The Future of Virtual Environment Training in the Army

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VE Growth Stimulants

Though there is a rich history in researching and developing virtual environments within the military, the Simulator Networking (SIMNET) program of the late 1980's and early 1990's really showed us the deep value of virtual environment applications (Miller and Thorpe, 1995; Davis, 1995; Singhal and Zyda, 1999). Twenty-five years later we have made a number of significant advances in this area, but we remain on the top of an iceberg of unexplored potential in this field. Beneath the waterline lie hundreds of valuable applications that go beyond training and that can apply VE technologies to real military operations from logistics, to command and control, to situation understanding, to information fusion. In both the commercial and the military worlds, the power of VE is significantly enhanced by the growing availability of digital data in every industrial and government domain. In a world where reconnaissance photos are captured on physical film, there is little that computation and VE can do to enhance this information. But once those photos become digital, it is possible to analyze, fuse, integrate, and morph them so that the photos become the visible skin within a VE. As all information about the world becomes digital, it opens opportunities for us to generate higher levels of understanding and create new advantages over our competitors. As the world has become networked, digital data has become globally accessible so that digital photos from every continent can be viewed in real-time anywhere in the world. As network bandwidth, computational power, and VE algorithms advance, we will reach a point where these images can be stitched together into a seamless 3D map of the entire world and navigated in real-time. This data will include digital images, sound waves, weather patterns, population densities, personal locations, RF spectrum, financial transactions, and dozens of other specializations.

From a military perspective, most of the situations that we deal with and the information in which we are interested are geographically oriented. In the past, our technologies have limited our ability to reconstruct information into a geographic form similar to the world from which it was collected. The VE is the ultimate replacement for textual, graphic, and other paper-oriented representations that have dominated our decision making for centuries. We live in a time when leaders, managers, and engineers are very comfortable communicating information that has been structured in the form of graphs and tables. The next generation will be just as comfortable structuring information into unique VEs and exploring those collaboratively as a means of understanding and manipulating the world.

Commercial Leadership

Sometime in the late 1980's we reached a tipping point (Gladwell, 2002) at which commercial industry took the lead from government laboratories in advancing computer technologies. The explosion of consumer-grade computing power led to a corresponding explosion in software applications that could exploit this power. One of these growth areas was the computer gaming world in which products like Quake, Unreal, and an annual harvest of new competitors present some of the best VE rendering available at consumer price levels. We expect that the civilian markets will continue to drive R&D into VEs and the creation of ever more beautiful and accurate visualization. Our fascination with 3D shooting and driving games may wane to be replaced with some other product, but commercial leadership in this area will continue because of the billions of dollars that can be earned and reinvested by successful companies (Smith, 2006; Dodsworth, 1998).

Just as e-mail and instant messaging have replaced the telephone as the leading medium for personal communication and the Web has replaced the library as the leading repository of information, VEs will replace the Web page as the primary medium for shopping, socialization, and exploration. We expect that some form of VE will become the context within which online digital information is organized, replacing the linked, flat web pages that convey this information today. Applications like Google Earth, Second Life, and World Wind are beginning to illustrate this future. Imagine a World Wide Web in which all of your information is knit into a single context. Your Facebook friends live as 3D avatars in your VE apartment, your favorite YouTube clips are streaming on one wall, and the contents of Wikipedia are lying on a coffee table. But in a VE, there is no reason that your apartment, your personal space, has to look anything like a physical habitat; it could be a giant garden, forest, cloud city, or ant colony. The information you need and enjoy may grow like flowers in the garden all around you, their colors representing currency, importance, or source.

These VE expressions are uniquely personal, playful, and civilian, but the technologies behind them will be seriously powerful. Like the radio and the semiconductor before them, these technologies are not limited to entertainment, business, or national defense, but can be applied equally to all of them. The commercial world will be the fountain from which advanced VE technologies spring and the fountain to which the military will go for new innovations.

Though computer generated VEs will be driven by commercial industry, there may be other alternatives to loading information into the human mind. Direct neural stimulation may allow us to inject information without going through the visual sensors. Technology that enables a blind person's mind to "see" is similar to that required to allow us to generate a VE in the mind without going through the eyes. The advantages of this approach are beyond our current understanding. This may prove to be a valuable addition to the standard visual scene that is perceived by a sighted person. Neural stimulation may provide a means for creating a new sense of the data that is contained in the world, effectively enhancing our ability to perceive rich mixtures of data in a VE.

Further afield is the possibility of creating or enhancing the VE through the use of chemicals. Is it possible to chemically stimulate the brain in a way that creates useful communication or understanding of data? The 1960's experiments with LSD cast a dark shadow over these kinds of experiments, but new research into chemically enhancing athletic and soldier performance are bringing these ideas back into vogue. Just as caffeine can enhance alertness and reaction time, other chemicals may improve understanding of digital data that is part of combat operations or that drives training for life threatening operations.

VE Applications

Currently, we refer to the military use of VEs as "serious games". This has been a useful term, but it will become archaic as our ability to distinguish game technology from non-game applications fades away. We do not identify computer CPUs or graphics chips as either "entertainment chips" or "serious chips". They are just tools that allow us to build the applications that we need. The same will occur with "serious games". All industries will have VEs that meet their needs, just as they have specialized computing and communications devices today (Bergeron, 2006; Lenoir, 2003).

Since 1992, the military has identified its simulation tools as either Live, Virtual, or Constructive. This delineation highlighted the fact that we have not have the computer power to create both breadth and depth in a VE. "Virtual" simulators represent small areas with few objects in high detail, while "constructive" simulations represented very large areas and many objects with less detail. Advances in computation, communication, and our understanding of the problem will allow us to stretch the boundaries of both of these domains so that there is little difference between the two. In the future, "Constructive" and "Virtual" will refer only to the view that is being presented to the human or to an AI, and not to an inherent limitation of the models that are driving the virtual world.

There have been three distinct generations of "Constructive simulation" and perhaps future VEs will bring us to a 4th. The first was the use of sandtables and miniature figures, essentially a scaled representation of the real battlefield. The second was the paper boardgame that allowed greater abstraction and additional rigor in the rules and mechanics of behavior. The third was the computerization of the wargame which allowed it to extend its algorithms to the limits of the computer, rather than the limits of a human player (Allen, 1989; Perla, 1990; Dunnigan, 1993). Advances in VE will allow us to create a constructive simulation that is just as detailed as a virtual simulator if we so choose. We will be able to employ aggregation and abstraction as a useful tool, rather than being forced to use it because of the limitations of our computing devices.

In the "Live" domain there will be VEs embedded in real equipment just as 2D map displays are today. These VEs will be integrated with the screens and the HMDs that are used as portals into flat, disassociated, 2D data. Rather than seeing the battlefield from a top-down, 2D view, the operators will be able to see it in 3D from any angle that they find useful. This is a hugely powerful paradigm and carries so many potential options that

the challenge will be in determining where the valuable views lie, not in rendering and animating them for the operator. In this world, there will be little difference between the objects that come from a simulation and those that exist in the physical world. All of them will be seamlessly integrated together in a VE.

Army Missions

VEs are supplemented with physical and cognitive models, software coordination and control tools, and external interfaces to operational devices to create simulation-based training systems. As the nature of the Army mission has changed, simulations and VEs have been challenged to represent new missions, new threats, and new tactics in a manner that captures the essential elements of the real world, and which can be used to teach this reality to humans. We have emerged from four decades of a Cold War in which most military training focused on large combat operations that occurred on a specified battlefield where all participants were expected to be combatants. But more recently we have been facing small unit operations in an urban environment where the military is called on to perform humanitarian operations, search and reconnaissance, facility defense, and combat operations all on the same day. This has created a situation in which our VEs and simulations must represent a much more diverse set of objects and interactions. They can no longer be "combat only" representations of the world. The focus of current and future missions appears to be on much smaller areas, making it both possible and desirable to represent very high levels of detail in the area of operations. This detail calls for a VE that can recreate combat operations in a single city block, but also allow person-to-person communications that build a body of knowledge that will impact future missions. These will generate a rich variety of actions that emerge at some future point in the simulation. Many of the current models behind VEs are oriented toward immediate action and immediate consequences. In most cases, these actions/consequences are discrete and do not carry forward to influence actions between objects in the future.

While the military simulation community has been wrestling with models of information processing and human reaction, we have not explored the richness of person-to-person relationships and their contributions to the groups with which these people are affiliated. There is a great deal of "soft social science" that needs to be incorporated into VEs in the future. We are less interested in better physics models of weapon penetration and aircraft lift, and more interested in models that influence individuals and groups to engage in peaceful or hostile confrontations with each other. Complicating this is the fact that models of physics are universal, but models of group and personal relationships are highly cultural, social, and geographical. Huntington (1996) has suggested that all future competitions will be based on seven unique cultures that have emerged in the world. Rather than a bi-polar world threatened with traditional combat, we live in a seven-part world in which the confrontations may be focused in the political, military, economic, social, infrastructure, or information domains. VEs that are able to represent such a diverse world accurately and effectively will be a significant challenge and a significant focus in the future.

Advantages

VEs that are created electronically, biologically, or chemically all present significant advantages for military operations and training. They create an improved space for accessing, absorbing, understanding, and applying information. These are all information-based terms that create a pattern very similar to the Observe, Orient, Decide, Act (OODA) Loop that was first proposed by Colonel John Boyd (Coram, 2004).

The advantages to be gained are so significant that VEs will continue to grow in importance and in the breadth of their application. We can look forward to specialized versions of VEs being used for hundreds of different applications, each with a unique requirement for the technology but based on a foundation that can be reused for special needs (Anderson, 2006). As the limitations of computer and communication technology fall away and our level of expertise in creating and manipulating these environments increases, VEs will appear in all types of consumer and military systems to aid people in making better decisions and taking more appropriate actions. VEs are not a training technology. They combine technologies that has been matured in both the training and entertainment domains, but which is now ready to spread into other commercial and government applications.

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