Campus Profile
California State University, Los Angeles
Innovative methods of education for nontraditional students

California State University (CSU), with more than 350,000 students on 20 campuses, is the largest university in the United States. In November 1988, CSU purchased 44 NeXT computers, appropriated one per campus, and called for proposals for the remaining 24 machines. In January 1989, CSU awarded 3 campusesĐLos Angeles, Long Beach, and SacramentoĐgrants of 8 NeXT computers. At California State University, Los Angeles (CSULA), faculty from many departments are building a learning environment comprising of visual and interactive techniques. "We hope to improve our ability to educate students, especially those with whom traditional methods of instruction have failed," says Robert Desharnais, assistant professor of biology.

CSULA is attended by 21,000 students from diverse ethnic and academic backgrounds: 30 percent are Asian, 30 percent are Latino, and 10 percent are Black. English is not the native language of the majority, and many students are accustomed to teaching methods and academic standards different from those at CSULA. Educational opportunities are extended through a wide range of programs including tutorial labs and placement testing, but obstacles in the traditional classroom remain a source of frustration for students as well as faculty.

Composed of six schools, CSULA offers bachelor of arts, bachelor of science, and master of science degrees; the School of Natural and Social Sciences, with graduate degrees in all its science departments, is the largest. Associate Dean Joe Bragin wrote the proposal that resulted in the initial grant of eight NeXTcube computers. "We're using NeXTstep to develop a highly visual, interactive learning environment that will capture the imaginations of students and involve them directly in the educational process," says Bragin.

Cal State NUGgets produce concrete results

Bragin organized a team of nine faculty members from six departmentsÐbiology, chemistry and biochemistry, fine arts, geology, mathematics and computer science, and physics and astronomyÐand founded a NeXT user group called the Cal State NUGgets. Bragin launched the collaborative project in a somewhat unconventional manner. "Rather than put the machines in a lab," Tony Longson, associate professor in the art department, explains, "Bragin sent them home with individual members of the faculty. We figured out how to use them, then how to develop applications using Interface Builder, Objective C, and PostScript. Every other Saturday we met to show each other what we had learned. When we felt we had a grasp on the development environment, we shifted the emphasis from just using the machines to developing specific courseware applications."

The NUGgets held biweekly, three-hour meetings. Group members had used other computers before, though most were strangers to UNIX and the Objective C programming language. The group's most proficient programmer, Don Kiel, professor of mathematics and computer science, relinquished one course from his teaching load to prepare lectures for the meetings.

Since then, the biology and geology departments have set up labs of NeXT computers to be used by students. Theoretician Trina Valencich was awarded a CSULA faculty workstation grant to expand NeXT development in chemistry and biochemistry. The NUGgets continue to meet biweekly and now focus on recruiting new faculty, testing and refining applications, and, most important, integrating courseware into classrooms.

The NUGgets have produced a library of educational software for undergraduate courses in nine disciplines. Roland Carpenter, professor of physics and astronomy, develops programs that range from demonstrations of basic principles to dynamic simulations of complex physical systems. Carpenter's applications to teach astrophysics include animated simulations that demonstrate celestial mechanics and stellar evolution; his simulations for use in general relativity courses illustrate ideas such as gravitational collapse and black holes. Kiel's applications to teach computer graphics include The SpiroGraph for radius drawing, Bezier Curves for curve drawing, and Three-D for animated wire frame diagrams. Longson wrote Recursion to illustrate recursion, and Gravity to depict gravitational attraction of bodies in two dimensions. Desharnais created PSRun to display PostScript images and animation. In pilot studies, students validated the ease of using the software, and faculty believe unanimously that learning potential is enhanced by the consistent and intuitive graphical user interface (GUI) of NeXT computers.

Interactive simulations: FlyLab and Competition

FlyLab is a genetics simulation program that illustrates the principles of Mendelian inheritance. Using FlyLab, students design flies, mate them, and examine the offspring. Mendelian laws of heredity are graphically illustrated in FlyLab, enabling students to observe the transmission of genetic qualities from parent to offspring. "I designed FlyLab because it's impossible to do all of the variations and crosses in a lab experiment. A lab experiment is a one-shot deal," explains Desharnais. "If something goes wrong, that's itÐstudents don't see results. FlyLab provides tremendous flexibility. Students see mutations such as curly wings or wingless, and they can actually see what the fly looks like."

Selecting from many possible mutations identified in FlyLab's Construct-a-Fly window, students build flies and mate them by dragging two flies into the Mating Window. Clicking the Mate button yields a window showing the offspring. Any two flies can be mated to produce another set of offspring. Students examine the offspring to learn rules of genetic inheritance. "Without the graphical interface, students look at it as a chore," says Desharnais, referring to text-based programs. "They don't get to see what the fly looks like, and they often forget what the mutation looks like."

Using Interface Builder to create his interfaces, Desharnais says, "It's easier for me to design applications that are beneficial for the students. FlyLab is a good exampleÐthe students get really excited." The GUI also enables the effective presentation of abstract theories and mathematical formulas that may not otherwise be accessibleÐthis is the case with Competition.

Developed by Desharnais, Competition is a population ecology simulation application that demonstrates conditions under which two competing species may coexist. "Many students don't realize that biology involves mathematics and statistics and become alarmed when they walk into class and see formulas on the blackboard," says Desharnais. "I designed Competition to give these students a way to see the dynamics of the equations."

Competition is based on the classical Lotka-Voltera model, that describes the changes in numbers of two species by three parameters: growth rates, carrying capacities (the number of animals the environment can support), and competition coefficients, defined as the percentage of overlap in use of resources by the two species. Students adjust the parameters and watch the species compete. The simulation is depicted on a graph with an x/y plot, and a curve represents the trajectory of the two species populations as they change over time.

Extending curricular benefits: a task shared by artists and scientists
"There's a notion that artists live outside society and have nothing in common with scientists," says sculptor Tony Longson, associate professor in the art department. "The idea that artists are isolated from society is nonsense. Renaissance artists were scientistsÐthere were no boundaries between those disciplines. I've always believed artists and scientists need to work together."

Longson's participation lends a wider perspective to the project. "It's an exchange. Scientists have a lot to offer artists in the way people think about problems. Artists should learn the language of scientists and vice versa for a more down-to-earth reason: artists and designers know how to best present ideas and data, and scientists typically have no training in this area."

The practical instructional value of courseware has been maximized through an effort shared by CSULA educators, but, as Longson remarks, "There's more to the process than creating the software. Installing a program isn't all that's required to use itÐthere are network issues and logistics of system management." His proposal to chair a panel dedicated to these issuesÐ"What Next: A Provocative Look at Creative Curriculum and Logistics in Teaching Artists and Designers to Use Computers"Ðwas accepted for presentation at SIGGRAPH 1991, an annual conference on computer graphics. The panel examined administering networks and managing computer-based educational projects.

"In most environments, encouraging creativity is difficult because more time is spent surviving the network than is dedicated to teachingÐteachers must constantly reinstall software, manage disk space, and organize files," says Longson. "NeXT is much easier to administer." Basic as well as network-wide administration tasksÐincluding establishing user accounts, connectivity, back up procedures, and software installationÐare simplified and fully supported in the NeXT environment.

"NeXT extends our ability to teach," says Longson. "We're looking to use NeXT computers for animation and hypermedia." Longson encourages graduate students to use NeXT computers by demonstrating the value of the technology by applying it to his own workÐgenerating geometric patterns in PostScript. He screen-prints images on layered sheets of Plexiglas to construct three-dimensional objects that explore visual space.

Image is everything
"When students see an image, they gain a better understanding than they would with words. They can see what we mean; they don't have to take our word for it," Joe Bragin says. "It is important for students to have a mental imageÐI'm convinced this is how they learn. This is what's behind every one of our custom applications."

Ideal Gas, developed by Joe Bragin and Vicky Bragin, assistant professor of chemistry, is an interactive simulation that demonstrates the kinetic molecular theory of ideal gas. Molecular motion is illustrated with changing temperature and pressure, and students "get a better understanding when they see molecules bouncing off the screen. With Ideal Gas, students can easily visualize what's happening at the molecular level."

Many applications created by the NUGgets are animated models of experiments that would be impossible to run without a laboratory. "Restrictions, such as lack of time and excessive cost, often prevent us from performing experiments. NeXT technology facilitates this activity because we're able to develop applications that simulate experiments," says Joe Bragin. "Perhaps most important is the rate at which faculty can develop effective applicationsÐRoland Carpenter makes a new application every week," Bragin says. Carpenter's classical physics applications include Atwood Machine, illustrating mass and motion, Coupled Oscillation, with motion of spheres coupled by springs in two dimensions, and Rotating Top, depicting rotation and precession.

Understanding earthquakes
Earthquake is an interactive application that simulates an earthquake with animation. "It shakes the screen as if the display itself is exploding!" says geologist Gary Novak, who created Earthquake for nonscience majors. It illustrates the process used to locate an earthquake's epicenter, the section of the earth's surface directly above the focus of an earthquake.

Earthquake teaches the principles of seismology that are involved in locating an epicenter and determining the Richter magnitude of an earthquake. "Students see the actual recording of the seismogram, the recording of the seismic waves at three different stations or observation points, as prescribed by the method of triangulation," says Novak. "Earthquake lets students understand the Richter scaleÐthe physics behind it and how to use it."

"With the ability to build sounds and graphics into applications, we can write applications to meet the needs of students and gain their attention." The Sound Kit, comprised of Objective C classes and C functions, is used to integrate sound effects into applications, increasing the educational potential of the applications.

The NeXT interactive electronic blackboard
Responding to a proposalÐ"The Interactive Electronic Blackboard for Natural Science and Mathematics Education"Ð(authored by Desharnais and Novak), the National Science Foundation (NSF) awarded CSULA a $100,000 matching grant to implement an electronic classroom of 25 NeXTstation Color computers. Pledging its support of the program, the university has guaranteed equal funds for the classroom. Targeting existing courses and planning four new interdisciplinary courses, the classroom will incorporate applications developed by faculty in conjunction with NeXT bundled software and commercial applications.

"Cal State is a teaching university. We work with students daily. NeXTstation computers will be used as interactive electronic blackboardsÐstudents will use more of their senses in this powerful, intuitive approach," says Novak. "NeXT makes sense for that kind of interaction."

Scheduled to begin with 1991's fall quarter, the program's objective is to substantially increase the retention rates of math and science students, with particular attention paid to nontraditional studentsÐstudents with weak academic backgrounds and English language skills. The faculty expects to achieve results of regional and national significance.

NeXTstation Color computers will be networked in the classroom, to other campus systems, and to networks outside the university, enabling students to take advantage of NeXT's powerful network, database, and communication tools. "We want our students to ask questions, interact with each other, and access existing databases. There is so much information passed across networksÐthis is an exciting and efficient way for our students to join the dialogue," Novak says.

The electronic classroom's network will also facilitate communication between faculty and students. "We want to network the computers so students can print our lecture notes and use them in conjunction with courseware simulations. They'll be able to participate in the classroom, instead of scrambling to take notes that are potentially meaningless," Desharnais explains. "The NeXTmail application will be used as an electronic blackboardĐan interactive experience, using sound, text, and graphics." Instructional materials will be distributed as mail messages; an instructional message on the topic of the human heart, for example, features a graphic, a sound, and an application. Students will listen to the pronunciation of terms and a heartbeat and view an EKG simulation. "Students will learn science and math more effectively, and they will be able to improve language skills in the classroomĐthis is an exciting opportunity for teachers and students."