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Virtual Reality: In the Mind of the Beholder

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Rydell looked down at the glasses and saw that the lenses were black now.
"Go on," Warbaby said.
Rydell noticed the weight as he slid them on. Pitch black. Then there was a stutter of soft fuzzy ball-lightning, like what you saw when you rubbed your eyes in the dark, and he was looking at Warbaby. Just behind Warbaby, hung on some invisible wall, were words, numbers, bright yellow. They came into focus as he looked at them, somehow losing Warbaby, and he saw that they were forensic stats.

William Gibson, *Virtual Light*

There are as many definitions of virtual reality as there are people who have heard of it[1] (see "For further information"). To us, a virtual world is an application that lets users navigate and interact with a three-dimensional, computer-generated (and computer-maintained) environment in real time. This type of system has three major elements: interaction, 3D graphics, and immersion.

THE ELEMENTS

Interaction is the process of inputting data to the system and receiving data from it. The 3D graphics, a form of computer output, let users "see" the virtual environment. Immersion refers to the user's feeling of "presence" in the virtual world. An immersive application convinces users that they are in a replicated environment.

These definitions are very broad. An e-mail program is interactive, a movie is immersive, and a database can easily be represented by 3D graphics. What turns an application into a virtual environment is combining these three elements in real time.

Real-time updates of the graphics scene reacting to the user's changing point of view help to create a feeling of presence in the virtual world. These updates, however, are very computationally demanding. The importance of real-time speed and the difficulty of its implementation make it an important issue in VR research. Devising new ways to overcome the computational limitations of today's most powerful equipment takes not only effort, but creativity, as we will see in this issue. Finding new shortcuts in image rendering, a major concern for most graphics specialists, is even more important to those working in VR.

SETTING THE SCENE

Real-time interactive 3D space, however, is only the stage for VR performance. Even as we perfect the means of generating such a stage, the question has already been posed: What will occupy it? As we see in this

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issue of *Computer*, the stage is already host to a broad range of serious applications. Our playbill features medical imaging, psychological treatment, simulations, visualization, and terrain database construction.

In contrast, the media have glorified frivolous VR applications, touting VR video games, ignoring serious research, and making outlandish assertions about VR as if these advances were already accomplished. If we strip away the fanciful overstatements and vaporware, we can better appreciate the researchers who are making valuable contributions. In this theme issue of *Computer*, we have attempted to separate the real from the imagined, the implemented from the proposed.

IN THIS ISSUE

We began by soliciting manuscripts describing real-world virtual worlds or VR applications that were actually being used. Of the 26 submissions from the United States and Europe, we were able to include only six. Some intriguing and innovative work has been left out. Although we had hoped to include a cross-section, we could not include enough research to be truly representative (for background, see D.K. Boman's international survey on virtual environment research[2]). Therefore, we offer a sampling that indicates the breadth of VR research.

Since we wanted to present applications that were furthering virtual world development and/or actually placing VR in users' hands, we chose application-oriented projects. The research we present produced tangible results in support of new interface concepts instead of merely being products or concepts themselves.

For instance, the system presented in "Two-Handed Spatial Interface Tools for Neurosurgical Planning" by Goble et al. produced both a new interface paradigm and a useful product. Although the application is very specific (brain surgery planning), the "spatial tools" paradigm of accessing a large amount of information quickly and intuitively can be extended to other applications. This is exactly what we envisioned when we began work on this special issue.

Some of the articles are a combination of research and implementation. For instance, the system described in "Virtual Environments for Treating the Fear of Heights" by Hodges et al. used a research method that allowed subjects to be treated for acrophobia at the Georgia Institute of Technology. After wearing head-mounted displays that simulated graded exposure therapy, some individuals reported a marked improvement in their ability to overcome the fear of heights. Another laudable element of this project is the interdisciplinary cooperation of computer science and psychology researchers.

Continuing in a research/implementation vein, Kuhl et al. from the University of Iowa present "The Iowa Driving Simulator: An Immersive Research Environment." This simulator lets users examine topics from traffic safety research to vehicle design. Used as a design aid, the Iowa Driving Simulation diminishes the number of necessary physical prototypes by creating virtual prototypes of vehicles and other systems.

"The Responsive Workbench: A Virtual Work Environment" by Krüger et al. describes another design aid. At first glance, the workbench seems to be just another novel interface device. However, it presents an interaction paradigm that takes a new approach to user needs. Designed for use in such fields as computer-aided design and training, the Responsive Workbench provides an unencumbered 3D display. The technical quality of this system is noteworthy. This article also illustrates how researchers are attempting to bridge the gap between lab equipment and marketable, intuitive end-user applications.

The end user is also the focus of the military's Close Combat Tactical Trainer. CCTT, the heir presumptive of the SIMNET (Simulator Networking) program, will be used to train ground combat forces in tactical operations. "A Large-Scale Complex Virtual Environment for Team Training" by Mastaglio and Callahan is the only article associated with one of VR's top sponsors, the US government. With work being conducted within the Army, Navy, and NASA (among other programs), government funding is responsible for much of the common knowledge in the fields of 3D sound and distributed virtual worlds. CCTT promises to be one of the largest and most well-funded VR research projects, with lessons learned during its development spreading to many nonmilitary VR researchers and end users.

In contrast to end-user applications, the last article discusses VR development databases. Many VR researchers need quickly built, easily maintained terrain databases. "Automating the Construction of Large-Scale Virtual Worlds" by Polis, Gifford, and McKeown presents a system that generates very high fidelity databases suitable for ground-based simulations. By automating a process that hitherto has been a painfully tedious experience, this system could prove key to the success of many VR applications.

VIRTUAL REALITY IS NEITHER FRIVOLOUS nor necessarily the most important invention since transistors. If nothing else, we hope you come away from this issue of *Computer* appreciating the diversity of current research and understanding that VR is more an interface concept than a single product. ∎

References

1. *Virtual Reality: Scientific Technology and Challenges*, N.I. Durlach and A.S. Mavor, eds., National Research Council, National Academy Press, Washington, D.C., 1994.

2. D.K. Boman," International Survey: Virtual-Environment Research," *Computer*, Vol. 28, No. 6, June 1995, pp. 57-65.

For further information

1. Special Issue on Virtual Reality, *IEEE Computer Graphics and Applications*, Vol. 14, No. 1, Jan. 1994.
2. Special Issue on Virtual Reality, *IEEE Spectrum*, Vol. 30, No. 10, Oct. 1993.
3. *Presence, Teleoperators and Virtual Environments*, Vol. 3, No. 4, Fall 1994.
4. For a list of VR Web sites, contact ftp://taurus.cs.nps.navy.mil/pub/NPSNET_MOSAIC/npsnet_otherlinks.html.

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