by Carol Gunther-Mohr

Virtual Reality Training Takes Off

VIRTUAL REALITY is a computer-based technology that gives learners a realistic, three-dimensional, interactive experience. Unlike animation or video, in which images are played and replayed in preset sequences, VR can be viewed, interacted with, and examined from any number of perspectives in any sequence.

Through the 1980s, VR required expensive equipment. And VR was used mostly for scientific and military applications. Today, you can run VR on a multimedia PC using commercially available VR development tools to create learning environments for many different applications.

Currently, VR is used in such fields as architecture, medicine, and engineering as a highly interactive training tool. Many PC-based VR training applications exist for teaching technical skills. For instance, when the National Guard wanted to improve the skills of maintenance mechanics, it sent a virtual tank, via a PC, to local armories rather than sending real tanks at great cost. Now, even in rural locations, new recruits can practice critical troubleshooting skills rather than just reading the manuals.

VR and training

VR technology makes it possible for trainees to work in realistic settings with real equipment, any time and any place.

VR is particularly beneficial

- when such hazards as radiation or toxic chemicals are involved
- when trainees cannot access new products or expensive equipment
- when trainees cannot travel to a training site.

Some speculate that VR may improve a trainee's ability to learn and retain information and skills. While most of this evidence is anecdotal, studies are underway to examine the effectiveness of VR-based learning.

At Research Triangle Institute in North Carolina, for example, we are conducting VR effectiveness studies in a controlled setting. The studies are looking at how much realism is required to improve learning and skill performance, what types of learning benefit most from using VR, and whether VR can increase a trainee's motivation and retention.

In some cases, VR training is easier to modify and update than videos or real equipment in laboratories. That's because VR is developed in modules; each piece can be updated or changed as needed. Video is much harder and more expensive to update.

VR can build on other training systems. It can be incorporated into existing CBT modules and is compatible with many authoring software programs. VR is also useful in conjunction with traditional classroom and laboratory instruction.

VR requires special computer hardware and software. Many types of computers and VR software development tools are capable of displaying VR so determining what it takes to do VR requires careful analysis. (See sidebar, Should You Consider VR?)

The hardware used to display and interact with VR can range from a multimedia Pentium PC to a high-end graphics processor. Your VR setup could be one computer monitor or a number of different display devices, such as head-mounted displays or special 3-D glasses. Adding sound to VR can enhance realism but is not required.

A VR experience gets better with increases in a computer's speed, memory, graphics-handling, and screen resolution, and by adding 3-D devices and sound, realism, and interaction.

Several companies have developed PC-based software that helps users develop and display VR objects and environments. Using those tools requires some knowledge of software development techniques such as object-oriented programming and three-dimensional modeling.

A program developer should first collect visual and performance data. Then, based on that data, three-dimensional objects can be created and placed together in virtual environments. Those objects are given behaviors and rules for how to perform. For example, when a key turns, an engine starts, which in turn causes movement and sound.

VR development requires a complex set of skills. Most VR projects are best accomplished by a team in which instructional designers work closely with 3-D modelers and software application programmers.

The cost of VR depends on the features you need tempered by your budget. The factors affecting the cost of VR include:

- the amount and complexity of visual and other data it will include

VR Resources on the Web

University researchers

- Massachusetts Institute of Technology, Virtual Environment Technology for Training (VETT), http://mimsy.mit.edu/index.html
- University of Central Florida, Institute for Simulation and Training (IST) http://www.vsl.ist.ucf.edu
- University of Houston and NASA, Virtual Environment Technology Lab (VETL), http://www.uh.edu/
- University of Washington, Human Interface Technology Laboratory, http://www.hitl.washington.edu/projects/knowledge_base

PC-based VR tool developers

- Apple, QuickTimeVR, http://qtvr.quicktime.apple.com
- Microsoft, Direct3D, http://www.microsoft.com/media/learn/faq/direct 3dfaq.html
- Sense8, http://www.sense8.com
- SuperScape, http://www.superscape.com/
- Virtus, http://www.virtus.com

PC-based VR training producers

- Adams Consulting Group, http://www.adams-consult.com
- Nortel, http://www.nortel.com/entrods/vr/
- Research Triangle Institute, http://www.rti.org/vr/
- VR Institute, http://www.vrinstitute.com

- the amount of realism or detail in visual images
- how users will access VR materials.

To better understand the costs involved, compare standard multimedia with VR development. While the cost of multimedia courseware varies widely, average costs of $40,000 per hour of finished instruction have been reported in the *Multimedia Training Newsletter* and in *New Media* magazine.

One factor that drives the cost of multimedia is professional video production. When VR replaces professional video production, it can cost in the same range as multimedia training materials. In addition, VR is designed in modules that can be changed, updated, and reused.

VR outlook

We take for granted how easily computers handle number-and word-processing. In the future, though, VR may be in nearly every computer program, providing a rich source of interactive, visual experiences.

Advances in software to model human forms and behaviors, in hardware to deliver tactile and olfactory information, and in learning methodologies that take advantage of new technologies, will expand VR's potential.

Experts predict that VR over the Internet, using VRML (virtual reality modeling language), soon will be more robust and will allow many users to share and manipulate a common virtual environment. Even though increased bandwidth will give access to high-quality video images, VR will be critical for accessing things that don't yet exist physically, are too dangerous or difficult to access, or require interaction in three dimensions.

While today's VR training programs concentrate on the development of technical skills, tomorrow's VR may help trainees develop interpersonal skills. For example, negotiation skills could be practiced in a virtual environment that looks like a room full of people.

The virtual "opponents" in such a negotiation would be modeled on a variety of people's speech patterns, gestures, and experiences. These simulated people (intelligent robots, often referred to as agents) would use both predictable and unpredictable responses in the negotiation session.

Real users would direct the actions of 3-D representations of themselves, which capture the user's actual characteristics. Once all of the virtual players in the negotiation have been created, the negotiations could proceed and then be replayed, reviewed, and tried again as many times as needed. This ability to rehearse in a safe environment is a key characteristic of VR, whether the dangers are physical, like radiation, or psychological, like a tough opponent.

VR is an emerging technology that today is bringing new forms of interactivity to training programs. In the next few years, as VR technology advances, it promises to take training into a whole new dimension wherever learning takes place.

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SHOULD YOU CONSIDER VR?

Here's a sample of the *Virtual Reality Training Decision Tool*, developed by Carol Gunther-Mohr and Nina Adams. It can help you decide whether you should consider VR for a specific project or if you should develop a VR program in-house or consider outsourcing.

Consideration	Instructions	Points	Score
Availability of computers at learner site	If computer hardware at learner site is • Not available at all • Available but has to be upgraded • Available	 0 points 5 points 10 points	
Consistency of computer platform	If hardware and operating system at learner site is • Different or not available • Similar • Identical	 0 points 5 points 10 points	
Configuration of computers	If computers are • Not available • Standalone with no network access • On a network (internal or external access)	 0 points 5 points 10 points	
Availability of troubleshooters	If personnel to keep computers operational • Cannot be made available • Can be made available	 0 points 10 points	
Learning Content Content already available in interactive format	If interactive training program • Can be purchased for use without modification • Can be purchased/modified to meet requirements • Must be developed to meet requirements	 0 points 5 points 10 points	
Type of learning content	If skills are • Soft (e.g., communications) • Hard (e.g., technical)	 5 points 10 points	
Interaction with the physical environment related to the learning content	If learning is most effective • Without interaction with the physical environment • With interaction with an environment such as a factory, lab, or other worksite	 0 points 10 points	
Interaction with physical objects or equipment	If the most effective learning • Never requires manipulation of physical objects or equipment • Requires manipulation of physical objects or equipment	 0 points 10 points	
Availability of content experts	If content questions must be answered and experts • Cannot be made available • Can be made available	 0 points 10 points	
Conceptual learning	If content contains concepts which are • Easy to grasp • Difficult to grasp	 0 points 10 points	

The full text of this tool is available for free downloading at http://www.rti.org/vr/w/decision.html.