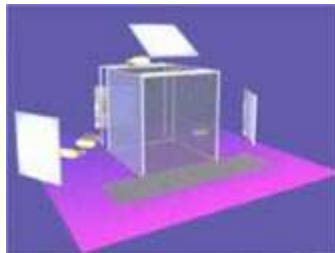AN MIT ENTERPRISE
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The cave at Brown University. (Image courtesy of Brown Graphics Group)

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The Virtual Voyager

By Paroma Basu   September 5, 2001

Our reporter visits a "cave" to see how virtual-reality environments can illuminate art as well as science.

I am feeling very small as I tread cautiously through a human artery. A track unfolds ahead of me, and as I follow it I notice a stream of brown blood silently flowing toward me. A steady thump makes me aware of how close I must be to a beating heart. The blood swirls as I come to a fork in the road.

I go left, walk a few steps, and crash.

I rip off my 3-D glasses and find my nose pressed up against a white wall. I am in an eight-foot cube, with screens on three walls and another one below my feet.

Watching the River Flow

This is the virtual-reality "cave" at Brown University's Center for Advanced Scientific Computation and Visualization. Big cathode-ray projectors fed by powerful computers cast high-resolution 3-D images onto the three walls and the floor.

Modeling blood flow is just one application of this immersive technology. Besides medical imaging, Brown's virtual cave is used for simulations in fields as diverse as archaeology and studio art.

"The cave is sort of like the holodek in Star Trek, except you can't touch anything," quips David Laidlaw, cave curator and assistant professor of computer science.

When I put the stereo glasses on again, I am re-immersed in a virtual blood vessel. What I see moves and changes as I shift my gaze. Thanks to a liquid-crystal panel on the glasses I'm wearing, the computer is tracking even the smallest movements of my head.

"Standing here inside the artery is an unusual point of view," remarks Andrew Forsberg, reading my mind.

Forsberg co-wrote the simulation to help medical researchers investigate problems like the speed of blood flow around a coronary bypass, the consequences of inserting the bypass at a different location in the artery and the effect of blood flow on plaque formations.

"This is just another way to simulate fluid flow," he says. "We're trying to explore how being immersed in the flow might help us to learn about these

problems."

Seeing into the Past

And now, far away from the complexities of medical imaging, I am strolling through the ancient ruins of Petra, in Jordan. I wander past richly textured Roman columns and enter the Great Temple, which once spanned the length of three football fields.

This is ARCHAVE, an application that reconstructs the famous excavation site and has the potential to become an important tool for archaeological analysis.

Switching to a different view, I now see a gray, idealized representation of the ruins. From here I can summon up any kind of information—soil types, trench data or details of the nearly 250,000 artifacts unearthed by Brown archaeologist Martha S. Joukowsky and her team.

"In archaeology what's really important is to document the site and the patterns within it," explains Eileen Vote, an architect who worked with civil engineer Daniel Acevedo to conceive and develop ARCHAVE. "We realized that if we could incorporate the trenches and the data within them, and then give archaeologists a way to visualize them in 3-D, they would be able to do a lot of visual analysis they couldn't do before."

Slipping on a glove that works much like a mouse, Acevedo pinches two fingers together to pull up a 3-D menu. He tells ARCHAVE to display all the areas where pottery was found, and various spots on the site suddenly light up with glowing red triangles.

"You don't have the dirt but you have all the objects," says Vote with pride.

ARCHAVE currently displays just one archaeological reconstruction of ancient Petra. But its success has inspired Acevedo to set his sights on developing the tools that archaeologists will need to build their own virtual-reality reconstructions.

Different Strokes

And now I am in another world, brush in hand, contemplating the intoxicating freedom of painting my own reality.

This is CavePainting, and doctoral student Daniel Keefe is engulfing me in 3-D brush strokes as if the very air around us was a canvas.

A dramatic new medium for artists, the CavePainting program also has potential for scientific visualization, says Laidlaw, who feels that the inspiration and personal richness of art should imbue scientific imagery as well.

Using the glove, Keefe summons up a 3-D tool called a "color picker" with which I can change the brightness, saturation and hue of my brush strokes. I can also change the size of my brush and zoom into the picture to render fine detail. Other functions named "Splat," "Extrude" and "Jackson Pollock" allow me to change the texture of my brush strokes.

Better still, once I paint an image I can walk right through it.

"[With this program] you can create a world that you live within," says Keefe.

"Now I want to start working on making these images look even more compelling visually, and then have them interact with you."

Back in the Real World

The first virtual-reality caves were developed around 1993, and by now there are several hundred of them in research institutions around the world. Unfortunately, they are rarely open to the public.

For the public, the closest thing to a cave experience can be found in virtual-reality theaters using large-scale projection systems known as "power walls." A few of these have already been built in Europe and Asia.

However, the virtual-reality theaters do not offer the same deeply "immersive feeling" as the caves, says Klaus-Peter Beier, director of the Virtual Reality Laboratory at the University of Michigan.

When I leave the cave and walk outside, my head swims with the images I've seen. The worlds the cave can conjure definitely *look* real. But as I stand out in the sun and feel the summer breeze, I realize that in the cave there's nothing to smell, not much to hear and certainly nothing to taste or touch.

It'll get there someday, I feel, but cave reality isn't that real just yet.

Paroma Basu is a reporter for technologyreview.com.

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