress experiencing, exploring and interacting with information, through emphasizing presence, which makes the users feel that they are there within the created reality (Waterworth & Waterworth, 2001).

The future of these two projects will focus on further developing and evaluating the software in a way that supports and enhances the potential of VR in education and training. The dimension of presence can be measured in a number of qualitative ways as its very conceptualization can vary in a number of ways. For example, Personal Presence is a measure of the extent to which the person feels like he or she is part of the virtual environment (Heeter, 1992) while Objective Presence is the likelihood of successfully completing a learned task in the real world (Schloerb, 1995). The COH project is currently designing a new measurement tool to capture measures of presence that capture experiential learning.

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