Ohio Supercomputer Center
Bringing data to life, in color

For the scientific researcher, mountains of raw data can often present as much of an obstacle to analysis as they do an opportunity to advance reserach. To harness the power of computers to reduce data to visual data form, a team of researchers at the Ohio Supercomputer Center (OSC) have created a tool that allows researchers in all data-intensive disciplines to visualize data using full-color graphics and animation. Called apE, which stands for animation production environment, this software is changing the way researchers see their work.

How apE works

The apE software is a graphic environment for creating scientific and artistic imagery. apE is a toolbox of predefined functions for creating, modifying, and manipulating scientific data. apE is based on a dataflow model. In a dataflow model information flows like water through a system of pipes, and is changed along the way by filters and operators that are controlled by the researcher. In essence, the user builds a graphical flow chart of the application, and the apE system handles the physical details of invoking, connecting, and managing the flow of data through the system. Using this system, the raw data can be converted into a variety of sophisticated images, any of which might provide important insights into the meaning of the data.

Because the apE dataflow process can be controlled graphically, researchers can perform extremely complex three-dimensional visualizations, fully rendered and even animated, without writing a single line of computer code. Users have complete interactive control over the transformation of data.

A medical researcher, for example, can examine data collected via MRI or CAT scans in a variety of ways. Individual slices can be colored or contoured, or slices can be combined to form a three-dimensional model. Surfaces can be detected and colored within the volume, or rendered as a

continuous translucent block. All these visualizations could be constructed and manipulated interactively, without ever compiling a program. To change the visualization, the scientist merely changes the flow chart. Final images can be recorded on video tape or saved for later printing on film.

Computational fluid dynamics provides another example of how apE can be used. To evaluate the flow of air along the edge of an aircraft wing, with apE a researcher can select several variables from the calculation (pressure or temperature, for instance) and apply color to the contours. In a three-dimensional simulation the researcher injects particles into the flow to observe their motion, much like releasing dye into a waterflow.

"When we were developing apE, we knew we couldn't count on scientists to use any particular type of computer, so we had to think globally from the start," says Scott Dyer, associate director of OSC and head of the apE project. For this reason, the project leaders designed apE to run in a UNIX environment, since the UNIX operating system was both powerful enough to support the software's capabilities and nearly universal throughout the academic community. Says Dyer, "We found that UNIX fully supported what we wanted to do, so we didn't aim for personal computers because they lacked the necessary operating system support for apE."

NeXT provides high-quality color

OSC houses Ohio's only public-access supercomputer facility, and has a network of approximately 50 UNIX workstations that includes NeXT, Sun, Macintosh, and Silicon Graphics machines. Users of the center appreciated many aspects of the NeXT platform, but they were disappointed with the absence of color on the original NeXT Computer.

Says Dyer, "We in the graphics project have been strong NeXT supporters. In the past, you really needed two computers, one for UNIX tasks, one for word processing and spreadsheets. The new color machines will combine those tasks onto a single platform."

Developers at OSC believe that color should be used only when it enhances comprehension or communication. As a result, apE uses color only in actual images. Other areas, such as the application

interface, do not use color.

On most of the UNIX workstations, it is common to use color-mapped framebuffers. The result is reduced color fidelity, due to having only 256 colors available, as well as distracting color shifts when switching from one application to another. On NeXTstep, apE draws the true color it wants; the Display PostScript software then represents that color as accurately as possible on either the 16-bit or 32-bit NeXT displays. In essence, the NeXTstep environment eliminates the need for color mapping.

"We don't have to deal with the color mapping problem with the NeXT color machines," Dyer says. "Even on the 16-bit machine [NeXTstation Color], you can work as if you have full color available. It makes faster, better pictures possible." The apE software runs on all NeXT computers equipped with Release 2.0 of the NeXT system software, but it is most effective on the NeXTdimension and the NeXTstation Color systems.

An alternative approach to software distribution

In addition to generating an innovative and practical software tool, the apE project also inspired OSC to enter the software distribution business. Members of the apE team knew they wanted to make their software widely available throughout the academic community, but were reluctant to follow the usual procedure of licensing the technology to a commercial company for marketing.

"We were concerned that the prices of software in the commercial world would make apE too expensive for our target users," Dyer says. "We didn't want our software to be ruined by either overcharging or lack of proper maintenance."

The obvious but unorthodox solution seemed to be for OSC to take responsibility for marketing and distributing apE itself. To obtain the 2.0 version of apE, users have the options of 9-track, cartridge, or 8mm magnetic media; NeXT users can even receive the software over a network. The software is largeÐconsuming more than 100 megabytes of disk spaceÐand includes both binary and source code. A fee of $75 covers everything, including complete documentation.

The apE team plans to continue expanding the capabilities of its software, such as allowing direct feedback between supercomputers and workstations, as well as expanding its distribution. Future plans will build on the project's original goal: to allow as many scientists, engineers, and artists as possible to take advantage of apE to add new dimensions to their research efforts.

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