THE THEATRE OF VIRTUAL REALITY

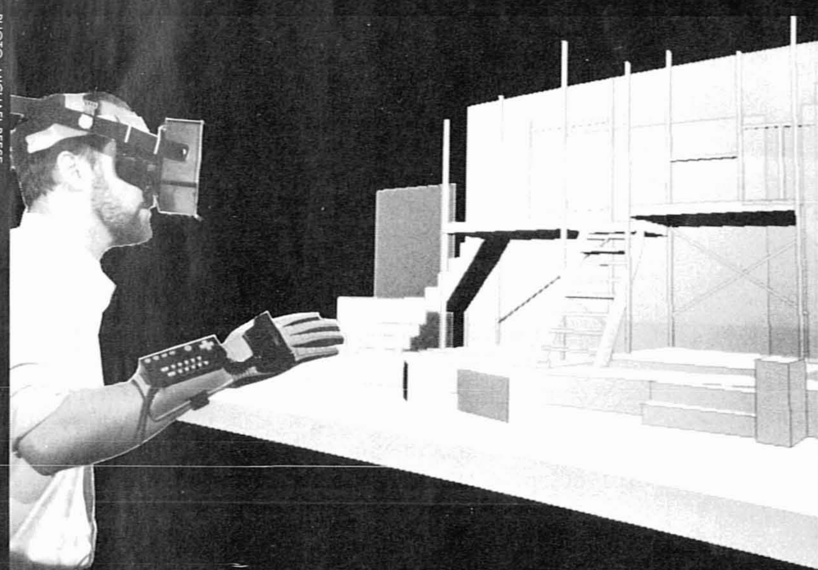

PHOTO: MICHAEL REESE

DESIGNING SCENERY IN AN IMAGINARY WORLD

IMAGINE DESIGNING SCENERY IN A MAGICAL THEATRE. That is to say, even more magical than usual. Sitting in your favorite seat, you look upon a set that was conceived only minutes before. It seems to you that the stage left wall needs to be a foot taller and invisible carpenters rush in to stretch the offending scenery to the desired height. After a few more such adjustments, you notice that the color of the cyclorama doesn't look the way you imagined, so the paint begins to change from one color to the next until you see one that suits your fancy.

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Still, the mood isn't right. You motion to mystical electricians, and in an instant the stage is awash with soft blue light. Add a little white side light and the scene is complete. It's time to check sightlines. With a snap of your fingers you are transported to another seat on the far side of the theatre. A wave of the hand starts you levitating towards a seat in the balcony. You then continue on, floating up into the fly loft so that you can see how your set will appear in a groundplan.

Returning from this never-never land is easy. Rather than clicking together ruby-slippered heels or stepping out of a looking glass, simply remove your head-mounted display and power down your computer, for you have been designing scenery in the electronic fantasy land of virtual reality.

PHOTO: MICHAEL REESE

TYPICAL VIRTUAL REALITY INTERFACE. HEAD MOUNTED DISPLAY AND POWERGLOVE ARE CONNECTED TO A MACINTOSH PERSONAL COMPUTER RUNNING VIRTUS WALKTHROUGH.

Virtual reality, or VR, and artificial reality are defined by the use of unique computer interfaces and interactive software that allow the operator to seemingly cross the boundary between the fictive spaces described in 3-D graphics and reality. This is typically achieved by either creating the illusion that the operator is within the environment depicted by the computer or by making computer-generated objects appear to occupy actual three-dimensional space.

The quest to establish a smooth, intuitive, and unobtrusive interface between computer-generated worlds and their human visitors has spawned a variety of unusual devices. Head-mounted displays consist of small computer monitors built into goggles. The purpose of these HMDs is to fill an operator's entire field of vision with the vista of a virtual world and thereby create the illusion of being within that world. Head trackers are input devices that tell the computer the direction in which the operator is looking. Electronic gloves command three-dimensional movement in a virtual world better than the typical 2-D input devices, the mouse and the joystick. More exotic systems use treadmills, stationary bicycles, electronic body suits, and myriad other devices to allow operators to navigate virtual worlds.

Virtual reality is a relatively new phenomenon. Although the theoretical basis of interactive computer interfaces was discussed by pioneers such as Ivan Sutherland at the University of Utah as early as the mid 1960s, practical models did not follow until the mid 1970s. In the 1980s, public awareness grew as practical applications were found for virtual reality.

Today, elements of VR can be seen in interactive computer games such as those found in arcades, home computers, and entertainment systems. At Disneyland and Disney World, patrons can enjoy computer-controlled rides that create the illusion of hurtling through outerspace or through the human body. Commercial airlines and the military use computer-based flight simulators to train pilots as well as airport simulators to train air-traffic controllers. Flight simulators designed more for entertainment than serious training are also available for use on personal computers. Architects use VR to walk through buildings that are still on the drawing board, and urban planners create virtual worlds that depict the future shape of our cities. But no field of endeavor has the capability to use the full potential of virtual reality like the theatre.

There are several attributes of the theatre that make it an ideal site for the use of virtual reality technology. First, the theatre can make good use of VR's ability to create worlds that do not adhere to the laws of physics. Like the theatre, where scenery and people fly, furniture moves by itself, and music seemingly comes from the sky, events in virtual worlds are limited only by the imagination of the creator. As in the theatre, objects can float in mid-air, trees don't have to be green or grow from the ground up, and the weather is under man's control. Conversely, architects and pilot trainees must use virtual reality in a way that mirrors the reality we live in or the end results would prove disastrous.

The theatre and VR share another attribute, one that is essential to both. Both are accessed in real time, created to be experienced in the present moment, not prerecorded or viewed as a static element. Exploring a stage set in virtual reality— discovering its spaces one after another as an actor would, going up and down stairs, using its doors, looking through its scrims—is more akin to an actual theatrical experience than viewing a sketch or scale model and therefore more gratifying.

This leads to another point. The theatre is unique in being able to use virtual reality not only as a tool or process in the creation of some final product but as an end unto itself. Just as an architect uses VR to design a building, a scenographer can use it to design a set. However, while the architect can't live in a virtual building, a theatrical event can be staged in a virtual world.

How could theatre be staged in virtual reality? What would the experience be like and how would it work? The possibilities are both numerous and varied, only requiring that we loosen our definition of theatre. It could be said that simply touring a virtual world is a piece of theatre. But while it may be theatrical, it is not terribly dramatic.

Other options could include a virtual theatre in which each member of the audience is provided a head-mounted display. The action of the drama could be provided by computer-generated characters controlled by "offstage" actors. Or perhaps live actors could be captured by a video camera and super-imposed into the virtual environment. Imagine being an audience member and being able to enter the unfolding story before you. You would seemingly be alone, exploring the dark halls of Inverness Castle until, rounding a corner, you stumble across Macbeth and his lady plotting the murder of Duncan. Or maybe you find yourself in a New York apartment, playing a hand of poker with Oscar Madison and Felix Unger. To partake in such a theatre, the audience need not even leave home. The future may hold some kind of entertainment network that people can access at home by plugging in their own VR equipment.

For those that enjoy a more communal experience, a virtual theatre may utilize live or computer-generated actors interacting with large projection screens. Computer-generated scenery could metamorphose on cues provided by the actors. Putting an audience in a room surrounded by such screens would provide an experience close to that of the fabled "holodeck" of Star Trek fame. In fact, there already exists such a room. "The Cave" is an experimental VR system in which visitors don special goggles that provide 3-D simulation and are surrounded by various images such as a computer simulation of the city of Chicago.

Virtual reality is not beyond the reach of the average scenographer. Because state-of-the-art systems can cost tens of thousands of dollars and require a high level of technical expertise, amateur VR devotees have found ways to fabricate their own less sophisticated yet effective equipment. The system I have created at the University of Kansas' University Theatre was created from spare parts and scavenged components from video equipment and video games, and cost less than $500. This "home-brew" virtual reality can be as convincing as more expensive commercial versions for the same reason that the theatre is convincing in the illusions it presents.

Both virtual reality and the theatre rely on our natural tendency to create a mental image of reality from only a few clues. Our perceptions of the world around us are very incomplete but our brains have been conditioned to fill in the missing pieces. This talent not only allows us to deal with the demands of everyday life, but to make sense of essentialy abstract constructions. For example, we are able to see depth in two-dimentional paintings and decipher the images on television.

This ability to complete fragmentary perceptions is evident in the theatre when we create a room with only three walls and no ceiling, turn all the furniture to face the same direction, and call it realism. The classic play *Our Town* is traditionally staged with only a few sticks of furniture and a couple of step ladders. In all productions, to a greater or lesser degree, we ask our audiences to suspend their disbelief and "go along" with the illusion so long as it is presented in good faith. If the illusion is well presented, the audience will soon cease to see it as illusion and accept it as the current version of reality. In virtual reality the visitor is asked to do the same. If the illusion created with a "home-brew" system is less detailed than those produced by a more expensive one, it merely requires the visitor to go a little further in accepting its version of reality.

My own system includes a home-brew HMD, made from two 2.7-inch color LCD televisions. The screen resolution of such a system is somewhat grainy but comparable to that of commercial HMDs. More sophisticated systems would generate separate stereo images for each eye in order to render a convincing 3-D image. However, creating two separate images slows computing time measurably and greatly increases the cost of the interface. Fortunately, a convincing illusion can be created by using the same image for each eye, separating them so that the user's eyes focus in parallel lines. The illusion of depth can be enhanced in the creation of the virtual world by placing objects on a patterned ground plane, a tactic used frequently in computer games.

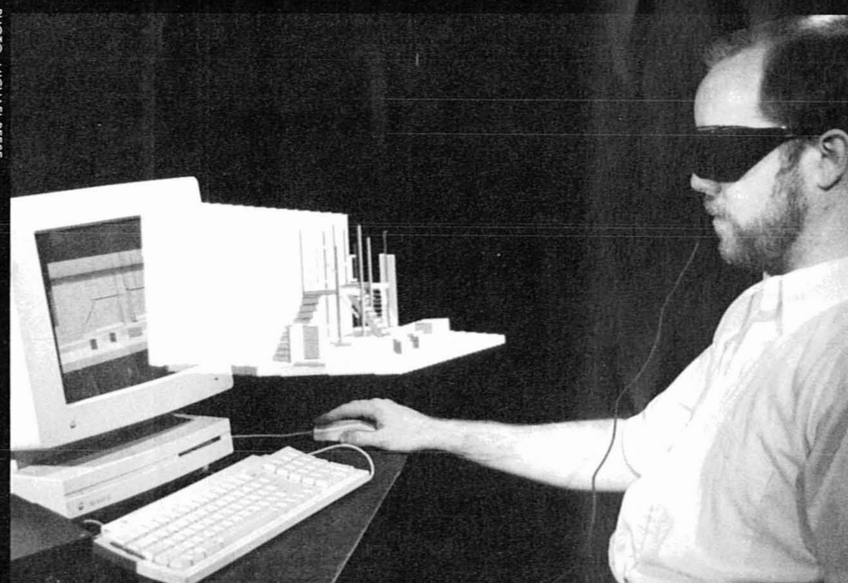
My system does not include a head tracker as it would require a more powerful computer capable of processing information at the speed necessary to create a smooth illusion. If there is a noticeable lag between movements of the user's head and the corresponding change in the view presented in the HMD, a sense of disorientation will occur, in some cases severe enough to cause motion sickness. In a low-cost system, users are only allowed to look in the direction they are traveling. After the user accepts this condition within this version of reality, the lack of head movement seems natural.

Movement within my virtual set designs is controlled by a Mattel™ Powerglove. This device was originally designed for use with Nintendo™ entertainment systems but has proved to be an effective low-cost alternative to commercial VR gloves. Worn like an ordinary glove, it allows a user to move through virtual spaces by motioning with the hand or fingers. The whole system is powered by an accelerated Macintosh™ LC running a 3-D interactive modeling program called Virtus™ *Walkthrough*, although similar results can be achieved with a variety of personal computers and interactive software packages.

The overall effect is rather convincing. As users navigate the virtual scenery, they begin to lean to the side as they go around corners, lean back with unexpected accelerations, and duck their heads under low virtual beams. Because users' perceptions of where they are do not coincide with their actual physical surroundings, I have them sit in a chair to minimize the danger of falling over or walking into an unseen actual table. The whole perceived experience then becomes similar to driving a motorized wheelchair through the virtual theatre.

After the user is seated, the HMD is placed on the head and the glove slipped over the right hand. The simulation is

PHOTO: MICHAEL REESE



LCD SHUTTER GLASSES CREATE A 3-D ILLUSION (SIMULATED PHOTO). HERE A RENDERING APPEARS AS A MODEL BEFORE THE SCREEN. RENDERINGS CAN ALSO BE MADE TO APPEAR AS FULL-SIZE SETS IN THE DISTANCE.

then powered up and the user is greeted with a view of the virtual stage as seen from the middle of the house. After making a few adjustments and setting the controls to zero, the user is ready to explore. By moving the gloved hand forward the chair starts toward the set. Moving the hand to the right and left turns the virtual wheelchair; up, down, and back motions produce corresponding movements within the virtual theatre. By depressing various keys on the keyboard, it is even possible to slide to the side, or tilt up, down, and to the side, even to the point of doing loops and barrel rolls. The longer visitors stay within the virtual environment, the more skillful they become at maneuvering within it. And as their perceptions grow accustomed to new parameters, the more realistic the illusion becomes.

Another device exists that creates an artificial reality by seemingly moving scenes rendered on a computer screen into the real world. This goggle-like apparatus is known as "shutter glasses." Again, while sophisticated and expensive models of this device are available, a home-brew version can be fabricated for about $40 by using inexpensive glasses made by the Sega™ Corporation for use with its game systems.

VIRTUAL REALITY MAY PROVIDE A METHOD FOR COLLABORATION BY ALLOWING DIRECTORS AND ACTORS TO BLOCK SCENES ON VIRTUAL STAGES AND DISCUSS THE EXPERIENCE WITH SCENOGRAPHERS BEFORE THEIR DESIGNS ARE FINALIZED.

Shutter glasses create the illusion of depth in images by rapidly alternating the transparency and opaqueness of its LCD lenses while the computer monitor presents corresponding right and left eye views. By carefully creating the left and right eye views, I have found it possible to produce the illusion of a scale scenic model floating in the air in front of the computer monitor, or a full-size setting seen through the "window" of the screen, or a combination of both, with some elements appearing before the screen and others behind.

These and other devices put virtual reality technology within the reach of the average scenographer. These new tools can be used by designers to visualize and present their ideas in a format much closer to actual production conditions than the traditional sketch. Virtual reality may provide a method for collaboration by allowing directors and actors to block scenes on virtual stages and discuss the experience with scenographers before their designs are finalized. And, as technology advances and theatre artists become familiar with the concepts of VR, productions will be staged on virtual worlds where anything is possible.

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Note

The bibliography of resources concerning virtual reality is too long to list here and is growing steadily. However, a good source for such a list as well as current information is the usenet newsgroup: Sci.virtual-worlds. The group is moderated by Bob Jacobson and Mark A. DeLoura of the Human Interface Technology Lab in Seattle WA. For those without access to usenet groups, the newsgroup is available via a mailing list. To join, e-mail Mark at madsax@u.washington.edu. An extensive archive is maintained and available via anonymous FTP at milton.u.washington.edu in ftp/public/virtual-worlds.