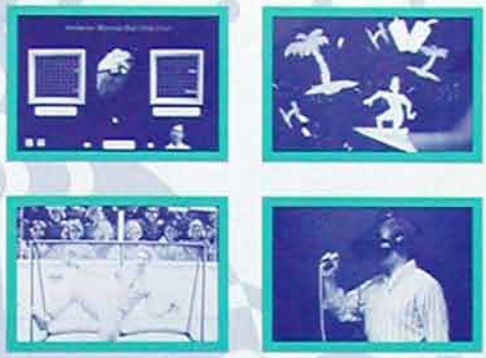
TOMORROW'S REALITIES

Virtual Reality

Hypermedia

29 July–2 August 1991



"The most beautiful thing we can experience is the mysterious. It is the source of all true art and science."

Albert Einstein

SIGGRAPH · 91 LAS VEGAS

Virtual reality (sometimes referred to as artificial reality) is difficult to define. The term has become a catch-all for, among other things, telepresence, artificial or synthetic experiences, and their various delivery systems (head, body, and desktop gear). Because it is an oxymoron, the term itself does little to illuminate the nature or importance of the technologies it describes. We might imagine that, to be successful, a virtual reality application must encourage (to borrow a phrase from C.S. Lewis) "a willing suspension of disbelief."

Few technical endeavors in recent years have evoked such fiery discussions in the technical community, and fewer still have invoked such passionate involvement of the humanities and the cultural sector. Perhaps it is because interaction with virtual reality is so tightly coupled to the human senses that it evokes a great deal of reaction and participation from the humanities. Perhaps it is because the technology is finally interfacing with the human, rather than the human interfacing with the technology, that the cultural sector is demanding to play a role in the evolution of virtual reality.

virtual, *adj.* being so in effect or essence, although not in actual fact.

reality, *n.* **1.** the quality or state of existing or happening as or in fact **2.** actual, true, objectively so, etc. **3.** not merely seeming, pretended, imagined, fictitious, nominal, or ostensible.

Virtual reality is more a coming together of previously disparate disciplines, with a fresh look at human interaction, than it is a whole new branch of technology. It is a result of the evolution of user interface design, flight or visual simulation, and telepresence technologies. It differs from many other computing disciplines in its emphasis on the *experience* of the human participant. One might say that virtual reality is communication through experience. But the quality of the experience is crucial. In order to effectively encourage creativity and productivity, the virtual experience must be credible.

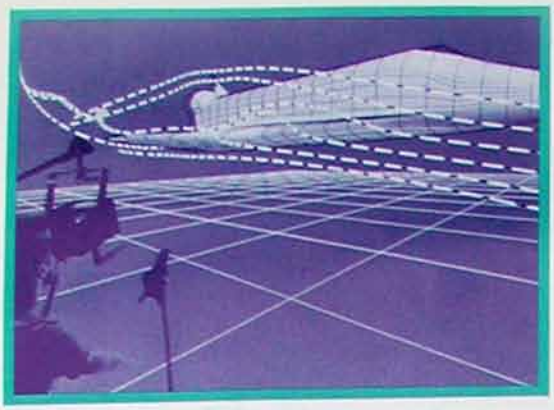
Experiential communication through computer technology requires earnest focus on the user interface of the application. Designers must consider the human factors of the devices which sense and stimulate the experience, the tasks to be performed, and the desired experience. A "reality" must both react to the human participant(s) in ways that are physically and perceptually appropriate, and conform to their personal cognitive representation of the microworld in which they are engrossed.

Virtual reality applications enable synthetic visualizations and experiences which may involve real data spaces and real people, or may present entirely simulated environments. Data transformed and presented in a virtual reality application may be from a remote location, a different time, or an alternative scale. It might be normally imperceptible information, such as microwaves or atomic particles transformed into a user-accessible domain. These possibilities raise two important questions, among others: Is the experience of something "synthetic" in a virtual reality inferior to other experiences? Is the knowledge acquired any less "real" than knowledge acquired through other forms of communication?

experience, *n.* **1.** an actual living through an event or events; personally undergoing or observing something or things in general as they occur **2.** activity that includes training, observation of practice, and personal participation **3.** knowledge or skill resulting from this.

The virtual reality exhibits in Tomorrow's Realities represent a diverse collection of applications, contributed by an even more diverse group of people. The experiences range from collaborative teaching, training, examination, modeling, and gaming to creation of cartoon scenarios through physical performance.

These virtual reality exhibits were selected for their overall design, delivery of experience, relationship of content to structure, attention to human-factors engineering concerns, and consistency of experience. For each submission, the jury first identified the application, the intended group, and the required tasks/experiences that the system addressed. Different applications require different degrees of fidelity of image, depending on the intended user group.



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Be Here Now

Submitted as virtual reality.

Be Here Now combines a Silicon Graphics 340 VGX IRIS workstation, a Polhemus 3Space digitizer, and a Fake Space Labs BOOM2 viewer to create three different virtual environments.

Fake Space Labs strives to build real tools for virtual worlds. "The Virtual Windtunnel" is an excellent example of a highly practical virtual environment system being used to do real science in an everyday setting. However, the only way to learn about and take advantage of the powers and abilities of virtual reality systems is to explore those systems as artistic media in their own right. "Tape World" and "Flatlands" are two such explorations.

"The Virtual Windtunnel"

Inside a simplified version of the NASA Ames Virtual Windtunnel, users explore numerically simulated airflow past a simplified model of the space shuttle orbiter landing at a five-degree angle of attack. A small cross-shaped cursor tracks the user's hand position while a streamline is computed in real time starting at the user's hand position. This gives users the feeling that they are releasing smoke into the virtual flow field from their fingertips. Users can then walk around inside the flow field and investigate vortices, separation, and other airflow phenomena.

The flow field was calculated offline on a Cray supercomputer and downloaded into the IRIS workstation. Although this allows users to interact with the flow field, the shuttle model cannot be given a new orientation with respect to the free stream without a new flow field calculation. In the actual prototype system in use at NASA Ames, users are not constrained to a single-flow visualization tool. For example, a "rake" of streamlines extended between the fingers can be used to visualize airflow phenomena more intuitively.

"Tape World"

This experiment in virtual worlds designed by algorithm generates a slowly rotating semi-static mobile of curlicues, cracks, and fractal dust. As each user enters the system, the computer generates a unique custom world for exploration. No two worlds are alike.

Ribbons are generated with user-specified width, curvature, torsion, length, and behavior. Brownian noise is used to create trails of powder and wiry crumpled balls of string. The end result can be compared to being inside a biological macro-molecule or exploring a box stuffed with present wrappings and stuffing. The world can be explored from different angles by walking around it with the viewer or lying down on the floor.

"Flatlands"

Piet Mondrian said that a painter should never try to imitate the three-dimensional world on a two-dimensional canvas. It seems ironic then, that when the empowering tools of a virtual environment system are available, we limit ourselves to trying to emulate our lowly three-dimensional world.

"Flatlands" consists of the same set of elemental lines found in the Mondrian painting "Composition with Line" (1917). These lines are transformed through the illusion of perspective to create a three-dimensional jumble which coalesces into the original painting when the participant locates a specific point of view. The experience interplays two essential characteristics of the virtual environment medium: the ability to disregard physical laws and concentrate solely on form, and the recognition of and respect for the user's continuous ability and desire to choose new points of view.

To make sure that you experience all three virtual worlds, please check the posted schedule for demonstration times.

System

The 4D/340 VGX IRIS, a multiprocessor, RISC-based workstation with specialized graphics hardware, renders images of moderate complexity at up to 700,000 lit polygons per second. This high-level graphics power allows generation of head-coupled stereoscopic images with reasonable frame rates and without significant lag, two factors vital to successfully engaging a user in a virtual environment.

Connected to the VGX through a standard RS232 serial data interface are the Polhemus tracker and the Fake Space Labs' BOOM2 viewer. The Polhemus tracker generates a low-frequency magnetic field through which its sensor is passed and derives a relative position and orientation between the magnetic source and the sensor. This gives the Polhemus an almost magical quality. It is able to track in three dimensions completely without constraints on the motion or path of its sensor within its working envelope. However, its full accuracy range is limited to 30 inches from the source, and it cannot be used with full accuracy near metal objects or magnetic devices. It also induces some lag while calculating the position and orientation of its sensor.

Most head-mounted systems use low-resolution LCD displays because they are unable to support the weight of high-resolution CRT monitors. The BOOM2's mechanical linkage comfortably supports CRTs that produce monochrome images with over seven times the resolution of typical LCD-based head-mounted viewers. This level of resolution is essential for real-life applications where data must be accurately visualized.

In addition to its resolution and tracking advantages, the BOOM2 is well suited to applications that require the user to quickly enter and exit virtual worlds. For example, researchers do not have to "suit up" every time they turn from their terminals to look at a 3D world. And in design meetings, the BOOM2 viewer can be easily passed from one user to another, allowing them to share a common viewpoint from a single viewing device.

Creation of "Virtual Wind Tunnel"

Steve Bryson and Creon Levit of the NAS project at the NASA Ames Research Center.

Flow Field Calculation

Yehia Rizk and Shmuel Ben-Shmuel.

Creation of "Tape World"

Creon Levit

Creation of "Flatlands"

Mark Bolas and Ian McDowall

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Fake Space Labs is a member of the Telepresence Alliance.

Application

Visualization, entertainment

Type of System

Authoring and player, single-user

Interaction Class

Immersive, inclusive

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