Summing the Bay

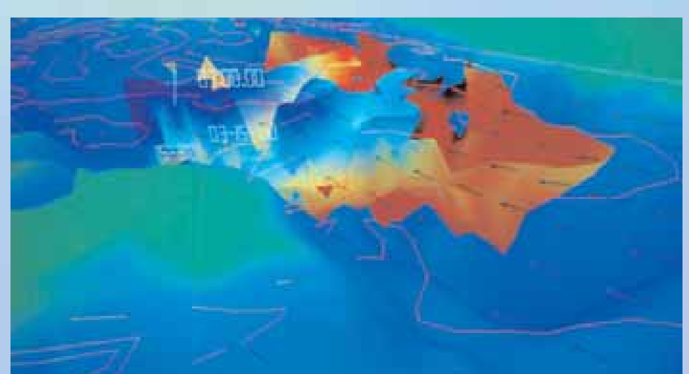
BY JAMES SCHULTZ

Liquid-crystal goggles snug against temples, Glen Wheless and a visitor set out on a journey over shore and bay. No wind blows and there is no sound of engine or smell of fuel. Wheless' only throttle is held between the thumb and first two fingers of his right hand. Yet Wheless soars and plunges with the abandon of a fearless, winged amphibian, diving easily into deep waters and floating effortlessly at what seems inches above a corrugated coast. • Most days, Wheless is a research assistant professor at Old Dominion's Virtual Environments Laboratory (VEL) located in the university's Center for Coastal Physical Oceanography. This day he is the pilot on a digitized "fly-through"of a computer model of the Chesapeake Bay. On Wheless' virtual sojourn, directed with a wand-like, hand-held device, it is possible to explore the deepest bay channels without so much as getting wet. The electronically synchronized goggles provide stereoscopic views of the effects of tides, winds, currents and the ebb and flow of marine life. • Data points are dynamically represented in three dimensions, with small, differently colored arrows depicting changeable parameters such as the speed and direction of water and wind. In this place where information appears to have weight and substance, a wayfarer can stop half in and half out of the water, watching events unfold above and below. The Chesapeake Bay is within fingers' reach, living in microcosm, summed by mathematical formulae and the power of microprocessors. • "This is the way to look at data," Wheless says. "If you don't like the view, change it. What's happening here? Over there? You can play around until you find what it is you want."

Bay On A Grid

Wheless says the idea for a computerized Chesapeake Bay simulation came to him in 1993 during a trip to an annual computer graphics conference in Orlando, Florida. There, for the first time, he went exploring in a CAVE, a Computerized Automatic Virtual Environment. Once he put on a pair of liquid-crystal goggles, Wheless says he was stunned by the appearance of even the most basic images projected from the CAVE's floors and three walls.

"The first time I saw something in the CAVE, I watched fish float by," Wheless recalls. "It was amazing. They had volume. It was like being on the Star Trek holodeck. I thought to myself: To look at scientific data in a place like this would be invaluable."



Back in Norfolk, Wheless and Old Dominion colleague Cathy Lascara, a fellow research assistant professor at the Coastal Center, began their search for funding to underwrite the simulation effort. The pair wrote a proposal to the National Science Foundation (NSF), which in 1996 granted $530,000 for the project. One of the largest initial costs was the purchase of an ImmersaDesk, a billiard-table-size screen on which the Bay simulation would appear. Buying a $1 million-plus CAVE would have broken their bank. Or, as Wheless puts it, "CAVEs are cool. But they're expensive."

The science foundation grant came about in part because of Old Dominion's involvement with the National Computational Science Alliance, a partnership among computational scientists, computer scientists and professionals in education, outreach and training at more than 50 American universities and research institutions. Led by the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign, with core funding from the NSF and the state of Illinois, the alliance is building what is known as the National Technology Grid.

The Grid will use a high-speed telecommunications network called Internet2 to integrate powerful computer workstations, advanced visualization programs, remote instrumentation and large speciality databases. Grid participants will have at their disposal advanced searching and indexing capabilities, digital libraries, audio and video streaming, even real-time satellite imagery.

Once the Grid is operational, researchers using desktop computers will routinely be able to write software and share it with peers at other institutions. On the Grid it will be possible for teams of collaborators at universities anywhere in the country to simulate global climate change, share next-generation computer chip design, examine the molecular workings of new pharmaceuticals — or monitor changes to the Chesapeake Bay.

Destroying The Limitations

Such technological progression has spawned at least one new word: "teleimmersion." For researchers, teleimmersion permits data visualization on a scale and to a degree not previously possible. "Teleimmersion will go beyond images that appear computer generated," Wheless predicts. "They will be photo-realistic images. In a virtual world, you'll look at something and it will look real."

As systems like the Chesapeake Bay simulation mature, teleimmersion will be one aspect of "collaborative visualization," the ability of Grid-present scientists and policymakers to share and interpret complex information. In the bay's case, for instance, the gradual and steady urbanization of the surrounding watershed has had harmful ecosystem effects. The VEL's bay simulation will model the deleterious effects of storm and agricultural runoff, the repercussions on marine life and the myriad physical processes forever driving bay circulation, temperature and salinity.

As part of the Computational Science Alliance, Wheless and Lascara are using CAVE-specific software to create other three-dimensional marine simulations. They have modeled Beaufort Inlet, north of Cherry Point, North Carolina, and the Shelikof Straits in southern coastal Alaska. The pair have refined their program to permit multiple users to examine data collaboratively in a common virtual space.

According to Wheless, that latest step may be the most important of all; it destroys the limitations of physical space and time, permitting teams of researchers to partner in real time no matter the location of their workstation, ImmersaDesk or CAVE.

"We're one of the first groups to study environmental data with the help of a CAVE," Wheless says. "There will be other people who'll want to do this soon. It's nice to see something that started out as an idea turn into something useful."

(Left) A virtual peek at the Chesapeake Bay through an ImmersaDesk shows water flow (black arrows) and distribution of larval fish (colored isosurface).

Simulation breakthroughs by research assistant professors Cathy Lascara and Glen Wheless allow marine scientists from Alaska to the Chesapeake to collaborate across space and time.