

## GEOLOGY

# **Geomathematics: A new course with *Mathematica*** *University of North Carolina, Chapel Hill*

José Rial, an associate professor of geophysics at the University of North Carolina (UNC), Chapel Hill, has little regard for the belief among his classically trained colleagues that geologists need only minimal training in mathematics and computer modeling to excel in their field.

"In an increasingly competitive academic and industrial market, geologists need to adapt the tools of mathematics to their everyday work," he says. "In the next century, it will be necessary for them to perform skillfully in a computer-based—almost entirely quantitative—environment, where high-performance computer modeling and simulations of everything from the accumulation of sediments in a basin to real-time remote exploration of mineral resources on the Moon or Mars will be commonplace."

To prepare UNC geology students, Rial last year developed a new course, called Geomathematics. He uses NeXT computers and *Mathematica* in conjunction with a traditional textbook.

"NeXT is a very good machine for geologists, largely because of its graphical interface," says Rial. "The computers help students visualize things in three dimensions, in nice projections from different viewpoints, and for all the domains of the parameters they want. Geologists appreciate that because they perceive things graphically as much or more than other scientists. It's difficult for them to grasp formulas solely on a blackboard. They have pictures—not equations—in their minds when they think."

Rial has used *Mathematica* Notebooks to design several interactive tutorial modules for the Geomathematics class. The modules aid students in graphically simulating geological dynamic systems, such as the cooling of intrusive magmas and the drifting and collision of tectonic plates, as they become familiar with fundamental mathematical concepts and learn to solve differential equations commonly encountered in these phenomena.

The modules cover a variety of topics, including geomechanics, systems of ordinary differential equations, and nonlinearity of geodynamic systems. Each module focuses on a particular subject and features examples of computations or graphing. In the tutorial portion of the module, students are typically asked to read about a particular formula, evaluate it and graph it, study its range and validity, change the controlling

parameters and graph it again, all within the same Notebook, which can then be stored on disk.

“With *Mathematica* on the NeXT platform it's easy for an educator to create graphics to convey complex ideas or difficult concepts to the student. Through graphing or displaying formulas, numerical data or analytic results, students can see the object of study and experiment with it all in a computing environment that does not require major proficiency in computer programming or the mastery of complicated operating systems,” says Rial.

Rial, who is a seismologist specializing in wave propagation, chaos, and nonlinear dynamic systems, also adds that NeXT technology “has been a salvation for my research work,” which depends heavily on graphical representation of mathematical functions. In his primary project, “earthquake hazard estimation,” Rial uses data, such as seismograms, to perform mathematical analyses that help him to predict how a particular area will behave during an earthquake.

“I've been doing some beautiful graphics with *Mathematica*, evaluating functions,” he says. “Using *Mathematica* with NeXT computers is a dream because of all the graphic software, and because of the very high-quality printout.”

He concludes, “I really like my NeXT machine. I originally planned to buy a Sun® SPARCstation. In fact, I was ready to write the purchase order for the Sun when I saw the NeXT machine. I thought I'd test the NeXT for a half hour or so and the next thing I knew, several hours had passed—I was hooked. It's a superior machine, without doubt. It has a great display, and I like the fact that it's a UNIX machine with better-than Macintosh interface features. Sun machines don't compare to the NeXT's ease of use. When I received my NeXT, it was up and running within 10 minutes. Some of my colleagues spent weeks getting their Sun systems set up.”

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