Integrating Virtual Reality Into Technology Education Labs

By Sylvia Tiala, DTE

Virtual reality provides a means to deliver standards-based curriculum to today's technologically savvy students.

Desktop Virtual Reality (Ausburn & Ausburn, 2004) is an instructional tool that can be used to deliver standards-based instruction (International Technology Education Association, 2000/2002) while tapping students' interests. Although there are no plug-and-play virtual-reality (VR) solutions currently available to the K-12 teacher, there are easy ways to teach concepts employing VR (interactive, three-dimensional, stereographic computer images). Experimenting with hardware and software can be time-consuming for the K-12 teacher. This article discusses the hardware, software, resources, and concepts needed to integrate VR into a classroom with a minimal investment of resources.

Today's students are technologically savvy. They use computers to play video games, post web pages, publish weblogs, and chat online. Seventy percent of children in the U.S. between ages 3 and 17 have access to computers (Child Trends 2003; DeBell and Chapman, 2003). Seventy percent of today's college students play video games (Riegle, 2004). The technologies used to produce video games are closely associated with desktop virtual reality (Ausburn & Ausburn, 2004). Computer-assisted drafting programs (CAD) and graphics programs are used to generate and animate three-dimensional (3D) computer models. Technologies used to create three-dimensional models for video games are also used to create virtual-reality models. Video gaming enthusiasts don helmets or goggles that have small computer monitors mounted in them. Similar head-mounted displays (HMDs) are used in virtual-reality activities. Input devices, such as mice, triggers, or thumb sticks, allow gamers to interact with a video game. These input devices can also be used in VR. Virtual-reality technologies tap students' motivation to use computers while delivering standards-based curriculum.
Standards-based Instruction

Virtual reality, HMDs, and trackers can be easily and inexpensively integrated into the technology education laboratory to address ITEA's Standards for Technological Literacy: Content for the Study of Technology (STL) (2000/2002). Virtual reality, like video games, integrates software and hardware residing on a local computer or network into a communication system. Studying this communication system directly addresses students' understanding of "The Nature of Technology" (STL Standards 1, 2, and 3). Students generating 3D computer models (STL Standard 11) used in virtual reality come to understand the design process (STL Standards 8 and 9) while using, troubleshooting, and maintaining a technological system (STL Standard 11). Exposure to desktop virtual reality introduces students to technologies used in movie animation, electronic gaming (Novak, 2005), chemistry (Illman, 1994), surgery, flight simulation (Shulman, 1999), marketing, engineering, military training, and robotics (Briggs, 1996; Wong & Wong, 1996). "The role of society in the development and use of technology" (STL Standard 6) can be explored within the context of these related technologies.

Desktop Virtual Reality System Setup

Software

Software applications drive the selection of computer hardware and the associated peripherals in any VR system. Alice, a freeware computer program from Carnegie-Mellon University, available for download from www.alice.org, may be used as the starting point for desktop VR. Alice integrates into graphics and web-design classrooms easily since computer workstations running modern CAD and graphics packages will easily run Alice. Alice's interface, shown in Figure 1, is used as the starting point for a first-time introduction to virtual reality for the following reasons:

- Three-dimensional objects are built and ready for animation.
- Alice is free from Carnegie-Mellon University and is regularly updated.
- Programming skills needed to implement higher-level VR systems are introduced while students create their own animated environments.
- Components of Alice have cross-curricular ties to math (moving objects along three-axis or absolute versus relative coordinate systems), science (reflectivity or opaqueness of objects and sound wave frequencies) and language (learning a computer language).

- Alice is easy to download and use with directions from the Alice website. Built-in tutorials and a beta version of Dann, Cooper, and Pausch's (2005) instructional text, *Learning to Program with Alice* (www.alice.org), provide additional support.
- Results of programming can be seen immediately.

Experience shows that students can animate single characters proficiently after five hours of practice. Many students will be able to develop interactive animations that integrate head-mounted displays by the end of a twelve-week semester. Multi-character, three-minute interactive animations are easily accomplished.

Sound Effects

Sound effects add another dimension to animations and can be added directly to an Alice environment after plugging in an external microphone. Science concepts relating to sound waves and careers in sound production applicable to movie production, animation, and audio recording can be addressed while creating Alice worlds. Figure 1 shows a rabbit, a frog, and a beach chair. In this animation the frog jumps out from under the chair and hops toward the lake. A sponge repeatedly dipped into a pail of water was used for the sound effect of a frog jumping. Students can experiment with recording, echoing, speed, and volume of sound to get the desired effects.

Head-Mounted Displays

An HMD, like that shown in Figure 2 (iO Display Systems' i-glasses PC), projects a VR world in front of a person's eyes and is needed for stereo imaging in a desktop VR system (www.i-glassesstore.com; www.stereographics.com). Images appear three-dimensional by projecting slightly different views of the same object into the left and right eye (StereoGraphics Corporation, 1997; Bungert, 1998).
Care should be taken when selecting an HMD, as people can experience nausea, fatigue, and dizziness if the HMD's resolution and refresh rates are too low. StereoGraphics Corporation (1997), General Reality Company (n.d.a; n.d. b), Bungert (1998), or other experts should be consulted for technical considerations inherent in choosing a viewing device.

Stereo images and three-dimensional (3D) graphics are both required for VR applications. It is important to understand the difference between 3D graphics and stereo graphics, as some software/hardware vendors interchange these terms.

Three-dimensional objects, like those shown in Figure 3, have width, height, and depth, while two-dimensional objects have only width and height. Three-dimensional objects are critical components for desktop VR worlds. Many computer-aided-drafting packages (CAD) and modeling/animation packages generate 3D objects and virtual worlds that a user can move through. The viewer is able to see the front, back, top, sides, and bottom of objects and their respective positions within a world.

Stereoscopic views are created when software and hardware split lines or pixels of a computer image into left and right images and send these to a display screen or HMD. Stereo graphic cards in conjunction with HMDs and CAD/illustration software capable of generating stereo images (alternating left and right views) are used to import stereo images into a desktop VR. Although current versions of Alice do not support stereo imaging, connecting an HMD to a computer is useful for conveying concepts related to stereo imaging and hardware/software interfacing.

**Tracking Devices**

Tracking devices like that shown in Figure 4, add an element of interactivity to a computer-generated world. Trackers connected to HMDs send signals to a receiver. The receiver sends positioning information to the computer and adjusts the user's view depending on where the head is located and how it is positioned in a virtual reality. There are several things to consider when selecting tracking devices. Cost is the major factor, as trackers range in price from several hundred dollars to tens of thousands of dollars. Degrees-of-freedom refers to what types of motion a tracker will register. Pitch, roll, and yaw and placement along the x, y, and z coordinates are measured with a six-degree-of-
freedom tracker that places the viewer inside a world indicating head position and orientation. Since many low-end trackers are limited to ten feet or less of motion, range of operation should also be considered.

Integrating trackers into a desktop VR system provides an opportunity to teach students about relative, absolute, and polar coordinate systems and calibrating scientific instruments for accurate readings. Maui Innovative Peripheral's Cymouse, shown in Figure 5, is an inexpensive, six-degree-of-freedom tracker that is easily integrated with Alice, using mouse emulation. Some modification may be needed to affix the tracker securely onto a computer yet allow for removal and safekeeping. Tracker range is limited to several feet due to cord lengths and tracker/receiver sensitivity. Integrating this hardware into the VR system allows students to see how the 3D software, peripheral hardware, and programming skills combine to produce an interactive computer-generated world.

Assessments
Students can be assessed under the three broad categories of 1) memorization, 2) application, and 3) synthesis. Memorization involves remembering in which menu, window, and object elements reside within the Alice program. Written worksheets, teacher observation, and informal questioning can be used to assess students' abilities to identify objects residing in the local Alice gallery or to choose specific regions of the Alice interface. This lowest level of assessment is applied as students follow written and verbal directions while learning a new computer application.

Application can be measured using informal questioning techniques, rubrics, and Alice projects. Consulting with math and science instructors may help make student assessments more rigorous across the curriculum. Students should be able to apply basic math and science concepts related to coordinate systems and animation to their Alice worlds. Exercises and projects are included in Learning to Program with Alice (Dann, Cooper & Pausch, 2005) or can originate with students and teachers. Students should be able to create storyboards, orient and move objects, and add sound to their projects. Advanced students should be able to use programming questions and control statements, add camera and animation controls, create visible and invisible objects, and use random motion events in their worlds.

Summative and formative assessment strategies are used to assess students' synthesis of Alice concepts. Rubrics and presentations can be used to evaluate students' final projects. Rubrics assessing students' abilities to work as a team and communicate with peers can be added if team projects are utilized. Projects might include developing animations to show centrifugal force, developing advertisements for a favorite book, or creating a video game to help children learn colors. Advanced students are encouraged to set up individual learning plans directed at their post-secondary career ambitions. Students interested in engineering may be encouraged to design new mounts for trackers on HMDs, explore video cards, or connect and troubleshoot input devices. Students interested in game design and animation are encouraged to look at higher level animation and programming languages as they design, animate, import, and export 3D graphics. Assessment may include design notebooks, daily logs, interviews, portfolios, competition entries, and presentations.

Implementing Desktop VR
Integrating virtual reality into technology education instruction is an exciting educational prospect. Technologies associated with VR can be used to create engaging lessons. Computer games and virtual worlds designed with Alice can be used to implement the International Technology Education Association's Standards for Technological Literacy. Scientific and mathematical concepts utilized with virtual-reality technologies enable teachers to provide cross-curricular connections. Students learn from hands-on experience and in non-traditional classroom contexts as called for by the American Association for the Advancement of Science (1993) and the National Council of Teachers of Mathematics (2000-2004). Virtual reality provides a means to deliver standards-based curriculum to today's technologically savvy students. Studying VR may motivate students to gain a deeper understanding of the communication systems they routinely use.
References


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