



Entertainment Technology and Virtual Environments for Training and Education

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Macedonia and Rosenbloom discuss the U.S. Army's training needs and goals, and how it came to realize that the best route to achieve those goals was through teaming the military with academia and Hollywood. In 1999, the army established the Institute for Creative Technologies in collaboration with the University of Southern California, where the technologies being developed by the entertainment and gaming industries, combined with the creative talents there, present tremendous opportunities to improve virtual reality training techniques. The institute's goal is to develop the art and technology for synthetic experiences so compelling that its participants will react as if experiencing reality.

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BRAN FERREN MAKES A COMPELLING ARGUMENT that the entertainment industry drives the technology advances needed for military virtual reality (VR) systems:

. . . Knowing how to create compelling experiences; do low-cost, high-performance computing; support large-scale network simulations; [and] build graphics-modeling software is (or will be) [the entertainment community's] stock and trade. In these areas not only will it be futile for the Army to try to compete, but a waste of energy and resources."¹

The military virtual environment community may fall behind its civilian counterparts by ignoring the recent changes in entertainment computing, such as low-cost computer graphics, agent technology, and the use of 3D audio.

Here we describe the advancement of VR by the entertainment industry, examine the current issues in military simulation, and describe how the US Army is addressing these issues with the assistance of the Institute for Creative Technologies.²

THE ENTERTAINMENT INDUSTRY

The military today cannot match the growing influence and resources of the entertainment industry. For example, Microsoft expects to increase research and development (R&D) spending in 2001 by 23 percent, to \$3.8 billion, compared to the U.S. Army's \$ 1.2 billion science and technology R&D budget. The Interactive Digital Software Association estimates that in 1998, interactive entertainment businesses invested approximately \$2 billion in new technology R&D, with an increase of more than 20 percent.³ This far outweighs current US Army R&D for training and simulation technology.

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As a result of greater resources, the entertainment industry advances more rapidly. For example, the graphics systems for game consoles and personal computers double their performance benchmarks every nine months,⁴ whereas even the “high-end” graphics platforms being used for the military evolve very slowly.

According to Richard Weinberg⁵ at the University of Southern California’s School of Cinema-Television, Sony’s PlayStation 2 (PS2) provides an example of a consumer-grade advanced technology gaming platform that could revolutionize both home gaming and interactive training for the Army. The PS2 is expected to have 34 times the power of the current leading game system, the Sony PlayStation, and more than twice the graphics performance of SGI’s high-end visualization system, the Infinite Reality 2. *Game Informer Magazine* proclaimed,

PlayStation 2 could be a glimpse at Hollywood of the 21st Century. Developers with this kind of power in their hands could theoretically create real-world environments, with living, breathing characters all affected by real-world physical attributes such as gravity, friction, and mass. Plus, PS2 can accurately simulate different materials such as water, wood, metal, and gas — real worlds that look like real worlds. Full-motion video that’s not full motion video, but real-time game play with speaking characters, fluid motions, and facial expressions.⁶

Other technology trends likely to affect military training are digital cinema, the convergence of television with the World Wide Web, and the continued rapid growth of multiplayer Internet 3D games such as Sony’s *Everquest*. Weinberg noted that the computer game industry has considerable expertise in games with military content, such as war games, simulations, and shooter games. For example, TalonSoft’s *The Oper-*



"As computer gaming has evolved from the 2D to the 3D realm, each new generation of students has been trained, through game play, to think more and more in 3D. Gaming has become a primer for a new way of thinking that is necessary for understanding the nature of chemical bonding."

—Shawn Sap, Colorado State MetaMol
Gallery of Molecular Modeling

ational Art of War II is expected to cover the Vietnam War, Arab-Israeli wars, Iran-Iraq conflict, and Operation Desert Storm at the operational command level, as well as several hypothetical conflict scenarios ranging from India-Pakistan to a new Korean conflict. *Extreme Tactics*, *Warbreeds*, and *WarZone 2100* are other war/strategy/shooter-style games available. In addition, flight simulation companies are taking advantage of the emergence of commercial game soft-

ware for training. Flight Safety International remarkets a version of Microsoft's *Flight Simulator*, a nonmilitary flight game, that the Navy uses in experimental new pilot training.

WHAT IS MISSING FROM SIMULATION?

Until recently, the military led in developing advanced virtual environments to support training, mission rehearsal, concept exploration, and engineering design. Experiential learning has been demonstrated through the development and use of the National Training Center, Conduct of Fire Trainers, Simnet, and flight simulators.

However, current military simulations fall short of achieving this vision for several reasons. First, the necessary technology does not yet exist and must be created. Our ability to immerse participants remains limited. For example, we can provide good auditory, moderate visual, and fair tactile/haptics, but essentially no olfactory or gustatory immersion. The ability to

track full body motion, gesture, and expression remains underdeveloped, and virtual mobility is limited to primitive 2D approaches. In addition, the existing technologies for physical immersion are neither portable nor wireless, have interoperability problems, fail to scale well, and have latency problems in closely coupled interactions over long distances. Also, defining (modeling), organizing, and distributing multimedia content is problematic.

Second, the stories and characters used in military simulations are shallow and rudimentary. A typical story consists of a background briefing plus an event list. A typical character is defined in terms of a role and a set of scripted behaviors. With such minimal story and character definitions, only a small degree of intellectual immersion is possible, to the extent of triggering some of the same key decision-making tasks that would occur in the real world. Richer stories and more engaging characters could further involve the participant and provide a more appropriate context for intellectual activity. (Note that for peacekeeping training the U.S. Army often hires actors for live exercises at its Combat Training Centers.) Lack of a rich story and character depth also impair emotional immersion, as abstractions do not generally induce intense emotions. Since emotions are powerful motivators and can lead to significant shifts in environmental interpretation and decision-making, the lack of emotional immersion imposes a major barrier to creating realistic simulations. More realistic military training better prepares personnel for making decisions in life-or-death situations. Emotional immersion is a particular strength of the entertainment industry.

Third, there is a lack of resources. Technical personnel working with domain experts currently build military simulations. However, creative personnel, such as writers and cinematographers, also need to be involved. Technical advances can open up new creative realms, creative needs can drive

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new research, and creative techniques can mask limitations in technology. Teams composed of people from all these areas can more effectively take advantage of changes and reduce technological shortcomings.⁷

THE INSTITUTE FOR CREATIVE TECHNOLOGIES

Early in 1999, U.S. Army leaders recognized a need for a major transformation of our forces and the limitations of our current simulation technologies. This transformation involved the development of new training and simulation systems for future conflicts that would harness the capabilities of both the entertainment industry and academia. The prime objective, as reaffirmed by Dr. Michael Andrews, Deputy Assistant Secretary of the Army for Research and Technology, is to build a special partnership with the entertainment industry and academia. The goal is to advance the Army's technology and quickly enable programs such as the Future Combat System.

A "university affiliated research center" (UARC) describes a strategic relationship, involving both breadth and depth in capabilities, matched with industry partnership to achieve major advancements in science and technology. This model is not new. For example, The National Automotive Center (NAC) serves as the Army's focal point for the development of dual-needs/dual-use automotive technologies and their application to military ground vehicles. The NAC identifies the common needs of the Defense Department, automotive industry, and academia for the purpose of collaborative research and development.

The U.S. Army and Department of Defense selected the University of Southern California (USC) as a strategic partner in the development of the Institute for Creative Technologies because of its unique confluence of scientific capabilities and en-

ertainment industry relationships, both necessary for leadership in simulation. USC's location, Los Angeles, is a hub of both entertainment and aerospace industries, and it is a leading private research university with excellent working relationships with industry.

USC's top-ranked School of Cinema-Television developed with the entertainment industry and continues to maintain uniquely close ties with it. USC's School of Engineering is ranked 12th in the nation. Its Information Sciences Institute is home to leading academic research groups in networking and artificial intelligence. USC's highly ranked Annenberg School for Communication leverages the Los Angeles area's varied strengths in new technology, telecommunications, film, television, radio, newspapers and magazines, and policy and research organizations.

USC established the Institute for Creative Technologies (ICT) under the auspices of the U.S. Army Simulation, Training, and Instrumentation Command (STRICOM) to focus on developing the art and technology for synthetic experiences so compelling that participants will react as if to reality. Thus, ICT will bring verisimilitude — the quality or state of appearing to be true — to synthetic experiences. This will revolutionize military training and rehearsing for upcoming missions, two highly critical military needs. Overall, it will provide a quantum leap in helping the army prepare for the world, soldier, organization, weaponry, and mission of the future. Beyond the military, ICT will also advance a new medium for entertainment, education, arts, and travel.



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From the beginning, ICT has actively engaged the entertainment industry (film, TV, interactive gaming, etc.). ICT will serve as a means for the military to develop expertise in, and benefit from, the technology developed in the entertainment industry, and for transferring technologies from the entertainment industry into the military. ICT will also work with creative talent from the entertainment industry to adapt story and character concepts to increase the degree of immersion experienced by participants in synthetic experiences, and to improve the outcomes of these experiences.

ICT will pursue a combination of basic and applied research, as well as some educational activities. Basic research will cover six thrusts crucial to verisimilitude:⁸

1. Immersion – providing compellingly realistic experiences
2. Networking and databases – organizing, storing, and distributing content
3. Story – providing compelling interactive narratives that propel experiences
4. Characters – replacing human participants with automated ones
5. Setup – authoring and initializing environments, models, and experiences
6. Direction – monitoring, directing, and understanding experiences

Applied research will focus on a small number of long-term themes, such as simulating futuristic style forces. Within each theme, a set of key projects will be identified, along with an integration architecture that will eventually integrate the projects into a single system covering the theme. Projects will be pursued via sequences of prototypes of increasing functional-

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ity and level of integration. The army and the entertainment industry will be actively involved at each step to ensure that the outcome meets their needs.

Key elements associated with USC's array of relevant existing capabilities include the following:

- The Entertainment Technology Center (ETC), a research and development project of the School of Cinema-Television. ETC's mission is to discover, research, develop, and accelerate entertainment technology. (See the sidebar for R&D collaborators.) Steven Spielberg and George Lucas sit on the ETC board.
- The Annenberg Center for Communication, which advances communication and information technologies through interdisciplinary research and outreach.
- The Integrated Media Systems Center (IMSC), a National Science Foundation (NSF) Engineering Research Center (ERC) and a leader in the rapidly growing and changing field of multimedia. In the NSF ERC selection process, USC's proposal was chosen over 117 others, including multimedia center proposals from Columbia University, UC Berkeley, Cornell University, and the University of Minnesota.
- The Information Sciences Institute (ISI), which combines world class research and development across a broad range of computer science and engineering with a strong relationship with the Department of Defense.

USC ETC R&D Collaborators

Time Warner
Viacom-Parmount
SONY (TriStar, Columbia)
Disney
20th Century Fox
Lucas
Dreamworks

ICT VISION

ICT's vision is to develop the art and technology for synthetic experiences so compelling that participants will react as if they are real, feeling fully immersed physically, intellectually, and emotionally. They will be capable of full 3D mobility. The events of the story guide their behavior, propelling them through engrossing scenarios stocked with engaging characters, either automated or manned — the high quality of the automated characters along with the provision of plug compatibility will make it impossible to distinguish between the two. Participants will interact with the experiences as if they are real. In short, the ICT will provide a new meaning for “high fidelity” — verisimilitude.

Imagine the soldier of the not-so-distant future. It is Sunday, and he is at home in Los Angeles. He and his best friend in Hong Kong are playing a computer game, relaxing by immersing themselves in the nostalgic world of the 1990s. They are founding an Internet startup company during the heyday of the speculative bubble, learning to deal with venture capitalists, trying to fend off large predatory rivals, and ultimately trying to steer their new company toward a successful initial public offering (IPO).

Just as the story becomes really engrossing, a high-priority video message arrives from his commanding officer with the news that he will be shipping out within a few days, along with the 5,000 or so other members of his Strike Force. The mission is to help keep the peace in the latest global hot spot, but no details are yet available concerning his unit's specific mission or the volatile situation that currently exists on the ground there. He also knows nothing about the country's history, culture, or language. Fortunately, he has a long flight ahead of him, and the army is ready.

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The soldier begins his flight with a brief online course covering the history and culture of the region. A virtual tutor called STEVE (Soar⁹ Training Expert for Virtual Environments) helps him make the best possible use of the very limited time he has available (see Figure 1.) He then dons his personal immersion system and walks into a simulated market in the capital city, where a helpful (computer-generated) shopkeeper introduces him to the basic aspects of the language along with the range of interpersonal interaction styles — both positive and negative — common to the culture.

Next, the commanding officer briefs the unit on its mission — to keep innocent civilians from being hurt in factional violence while preventing, as much as possible, new flare ups among the factions. By sharing an immersive space with his commander and the rest of his unit — even though in reality they are physically dispersed across several transport aircraft — he can join them for a quick tour of their area of responsibility, followed by a session in which they familiarize themselves with the uniforms and weapons used by the various factions. He can pick up and examine the uniforms, as well as see them on various models. He can try out the weapons himself, and pull up specs and performance numbers on them. At all times he

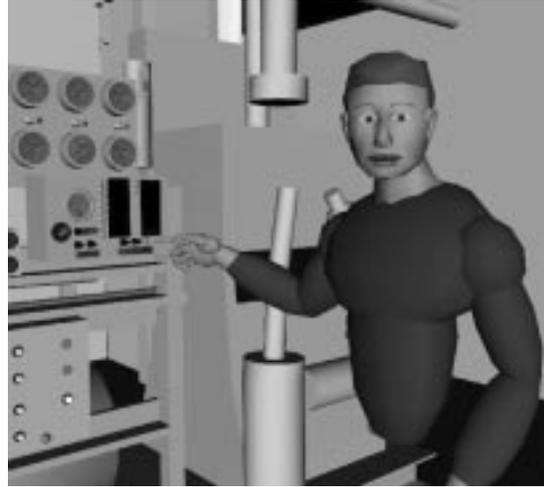


FIGURE 1

STEVE is an intelligent tutor developed by USC/ISI for the Office of Naval Research.¹⁰

(Courtesy of Jeff Rickel and
Lewis Johnson, ISI)

can discuss what he sees and does with his commander and the other members of his unit.

During his final few hours of the flight, the soldier immerses himself in a sample mission. The sights, sounds, and smells of the city immediately bombard him. People surround him, going about their daily lives. He is a bit scared and hesitant at first, but fortunately the rest of his unit stands in the street with him. A second unit is nearby. However, he remains unaware that they — along with all of the citizens with whom he is interacting — are computer-generated characters.

The soldier stands in a large central plaza in the city. A bazaar located in one part of the plaza is filled with throngs of people milling about, bartering for various goods. Several government buildings ring the plaza, and at the far end is a large church. The scene is a rich and confusing tapestry of life. Our soldier struggles to remember the identifying features of the various factions as he attempts to make sense of the scene. Suddenly, near the church, a large disruption occurs, and reports ring out, echoing off the buildings. What is going on? Is one of the rebel factions trying to attack the government?

Rifles at the ready, he and other members of his squad rush toward the disturbance, where they confront . . . a wedding party leaving the church and a group of celebrants setting off large firecrackers.

Switching the safety back on, the soldier shoulders his rifle and breathes a sigh of relief. The computer-generated tutor emphasizes the need to assess situations before taking action and points out that in this culture celebrations are often accompanied by fireworks easily

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The director ensures that the exercise follows the intended story line so that training goals are achieved.

mistaken for gunfire. This kind of immediate feedback is enabled through the use of computer agents as tutors. Because the feedback is provided in context, it can be more effective than an after-action review, where a substantial delay may separate the exercise and the review.¹¹

This scenario was orchestrated by the director, another computer agent that directs the behavior of the other agents in the simulation and the environment. By exercising control of these elements, the director ensures that the exercise follows the intended story line so that training goals are achieved. This scenario was designed to create a situation in which the soldiers would be confronted with an ambiguous but potentially threatening situation, forcing a decision on whether to act — and where the wrong decision would have disastrous consequences.

Although the soldier in the exercise is free to make choices, the director manipulates the simulation so that eventually, he is forced to confront the intended dilemma, thereby achieving the pedagogical goals for the simulation. For example, if the soldier and his squad had not noticed the initial disturbance, the wedding celebration would have become louder and more boisterous until it could not be ignored. Furthermore, the squad's failure to recognize the disturbance in its early stages would be an issue that the tutor would cover during its review of the exercise.

This describes just one of many possible experiences that ICT will make possible. Verisimilitude of this quality will require combining the art of interactive storytelling with the art and technology of compelling interactive experiences. It involves collaboration between the creative and technical experts of the entertainment industry and the researchers and system builders of the academic, industrial, and military R&D communities. All of these necessary components are either present at USC or linked closely to it.

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We expect that creating a true synthesis of art and technology,¹² of the capabilities of the entertainment industry and the R&D community — all in service of verisimilitude — will revolutionize military training and mission rehearsal. It will be more effective in terms of cost, time, the types of experiences that can be trained or rehearsed, and the quality of the result. It will also provide a new medium for entertainment, enabling both individuals and groups to be fully immersed and engaged in compelling civilian experiences.

Beyond entertainment, verisimilitude would also provide new media for both immersive distance learning and the arts, especially the performing arts. It could also support a new mode of virtual travel, providing immersive presence in a remote location and perhaps augmenting the local populace (with whom direct interaction may not be possible) with synthetic characters, with which interaction is possible.

TOWARD VERISIMILITUDE

The computer and Internet revolutions have substantially changed the direction of entertainment from delivery in a mass medium, such as television, to a mass customized experience via the Web and personal computer. The art of entertainment, however, still requires stories, characters, and direction to make the experience meaningful and enjoyable. The U.S. Army faces the challenge of adapting to the changes brought about through the mass marketing of supercomputing (for example, PlayStation 2), low-cost graphics, and the higher expectations of technically savvy soldiers.

Moreover, it is crucial that we address new types of problems such as urban conflict, operations other than war, and information operations that cannot be simulated well in military virtual environments today. As the vignette presented

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above demonstrates, it is urgent that the human dimensions of war and conflict be represented to provide training for the difficult decision-making problems our soldiers must face. NATO's experiences in Kosovo and the U.K.'s in Northern Ireland highlight the complexity and importance of such training.

The establishment of the Institute for Creative Technologies is just one of many steps necessary to inject the essence of verisimilitude into training and virtual reality systems. The U.S. Army will explore all avenues of entertainment technology to keep pace with the challenges presented, whether in application to distributed learning or embedded training systems. Ultimately, we want to prepare our soldiers for the future by experiencing it.

NOTES

1. Bran Ferren, "Some Observations on the Future of Army Simulation," *RDA Magazine* (Washington, DC: US Army, May 1999), 31-37.

2. See <<http://www.ict.usc.edu>>.

3. Michael Macedonia, "Why Digital Entertainment Drives the Need for Speed," *Computer*, 33 (2) (Los Alamitos, Calif.: IEEE Computer Society, Feb. 2000), 124-127.

4. Michael Macedonia, "Sony versus Wintel: Mortal Combat," *Computer*, 32 (7) (Los Alamitos, Calif.: IEEE Computer Society, July 1999), 112.

5. Weinberg was a key contributor to development of the ICT proposal.

6. *Game Informer Magazine*, May 1999.

7. Committee on Virtual Reality Research and Development, *Virtual Reality: Scientific and Technological Challenges*, National Research Council, Nat Durlach and Anne Mavor, eds. (Washington, DC: National Academy of Sciences Press, 1994).

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8. Michael Zyda, *Modeling and Simulation: Linking Entertainment and Defense*, National Research Council (Washington, DC: National Academy of Sciences Press, 1997), <<http://www.nap.edu/html/modeling/>>.

9. Soar is a cognitive architecture upon which STEVE's mind is constructed. The name Soar started as an acronym, but was converted into a proper noun a number of years ago. See P. S. Rosenbloom et al., "A Preliminary Analysis of the Soar Architecture as a Basis for General Intelligence," *Artificial Intelligence*, 47, 1991, 289–325.

10. J. Rickel and W.L. Johnson, "Animated Agents for Procedural Training in Virtual Reality: Perception, Cognition, and Motor Control," *Applied Artificial Intelligence*, 13, 1999, 343–382.

11. This vignette was partly developed by William Swartout, Director of Technology for ICT.

12. Providing what Richard Lindheim, the executive director of ICT, has referred to as *show technology*, as a complement to the more common combination of art and business as show business.

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