PETER MENZEL

Warren Robinett, research associate in UNC's computer science department, uses a first-generation head-mounted display that provides a 3-D view of the structure of a molecule.

JERRY MARKATOS

Frederick Brooks, professor of computer science and founder of the Virtual Reality research program.

Virtual Reality

In VR research, Carolina is the "intellectual hotspot of the world"

by Leonard Rogoff '69

Computer scientists at the University have designed systems that enable architects to walk through buildings before they are constructed and biochemists to grab molecules in their hands to structure new drugs. The operator is not merely sitting before a screen punching a keyboard, but is immersed in an environment, walking, touching and seeing his or her way through an illusional, three-dimensional world.

The idea that computer scientists can create a virtual reality in their laboratories has excited the public in ways that academic research rarely does. Virtual reality instruments may include a treadmill, a headset with magnetic-position sensors and goggles that project television images on their lenses. The technology may transform the way we predict weather, perform surgery, discover oil, or play videogames.

UNC's program is part of a worldwide effort to devise new technologies that will enable humans to communicate with computers in ways that resemble real experience. Virtual reality can take us into imaginary worlds that appear remarkably similar to our own. NASA experimenters at a California lab are using the technology to fly simulated vehicles across Martian terrain. Japanese researchers are already planning new virtual-reality communication systems for the next century. The French and British have their own programs.

Of all these high-powered centers the "intellectual hotspot of the VR research world" is not Tokyo, Cambridge, or Silicon Valley, writes Howard Rheingold in his newly published book *Virtual Reality*, but Chapel Hill.

The limelight is one thing the UNC computer scientists have studiously avoided even as the national media, led by the *Smithsonian* and *The New York Times*, have come calling. The scientists warn that public fascination with videogame wizardry and technological breakthroughs has led to much media hype.

Indeed, the public's first encounter with virtual reality is likely to be through the entertainment industry. Even now virtual golf can take a sporting hacker through a choice of courses, including Pinehurst number two, and Disney is employing VR technology in its Star Tours. For the romantically inclined, the term "teledildonics" has been coined to describe vicarious computer-generated sex.

track a person's hand and head movements, and change the image instantly as the person moves. The headsets contain magnetic sensors which track the user's head movements and goggles with mirrors that reflect images from tiny television monitors. The pictures vary in each lens—the same principle as the old-fashioned stereoscope—to create the illusion of depth. With see-through mirrors the user can superimpose the virtual reality upon the actual object.

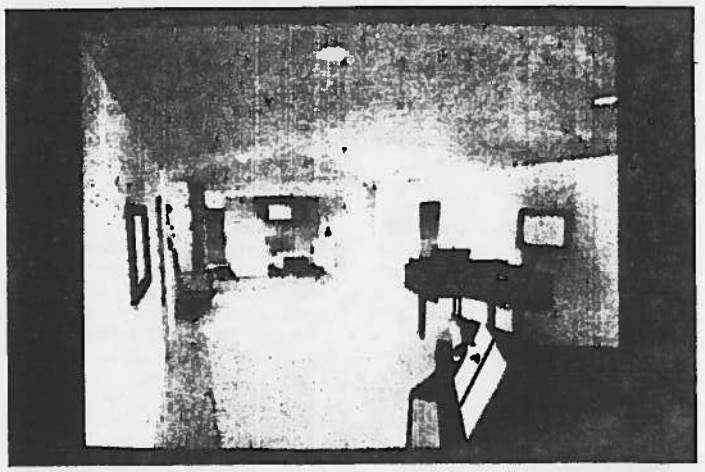
Within ten years, Pizer expects cancer patients to have their tumors located and "cooked" by ultrasound heat waves.

The technical problems are daunting. To drive a virtual reality system requires a computer of almost incomprehensible power, one that would have the computational speed to generate the images and respond to the user's movements. Henry Fuchs' stroke of genius was to devise a machine that uses 250,000 tiny processors operating simultaneously. The design is called Pixel-Planes. That is, every pixel, every grain of image in the virtual reality, is driven by its own miniature computer: 256 processors on a microchip.

The problem, Fuchs explains, is for the computer to act fast enough so that the user has the illusion that he or she is seeing things experientially, as real events in real time. The computational time that it takes the computer to respond and generate the image creates a time lag.

"A quarter-second delay will break the capability to perceive the object in 3-D space," Fuchs says. When the viewer moves his head, the object will not make a corresponding shift. This phenomenon induces "simulator sickness."

Most of the driving problems have a medical focus. Stephen Pizer is involved with four projects on medical imaging. His collaborators include radiologists, oncologists, surgeons and psychologists. For his dissertation, Jim Chung, a graduate student, is developing software that would allow radiologists to direct X-ray beams at cancer tumors. Julian Rosenman of the UNC Medical School is helping to perfect the technology—now at a preliminary stage of development—for radiation planning and therapy. The user has the illusion of walking completely around a patient with a tumor inside, backing away it appears smaller, stepping forward it looms larger. Holding the hand control, the user can arrange multiple radiation beams around the tumor, aiming it to avoid healthy tissues.



An image from the Walk-Thru project shows a room from the proposed renovation of Dr. Brooks' house, as seen in goggles of a head-mounted display.

Fuchs and Pizer, in collaboration with Duke biomedical engineer Olaf von Ram, are also developing ultrasound imaging that would present a 3-D view of a fetus in utero. Unlike the two dimensional screens now available, the enhanced ultrasound would allow the doctor to more easily locate the fetus' position, with the ability to discriminate movements within 1/15 of a second and to focus narrowly on organs—the opening and closing of a heart valve, for example. The technology may help doctors inject needles into the womb for amniocentesis and radically improve the prospects for prenatal surgery.

The "most extraordinarily exciting" of the medical imaging projects for Pizer, however, is image-guided surgery. Within ten years Pizer expects cancer patients to have their tumors located and "cooked" by ultrasound heat waves. With a head-mounted display, doctors would project an x-ray image on the living tissue, targeting the tumor and following the progress of the therapy. Most remarkably, the "operation" would be conducted on an outpatient basis, without incisions.

"A person would go in, have the tumor 'cut,' and go home," Pizer predicts. What excites Pizer is that this technology appears achievable, and industry is backing it with funding. The Chapel Hill researchers are collaborating with doctors at a Boston hospital, engineers in Schenectady and computer scientists in Zurich.

The major non-medical driving problem focuses on creating architectural interiors. An early prototype allowed departmental members to walk through the Sitterson Hall blueprints, an experience which inspired some redesigning. Architectural displays tend to be more dramatically realistic than the medical imaging, Fuchs explains. At a recent computer graphics convention in Las Vegas, UNC was invited to demonstrate a new technology called "walk thru." [Brooks and Fuchs politely credit each other for the inspiration]. Electromagnetic sensors in the ceiling and user's helmet track the user's movements in the room. Once the technology is perfected, the 3-D headset will give a realistic impression of walking through any conceivable interior. It will enable the designer to experience changes in details of the interior as he or she rearranges walls or windows in seconds, down to shafts of light reflecting on the floor.

The success of UNC's program clearly owes to leadership, and faculty quickly credit the courtly Southerner they call "Fred". "Fred has always encouraged other people to succeed," says Gary Bishop, a computer scientist who describes himself as a toolsmith. "A wise benevolent dictator is a fine model."

Fuchs was attracted to UNC in part because he found in Brooks not just a scientist of wide interests and learning, but a person who was clearly excited about interactive 3-D graphics. The people Brooks has attracted are, in Rheingold's words, "strong and diverse," with backgrounds in industry as well as academia. One notable recent addition is Warren Robinett, who developed videogames for Atari and and head-mounted displays for NASA. Robinett, who sees videogame-obsessed kids as pioneers of interactive computer graphics, is unapologetic about having fun while working for human betterment.

At a time when universities are building departments through an academic star system, recruiting big names with free-agent salaries, UNC has built a program by developing homegrown talent. Brooks certainly had the luster to draw talented faculty, but his foremost ability has