University of North Carolina at Chapel Hill
Solving equations and predicting earthquake behavior

Being a geophysicist can require spending a lot of time with computers. There are immense amounts of data to handle. Complex equations to solve. And sophisticated graphics to produce, for both analyzing the data and communicating findings.

Dr. Jose A. Rial, associate professor of geophysics in the geology department of the University of North Carolina at Chapel Hill, is using the NeXT Computer for all of these tasks. He is especially enthusiastic about the computer's data-storage capacity, graphics capabilities, and *Mathematica* interface.

ªThe NeXT Computer gives me the ability to have hundreds of megabytes of data on a single optical diskÐ for instance, all of the California and Japan seismicity information (data on earthquake location and time of occurrence) from this century,º says Rial. ªWith respect to graphics, the grayscale that I can obtain makes color superfluous. Since I don't need to use color, I can publish my results much more cheaply. And I like the front ends that the NeXT object codes allow me to construct to deal with *Mathematica*. Using *Mathematica* with the NeXT Computer is a dream, because of all the graphic software you can access, and because of the very high quality print-out.º

Rial is a seismologist and theoretician who specializes in wave propagation, chaos, and nonlinear dynamic systems in geophysics. One of his primary areas of research is called ªearthquake hazard estimation.º Using data such as seismograms, he performs mathematical analyses to predict not when earthquakes will occur in a given area, but how that area will behave during a quake.

ªWe know that the strength of the shaking depends a lot on what types of soils you have underneath,º he explains. ªMany cities like Los Angeles and San Francisco are built on flat land surrounded by mountains. The land is flat because it started out as a trough and has been filled in with all kinds of soft sediments. As the bowl-shaped basin vibrates during an earthquake, the sediments in it oscillate at `resonant' frequencies. I'm trying to figure out the resonant frequencies of oscillation of sedimentary basins like these.º

The work has very serious real-world implications: ªOnce we know what the resonant frequencies of a particular basin are, we'll have to design buildings that do not oscillate at those same frequencies in order to avoid the destructive effect known as `double resonance.' This happens if buildings oscillate in unisonÐat the same frequencyÐwith the ground, absorbing every bit of the shaking force until their oscillations grow so large that the whole structure shatters and collapses.º

Rial has found the NeXT Computer of great help in his research work, which depends heavily on graphical representations of mathematical functions. ªI've been doing some beautiful graphics with *Mathematica*, evaluating functions,º he said. ªOne thing I do is model solutions to partial differential equations. I know more or less what the solution is, and I can use Mathematica to evaluate it within a certain domain. It's wonderful, because I can see what the solution is going to look like. This gives me lots of clues as to how to proceed theoretically to guess the right solution.

ªIt's very exciting. Two days after I got my NeXT, I was doing simulations of solutions to partial differential equations just by typing a couple of lines on Mathematica. Getting the same kind of results, and at a much lower resolution, with my other computers would have taken me about two months of programming. On the other computers, it's hard work just to do the graphics well; things like putting in the scales, and grading the grays. Using Mathematica, all that is given. You can worry about what really matters in your work.º

Along with using the NeXT Computer in his research work, Rial hopes to use it in a graduate/undergraduate class he'll be teaching called ªGeomathematics.º Students will use Mathematica to become familiar with solutions to standard differential equations in physics: wave equations, diffusion equations, nonlinear systems, etc.

One of Rial's goals is to convince geology students that mathematics is useful, and that they can let computers do a lot of the work. ªThe computers can help the students visualize things in three dimensions, in nice projections from different viewpoints and for all the domains of parameters they want. And geologists appreciate that, because they work with pictures, not equations. They have pictures in their minds when they think.º By helping researchers and students picture things more clearly, the NeXT Computer can help them think, solve problems, and communicate more effectively.

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