ADMINISTRATION

Princeton University Libraries choose NeXT for office automation

Princeton University Libraries

When the Princeton University Libraries decided to upgrade their office automation systems, the staff's top priority was to find machines that were both powerful and very easy to use.

"Librarians are not computer technicians, but their applications require sophisticated computing technology," says Phil Menos, systems analyst.

The staff needed a machine capable of running word processing (with utilities to index documents of up to 1,000 pages), electronic mail, spreadsheet, database management concurrently, as well as desktop publishing capabilities and networking facilities that could provide easy access to academic and research networks.

They considered Macintosh and PC configurations, a minicomputer network, and a network of NeXT machines. After extensive research, they decided to purchase 27 NeXT machines. Today at Princeton's libraries, all administrative managers and their support staff have NeXTstations™ on their desks.

"The NeXT is the leading edge in computing: the best graphical user interfaces yet developed to assist the operation of the UNIX multitasking environment along with high-level standards, such as Display PostScript for a WYSIWYG display capability and Ethernet for high-performance networking," says Menos.

Library administrators use Lotus Improv for compiling cataloging production statistics and salary administration. They also use DataPhile for creating and storing employee performance appraisal forms and tracking inventory of computing equipment. They use WriteNow and WordPerfect to write grant proposals and correspondence and Draw to create organization charts and presentations. They communicate with one another as well as with librarians throughout the world via NeXTmail™ on the Internet.

"As a UNIX machine," says "Menos, NeXT is the leader in communications, allowing good access to other systems, including access to Bitnet and Internet. This is especially important in a library environment, where the flow of information moves across several hosts. Support for Ethernet is built into NeXT whereas it is only an option on Macintosh and MS-DOS machines."

He continues, "The NeXT's e-mail program is among the most powerful and easy to use available. NeXTmail was a key reason we bought NeXT machines. With NeXTmail, if two colleagues are working on a budget or a grant together, they now just send the Improv file or the WordPerfect file back and forth to each other via e-mail. It's simple."

Before purchasing the NeXT machines, Menos says, "Everything was single-tasking. We'd have to log off one machine and get on another to perform another task. Since NeXT is multitasking, the staff can be running e-mail, working on a grant in WordPerfect, and searching a database—or a number of databases—on the Internet—all at the same time. That we can do all of this from one system is very important to us."

Menos adds that the library staff was also impressed with the amount of software that came bundled with the NeXT machines: "The software that's bundled with the base system is generous and capable. Plus, there is a growing software market with software available to meet every business need—much of it original and creative work that has been written to take special advantage of the NeXT's unique user interface.

"The NeXT bundled software even includes DataVizBridge™ for transferring files to a Macintosh as well as for converting files to Word or Excel. For those who share work with Macintosh and MS-DOS users, or who wish to bring work home to a different kind of computer, there are efficient and effective ways to move files."

Concludes Menos, "NeXT combines the most innovative technology with the most features at the most competitive price. The machine has met the library's administrative and research needs in an effective manner that is best positioned to expand in the future."

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ARCHITECTURE

Historia de la Arquitectura with MediaStation

Instituto Tecnologico y de Estudios Superiores de Monterrey

Traditionally, architecture students at the Instituto Tecnologico y de Estudios Superiores de Monterrey (ITESM) had not devoted as much attention to their architectural history courses as faculty members thought necessary. Many of their projects were not of the quality expected by the school. And they were devoting little time outside of the classroom to further investigate the material reviewed in class lectures.

"The students' main interest is designing buildings," explains Fernando Huerta, a member of ITESM's academic computing staff. Although architectural history is a very important part of the curriculum, instructors were having a difficult time catching students' attention with the static charts and maps that are used in class lectures. Students were bored by the historical information. We needed to find an autodidactic method that would motivate students to spend more time investigating the subject on their own."

Working with three members of the architecture faculty, Huerta developed Historia de la Arquitectura, a multimedia database running on NeXTstation Color computers that contains 18 key architectural works from the Renaissance and modern periods. Using the database, the 275 students who enroll in architectural history courses each year learn at their own pace about the historical context in which the buildings were created; their main characteristics, including style and geographical and physical location; and the impact the various works have had on the field of architecture.

ITESM has been using NeXT machines since 1988, when it became the first Latin American university to purchase NeXT computers. There are currently 120 machines on site. According to David Trevino, computer services director, "We chose workstations because of power. We'd been working with PCs and Macs and found them good for word-processing, but we needed a technology that went further. We saw workstation technology as having a major impact on both academic and nonacademic worlds, and we evaluated NeXT as the best workstation in terms of both hardware and software."

He adds, "NeXT technology allows the integration of not only text, but images, sounds, and video. Course material becomes more alive, dynamic, and motivating on NeXT."

For Historia de la Arquitectura, faculty members provided Huerta with information on the various buildings as well as audio, images, and music. Using scanners, audio- and image-processing software, architecture students scann the text, audio, and images into MediaStation. All text and images are stored in standard RTF and TIFF formats.

With MediaStation, Huerta created four classifications (building type, author, style, and building name) by which students can retrieve information on the 18 works. He set up two archives—one for Renaissance buildings and one for modern buildings. The two Historia de la Arquitectura archives open to a table that includes a list of subjects appearing in the archives. Each window of an archive contains scrolling text that provides historical information on a particular building as well as important dates and characteristics regarding the building. While reviewing the text, students can click a separate file that includes various figures relating to the building. When students get to the end of the text, a bibliography appears, listing books and articles on the building that are available from the campus library.

"Because the NeXT environment is very flexible," says Huerta, "it's easy to

Historia de la Arquitectura is a multimedia database created with MediaStation, allowing easy access to rich architectural information in archive and tutorial formats.

update the archives as new information on buildings or architects becomes available."

Using Historia de la Arquitectura, students also participate in a multimedia tutorial in which they hear the voice of a faculty member reviewing information about the building as images of the work appear on the screen. Music from the period in which the building was constructed can also be heard in the background. Throughout the tutorial, various pointers appear on the screen, specifying parts of the building as the instructor refers to them in his commentary.

"Given the attractive, easy-to-use multimedia presentations we've been able to create, the coursework has now become interesting for students," says Huerta. "They now have a simple and intriguing way of learning repetitive information. Therefore, during class, teachers have more time to devote to student questions and expressing their opinions about a particular building or architect. This makes the classroom sessions much richer."

Huerta notes that, perhaps most importantly, the quality of students' homework assignments has improved and that students are now devoting more of their spare time to studying architectural history. "Students are more motivated," he says. "Because the material is so easy to find on MediaStation, it encourages them to do further investigation."

Because of the School of Architecture's success with their NeXT-based tutorial, ITESM's Marketing Department in the School of Business has asked the academic computing staff to create a similar application. The marketing tutorial will allow students enrolled in advertising courses to have access to a variety of advertising materials.

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ART HISTORY

Study Aids for Art History Classes

Western Michigan University

Like most art history professors, John Link faced the age-old problem of finding a way for his students at Western Michigan University to have access to the works of art he discusses during his lectures once class is over. "For security reasons, the department wasn't prepared to allow students access to our slide library," explains the professor of art, "so the students had no way to review the works of art outside of class."

Link decided to turn to his computer where he came up with a "complete solution" to his predicament.

Using NeXT technology, Link has developed a series of Digital Study Guides to augment class notes and refresh students' memory of art he presents during his daily lectures. The guides contain the images of 800 key works of art he features in his Contemporary Art and Theory of Art courses and his notes on the artists responsible for each work.

To create the guides, Link uses a scanner to digitize color images from slides of the art. Using a NeXTstation Color, he incorporates the images and his commentary into MediaStation archives, which he organizes by artists' last names. He then incorporates art and text from various archives into the series of Digital Study Guides, which are organized around topics, such as hyper-realism, abstract expressionism, and conceptualism. Now, Link's 100 students use the NeXTstation Color computers at their leisure in Western Michigan's open lab to access the guides and study full-color images of art with notes from their professor.

"With its graphical processing and networking abilities, the NeXT machine is a fantastic leap ahead for instruction in the visual arts," says Link. "Of course, color is extremely important for any use of computers in visual instruction, and NeXT machines, with a minimum standard of 4,096 colors, provide a cost-effective alternative to machines, like the Macintosh, that require a substantial hardware investment to achieve the same standard."

A former Macintosh user, Link says, "We considered using the department's Macintosh lab to create the study guides, but it would have been very difficult because of the machine's tiny monitors and the AppleTalk network. There's no way we could have supported the same high-quality color images because Macintosh does not support Display PostScript. Plus the Ethernet network, which NeXT offers at no additional cost, is ideally suited for moving large files, like our color images, over a network. I don't think the project would have been feasible without Ethernet."

Link also believes that NeXT technology is a boon to students and faculty in his department who design university publications and materials for outside clients.

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Students in Contemporary Art and Art Theory courses use MediaStation-based Digital Study Guides to review Western Michigan's extensive slide collection.

B I O L O G Y

Computer labs

supplement labs

or most students enrolled in their first year of biology, mastering scientific concepts often takes a backseat to understanding the array of alien-looking equipment in the biology laboratory. Until recently, students at Allegheny College were no exception.

"Students were spending the majority of their lab time trying to comprehend the equipment. As a result, they

experiments to further test the hypothesis.

"An advantage of using NeXT for biology," says Kleinschmidt, "is that a much wider range of possible conditions can be tried in testing hypotheses. The students are limited by the wet labs because there isn't time to do multiple experiments. Students are spending more time than ever before evaluating data, and they are more engaged in the work than the pre-NeXT students were."

The Gator Pre-Labs application series is available via anonymous FTP from pellns.alleg.edu in /pub /next/Biology.

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BUSINESS ADMINISTRATION

DECISION MAKING WITH OBJECT-ORIENTED

University of British Columbia

Professor of Commerce and Business Administration Robert Goldstein and his colleagues in the MIS Division at the University of British Columbia (UBC) wanted to study the effectiveness of computer support in group decision making. To get the project off the ground, the faculty first needed to develop a method for gathering the real life situations they planned to observe and analyze.

Taking a cue from other leading universities, the MIS Division proposed that UBC build its own computer-supported meeting facility to aid in the research effort. Regional corporations as well as UBC's academic and administrative departments could then rent the site so long as the MIS faculty could, in confidence, observe their meetings to gather data for an ongoing research project.

Once the UBC administration approved the project, the faculty's next priority was to find the computer system best suited for the work. They discovered that schools with existing meeting programs operated primarily with PC-based systems. They also found that the PC systems were cumbersome for participants because of the learning curve required for new users. In many cases, for example, participants had to use several difficult-to-remember commands in order for the computerized discussion to run effectively. Ease of use and processing power were paramount, and the PC environment did not offer these capabilities to the MIS faculty. Nonetheless, UBC considered PC, Macintosh, NeXT, and other UNIX systems for the UBC meeting room.

"The first thing that struck me when I visited other schools was the limited user interface on their computers," says Goldstein. "And one of NeXT's strongest points is its graphical user interface. The NeXTSTEP environment is far more user friendly than any of the other systems."

Goldstein also says NeXT is "the best platform for developing the custom apps we need to run meetings. With its object-orientation, we expect NeXTSTEP to significantly reduce both the time and cost it takes us to get our system and apps up and running. No other platform could have provided us with a quicker route."

When construction is completed in mid-1992, UBC's meeting area will include a primary meeting room, an observation area, and two rooms for conducting "breakout sessions."

The primary meeting room will hold a modular conference table with 12 built-in NeXT monitors and keyboards for use by participants. One wall of the meeting room will contain a large projection screen that will display ideas and comments as participants work at their machines. Each participant's machine will be equipped with data retrieval, computation, and communication software. Locally developed custom applications will be used to manage the meeting process. Goldstein notes that prior to purchasing the NeXT machines, the MIS faculty tried Greyboard—a public domain network conferencing version of the Draw program—and "it demonstrated to us how feasible our project would be in the NeXT environment. Although Greyboard is more limited than the apps we plan to develop, we realized it was clearly a step in the direction we wanted to go."

Goldstein says the UBC setup will be conducive to discussing a wide range of topics—from naming a new product or revising a company's organizational structure to developing a corporate financial plan. And though most schools use people to facilitate computer-based meetings, Goldstein thinks meetings at UBC will eventually be run by a semiautomated facilitator application that faculty and students in the MIS Division will create using NeXTSTEP.

"Most systems downplay the capabilities of collaborative software and rely more on the meeting facilitator," he says. "Consequently, the success of a meeting is due in large part to how effective the facilitator is. Our custom software will reduce that risk."

He concludes, "We have a powerful application-building tool in NeXTSTEP. We're convinced that, spending relatively little time and money, we'll

create a system that will outperform those currently in use."

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BUSINESS ADMINISTRATION

High school summer program encourages entrepreneurship

University of British Columbia

Shad Valley, a project operated by the Canadian Centre for Creative Technology, is an innovative summer program in technology and entrepreneurship for top students in grades 11 and 12. At eight Canadian universities, 400 students (50 at each site) participate each July in lectures on computing, entrepreneurship and science, hands-on labs, and seminars as well as project work in technology and entrepreneurship.

According to Ron Foreman, director of the University of British Columbia Shad program and associate professor of botany, "One of the motives behind this program is to build the 'old-boy-and-girl network' of the future." Already, the 2,500 graduates of the 10-year-old program have started nearly 100 businesses—an impressive figure given that more than 80 percent of the students are still in high school.

When Foreman took over as program director in 1990, he decided to replace the DOS machines that Shad students had used in previous years. "Although the kids were quite proficient on the DOS machines, I wanted to use a more powerful platform that would jump out to them as user friendly. Our task is to challenge these kids to the best of our ability and to provide them with the tools to meet the challenge."

Foreman, who has access to several computers, including a NeXT, says, "I knew the NeXT machine would be the perfect computer for these students. Since I purchased a NeXT, all my other machines just gather dust. NeXT is a fantastic platform. I currently own PCs, Macs, an AES-Lanier, and a Xerox Documenter System. With its graphical interface, multitasking capabilities, and the object-oriented programming, nothing comes close to NeXT."

Foreman worked with the UBC Department of Botany and the Dean of Sciences Office to obtain a cluster of NeXT computers that is used to teach undergraduate and graduate botany classes during UBC's academic year and for the Shad program during the summer. "When the Shad kids first saw the NeXT machines, their eyes were like saucers," says Foreman. "They couldn't believe what the machine could do. They couldn't believe what they'd been missing before"

During the month that Shad students are at UBC, they set up a "company," invent and design a product, conduct engineering and marketing evaluations, and develop a business and financial plan. During the final week, they present their business plans to a group of Canadian venture capitalists who have volunteered their time to the program. In the past, student businesses have developed an appliance to crush cans, a revolutionary spinal backboard for aquatic centers, and a new composting technology.

Students primarily use the NeXT machines to develop business and financial plans and the marketing presentation they present to the venture capitalists. Students use applications such as Lotus Improv, WordPerfect, Diagram!, and *Mathematica*.

"I've been amazed at the quality of the presentations and plans students prepare," says Foreman. "When we used PCs, we didn't get the aesthetic quality or the thorough analysis we do now. Students are doing the same work, but they're not just cranking out raw information. They're providing us with 20-year projections in their business plans and a set of financials that consider a variety of scenarios. The marketing materials they create are wonderful; some teams even create individual portfolios for each of the venture capitalists."

Foreman points out that he and the other nine staff members "do not teach in the traditional sense. The students are responsible for running their own projects. Throughout the process, faculty assist students and refer them to other faculty members or businesspeople they might use as consultants. The students provide the energy and direction."

At UBC, the students are organized into four "companies." Each company is given 24 hours to make various job assignments—from CEO to controller to vice president of sales. Each company is assigned an office containing two NeXTstations. A faculty member presents a half-day seminar on the system at the UBC Computer Science Department's NeXT computer lab. Students also have the option of attending a 12-hour seminar on NeXTSTEP object-oriented programming.

The teams of students put in 12 hour days at Shad. Besides working on their projects, students attend lectures and seminars given by academic and business leaders. In previous years, students have visited a local hospital to learn how a CAT scan operates and a film studio to observe production of computer-

generated television commercials.

Says Foreman, "The program debunks many stereotypes about business: that it's boring; that it's for other people, not me. At the end of program, students write reports on their experience. It's not uncommon for them to say, 'This has been the best month of my life. I wanted to be a lawyer, but now I'm thinking about becoming an electrical engineer'. We're the envy of the other Shad sites because we have NeXT machines. They really challenge the students."

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COMPUTER SCIENCE

New focus for introductory CS students

Gettysburg College

The traditional teaching approach for most introductory computer science courses involves implementing concepts through programming language syntax. According to Rodney Tosten, assistant professor of computer science at Gettysburg College, one unfortunate consequence of this method is that students often "become lost in the code development and encounter tremendous trouble in understanding the real concepts."

"Although this approach has successfully taught a large number of students," he says, "many others have completed the introductory courses assuming that computer science and programming are synonymous. We feel that the introduction of improved computer hardware and software development environments has outdated this approach."

To take advantage of new technology and improve students' understanding of computer science concepts, Tosten and Carl Leinbach, chair of the Mathematics and Computer Science Department, revised the curriculum in Gettysburg's three lower-division CS courses—Introduction to Computing, Data Structures and Computer Organization, and Assembly Language Programming.

"We wanted to expedite the coding phase," explains Tosten, "and provide more time for students to learn and explore concepts. We want first- and second-year computer science students to learn that computer science concepts are grounded in solid theories."

Tosten and Leinbach decided to use NeXT machines in the courses based on three factors they considered key in the curriculum redesign.

"The object-oriented environment was a significant factor," Tosten says. "NeXTSTEP incorporates the object-oriented paradigm throughout its operating system and user interface instead of within an individual programming package.

"In addition, NeXT's various software support systems, including Interface Builder and Display PostScript-based graphics, provide a powerful environment for application construction. The third factor is NeXT's support of the UNIX operating system. All in all, these things really set NeXT above other platforms."

Tosten and Leinbach came up with two strategies to teach the courses using NeXT machines. First, they wanted to implement course concepts in an object-oriented environment so students could create and maintain individual object structures.

"We believed that if students were using their own object libraries in conjunction with the system object libraries, they would be able to experiment more with abstract ideas," says Tosten. "They could construct applications more quickly and effectively and thereby eliminate their preoccupation with coding."

They also wanted to provide students with more visual reinforcement of abstract ideas. "With Interface Builder," Tosten says, "students work with concrete visual objects associated with abstract concepts. They also build and dissect objects so they can observe and compare a variety of abstract ideas for solving the same problem."

Throughout the semester-long data structures course, students now implement data structures as objects and then use these objects to construct larger applications. When studying sorting, for example, they implement several sorting algorithms in a "package skeleton" provided by the instructor. When they've finished the assignment, they have a package that allows them to experiment among the sorting algorithms.

As an assignment in Introduction to Computing, students implement a loop structurally, visually, and through code.

"This way," says Tosten, "the students interact with the concept in three different settings. The combination of these strategies presents the student with the tools to implement concepts through code and to explore concepts structurally. The visual representation of an idea gives the student another method to learn and experiment with the major concepts of computer science."

Using Interface Builder, Tosten has

also developed an interactive database, called IntroBase, for use in Introduction to Computing. IntroBase serves as as a tool to introduce database management theory and processing and as a bridge from using applications to building them..

"It provides an easy way to introduce students to the concept of an algorithm and the problem-solving process," says Tosten.

With NeXT's graphical interface, students in the Computer Language and Assembly Language course are able to construct and experiment with graphical representations of architectural components such as an address decoder.

"The focus of this course is less on assembly language programming and more on concepts and theory," says Tosten. "We want students to understand how high-level language structures are implemented in assembly language code and how they affect the machine's behavior at a lower level."

Concludes Tosten, "The NeXT platform is an excellent teaching platform for us. With the NeXT machines, we've been able to cover computer concepts we were previously incapable of presenting. Our overall teaching approach with NeXT now raises the student from the traditional role of a programmer forging out the code that implements concepts to that of an active scientist engaged in experimentation."

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COMPUTER SCIENCE

MACH MAKES ITS MARK IN OPERATING SYSTEMS

Simon Fraser University

When the School of Computing Science at Simon Fraser University (SFU) in Burnaby, British Columbia, decided to upgrade the instructional computing facilities, the faculty wanted a machine with a superior operating systems environment. The school considered several UNIX machines and eventually decided to purchase 29 NeXT computers.

"NeXT addressed more of the items on our wish list," says Eric Kolotyluk, manager of Research and Education Systems. "We were getting a workstation environment at PC prices and Macintosh ease of use in a 'real' operating system environment."

One of the primary reasons SFU decided on NeXT was its Mach operating system. Says Kolotyluk, "We felt we could take the classes further by giving students hands-on experience with Mach. It's one of the first new 'real' operating systems to come out in a very long time and the only serious contender to contemporary UNIX systems. We had been teaching standard UNIX, but that's like teaching history. The current trend is toward micro-kernel technology, which is what Mach is based on. In addition, Mach has some incredibly elegant features."

SFU uses NeXT machines in three of its operating systems courses: Introduction to Operating Systems, Advanced Operating Systems, and a graduate course in operating systems design. Plans are to move the Operating Systems Implementation course from a PC environment to the new NeXT computers. The school also uses the NeXT machines to teach courses on LISP and Prolog, as well as constraint-based logic programming using SFU's new Echidna expert system shell. In addition, the school plans to create a new course in graphical user interface design using Interface Builder.

"NeXT has the usability of a Macintosh system and the power of a UNIX-system," says Kolotyluk. "Other systems may have more software and applications, but they are typically more difficult to use. NeXT machines have also proven to be more reliable under the stresses of O/S students who typically write systems level code that gets out of hand and causes other systems to crash. NeXT is just a nicer, cleaner, smoother, more reliable environment."

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COMPUTING ACROSS CURRICULUM

High school chooses NeXTSTEP for curriculum development

Glenbrook South High School

Kimberly Schmidt, Ryan Kaufman, and David Jeske don't have after-school jobs at fast food joints or local malls like many of their 2,000 schoolmates at Glenbrook South High School. Instead, they earn their spending money—along with real practical experience—developing NeXT software applications and simulations for use in high schools and universities.

"NeXT machines have opened up the learning environment for students beyond our walls," says John McConnell, instructional supervisor of mathematics. "NeXT machines have shown students at all levels that they can contribute something significant to the world by learning to use computers."

For the past year, Glenbrook South, in cooperation with Argonne National Laboratories, has worked toward integrating the use of NeXT computers into its mathematics, science, and writing curricula. With help from McConnell and Glenbrook students, Argonne has developed a variety of education applications—from pre-calculus tutorials to collaborative problem-solving sessions—for use on the NeXT computers. Argonne also plans additional collaborations with schools in Florida and Texas. Glenbrook South's sister school—Glenbrook North—already has a lab of NeXT machines and will begin using them for instruction in the fall of 1992.

Although Glenbrook South already had a large Macintosh lab on site, McConnell says the school installed NeXT machines because "the hardware and bundled software applications were unbeatable for our purposes. NeXT was the best we could get for our dollars. In fact, the price of a NeXT machine with eight megabytes of RAM and bundled software was less than the price of configuring a Macintosh SI. We know we're going to get many years of good use from these machines—a very important consideration for any educational institution."

Currently, mathematics instructors use NeXT machines and *Mathematica* to teach advanced algebra, precalculus, and calculus. Science instructors use MediaStation to present material on cell life and chemical components as well as animated examples of different crystalian structures. Students have begun using NeXT machines in the school's computer lab on their own—for composing history and English papers, as well as communicating with their instructors via NeXTmail. Just a semester after instructors began using the machines in the classroom, individual use of the computers has skyrocketed, according to McConnell.

"The NeXT machines are creating a more lasting, realistic and active learning experience for our students," says McConnell.

In calculus classes, students use *Mathematica* to solve complicated integration problems, compute tangent lines of derivatives, and graph polar functions. They're easily able to change functions, revise calculations, regraph solutions, and make conjectures about the results—things that weren't possible in the days of pencil and paper. McConnell recalls, "In days gone by, teachers said to students, 'Here's the rule, now go graph it.' With NeXT machines students and teachers have the technology to be incredibly more flexible. We have the opportunity to delve deeper into problems."

Besides the traditional problem-solving tasks, McConnell says he frequently gives his students writing assignments in which they must explain how they derived a solution for a particular problem. NeXT, he says, provides the "perfect platform" for writing about mathematics.

"The 17-inch screen is critical for allowing students to access math and writing documents simultaneously," he explains. "The screen is so large that it's easy for the students to have *Mathematica* windows up along with the WriteNow documents. They can easily cut and paste information from one application to the next."

McConnell says NeXT's UNIX platform and Ethernet networking system are also pluses for faculty and students.

"UNIX now plays a major role in our school district's computing environment," he says. "We felt we were making a move toward cutting-edge computing by investing in a UNIX-based system, like NeXT. In addition, NeXT's Ethernet network is quick and efficient. Even if we're running a lot of applications, the network doesn't get bogged down. Apps appear on screen very quickly."

Looking ahead, McConnell wants to begin using NeXT machines in Glenbrook's introductory mathematics courses, including geometry and algebra. When the NeXT lab at Glenbrook North is functional, he plans to run NeXT-based classes simultaneously so North and South students can communicate with one another about particular assignments.

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COMPUTING ACROSS CURRICULUM

EPICS program adopts NeXT

The Engineering Practices Introductory Course Sequence (EPICS)—a four-semester interdisciplinary program—at the Colorado School of Mines is one of the leading engineering education programs in the nation. Yet, in the late 1980s, faculty and administrators discovered that students were not completing the program with the computer skills required for their upper division courses.

"The theory behind the program had been to expose students to as many approaches to computing as possible—from hand-held calculators to personal computers to mainframes," says Barbara Olds, director of EPICS. "But we found that students weren't programming well enough for their upper-division courses because they had been exposed to a little bit of everything rather than learning a few applications very well."

During the summer of 1990, EPICS faculty began to revise the curriculum, limiting the computer instruction to three main applications—Fortran, Autocad, and a spreadsheet. The program is gradually moving from MS-DOS to a NeXT workstation environment. Currently, NeXT machines are used heavily in instruction of the third-semester course, EP201, and the faculty is working toward implementing NeXT machines and applications, such as Diagram! and Lotus Improv in the second semester course, EP102.

According to Jacob Gore, assistant professor of mathematical and computer sciences, "There were several driving reasons for wanting to move to a workstation environment. First, we wanted to familiarize students with appropriate technology. PCs are outdated and have lost ground to workstations in the engineering workplace. In addition, single-user machines, like MS-DOS and Macs, are prone to virus attacks. Students enrolled in the spring semester of EP102 spent up to a third of lab time recovering from virus attacks and attempting to pre-empt them. Many students had to redo several assignments because of lost data.

"Plus, EPICS computer courses were going through far too much paper. Too often, assignments got lost in the flood of paper between the students and the graders. This was costly, unprofessional, and unfriendly to the environment. Workstations, like NeXT, make paperless classes possible."

Gore says that administration of the Ethernet network is also simpler and more cost effective. "We need an environment where the administrators can concentrate on keeping things running smoothly and not waste time on rebuilding systems or restoring locked networks," he says. "The NeXT workstations are designed for multi-user use. The network they use is very robust—robust enough to operate over national and international, noisy telephone lines. In addition, the NeXT workstations deal gracefully with temporary losses of access to the server, typically without any loss of users' work."

In EP201, students are introduced to engineering problem-solving using NeXT computers. As a "real life component" to the course, students work in teams of three or four to develop computer-based solutions to problems. Last semester, for example, one group worked on filtering and linear regression parsing of samples of electric current drawn by mining equipment during a work shift. The line segments this project produces serve as input to artificial intelligence software that tries to recognize what the monitored equipment is up to during the shift.

Gore and Bob Cameron, associate professor of mining engineering, who team-teach EP201, also instruct students on problem-solving with Fortran. They use Absoft's object-oriented Fortran 77 compiler and the freely available F2C Fortran to C translator and typically present a Fortran construct

An integrated environment for computer science: Redmark (left) is used for grading assignments, while NeXTmail (center) and NewsGrazer (right) run concurrently.

during each class period, assign up to three exercises to reinforce the constructs and provide assistance as students perform the exercises.

With a Diagram! palette of flowchart symbols developed by Gore, students create flowcharts for their program designs. "Diagram! has been a big help," says Gore. "Students usually hate creating flowcharts, but this application has made it enjoyable for many of them."

Students use NeXTmail to communicate with one another and Gore, who posts syllabi, homework assignments, course materials, and announcements electronically to the local Usenet group. Students must submit all homework and project materials through electronic mail; paper is not accepted for grading.

Graders use Redmark, an on-screen review and redlining application, to correct all assignments. According to Gore, "Redmark has cut grading time by 70 percent. Graders can now just scribble their remarks on an image of the homework. In addition, everything the students mail is now automatically archived on the NeXT, which has brought the number of lost homework assignments to zero."

Besides EPICS, the CSM Mathematics and Computer Sciences Department uses 25 NeXT machines with *Mathematica* in their freshman and sophomore calculus classes.

"The NeXT lab provides an impetus for us to think about how calculus should be taught," says Professor Frank Hagin. "We've decided to place less emphasis on marginal topics that will rarely be used. We make good use of *Mathematica* Notebooks—which are basically self-contained teaching units—and have students work through the Notebooks as laboratory assignments."

Says Hagin, "You get a lot of bang for your buck with NeXT. The bundled apps provide us with everything we need to teach calculus. NeXT is a bargain compared to a well-equipped Macintosh. And it has a very elegant and powerful software system that we think represents where computing systems are headed in the future."

According to Derek Wilson, director of the CSM computing center, NeXT machines are also used as productivity tools by 40 CSM administrators and faculty members.

"With NeXT, you have the functionality of a PC with the power of a workstation," he says. "The critical apps are straight forward and completely usable. And it's great that we can run multiple apps at the same time. Because of this, the NeXT has had a significant impact on the way we work at CSM. For example, I used to have information scattered around in a variety of paper files. When I'd get a call about the status of a project, I always had to get back to the person later because I needed time to sort through my paper to get the information. With NeXT, though, I might be running Digital Librarian, Lotus Improv, and DataPhile at the same time so it's easy to just pull up the information immediately and access it on the spot for them."

He adds, "It's terrific that students have access to all sorts of applications that come bundled with the NeXT. The apps—combined with multitasking capabilities—make NeXT a much more productive learning environment for students."

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ECONOMICS

Creating interfaces for experimental economics

University of Michigan

An economist often tests theories about people's behavior in strategic interactions like bargaining, auctioning, and negotiating. Typically, using a network of computers in a controlled environment, the economist observes how people behave when asked to make a series of strategic decisions.

Using NeXT computers, Hal Varian, professor of economics and finance at the University of Michigan, is studying people's behavior as they play his adaptation of the well-known computer simulation, Prisoner's Dilemma. The two-person game is played over a network and simulates how people behave in bargaining situations. In Prisoner's Dilemma, players do best at the game if they cooperate. However, each is tempted to defect from the cooperative solution. Varian allows the players to

communicate over the computer network and then studies how this opportunity to negotiate affects the outcome of the game.

Varian says the biggest problem in developing these experimental economics simulations is designing an easy-to-use interface at an affordable cost.

"It is important to have an intuitive interface," says Varian, "since the subjects have to learn to play the game in a short period of time. Furthermore, the interface should be fun to use. An attractive visual interface makes people interested in the game and encourages them to play to win."

He found that developing such interfaces by "conventional methods was costly and time-consuming." Varian says his productivity was significantly enhanced once he started working on the NeXT platform.

"With Interface Builder, development time has been significantly reduced. Plus, the object-oriented design of the NeXT machine encourages reusability. Although each experiment is run only a few times, each experiment has many features in common with the others. Having a tool kit of objects for such games and simulations has proved very useful in subsequent research projects."

Varian adds that these simulations are useful not only in research, but in teaching as well. "Economic concepts become much more vivid when students can get hands-on experience," he says. "The NeXT platform provides a convenient platform for this type of experimentation."

In the future, he plans to develop simulations of market games, auctions, and bargaining, for use in both teaching and research.

Varian also recently published a new edition of his graduate economics text, *Microeconomic Analysis,* using TEX software on his NeXT.

"The integrated environment offered by NeXT makes the author's job much easier," he says. "All the tools necessary for producing professional technical publications using TEX come bundled with NeXT machines—and all the tools work very well together."

To supplement the text, Varian has developed 25 *Mathematica* Notebooks that illustrate the principles involved in applying mathematical models to economic problems. The Notebooks contain lessons on optimization, sensitivity analysis, optimal pricing schemes, econometrics, and cost-benefit analysis.

"It's terrific that *Mathematica* comes bundled with the NeXT," says Varian. "NeXT has the best implementation of *Mathematica* and also the Notebook front-end. *Mathematica* runs on many platforms, but the NeXT is the easiest to use and the most cost-effective platform I know of."

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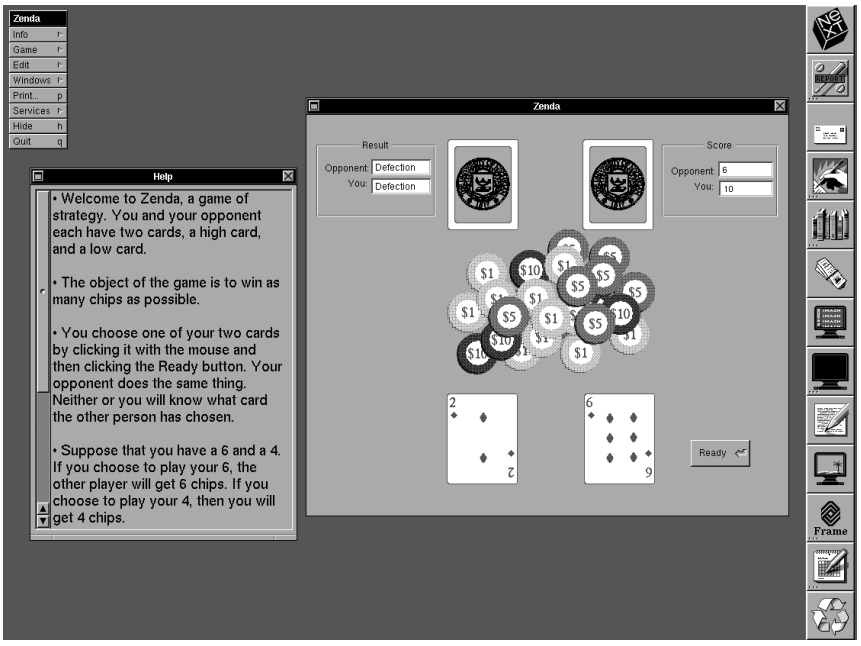


Prisoner's Dilemma is a two-person game that can be played over a network to simulate how people behave in bargaining situations.

ENGINEERING

SPEL: The Signal Processing Educational Laboratory

University of Michigan

Assistant Professor of Electrical Engineering and Computer Science Gregory Wakefield says that if he and his 12 University of Michigan student researchers had not used NeXT computers for a research project on acoustical and auditory signal processing, the project might never have gotten off the ground—let alone into the hands of researchers at Ford Motor Company.

"If we weren't using NeXT machines, we would have needed a support staff of software engineers and hackers," explains Wakefield. "We would never have been able to take the project this far on another platform.

"Interface Builder, the App Kit, and Sound Kits were key," he continues. "They allowed us to build flexible apps in an intuitive fashion. NeXT's multimedia props were also very important. In fact, that's why we purchased the machines in the first place. We saw a lot of value in having video, audio, and text capability in one machine. The quality and availability of third-party software on the NeXT were also important factors to us."

With NeXT technology, Wakefield and students created a digital signal processing system that simulates how the human ear reacts in a variety of acoustical environments. Since 1989, Ford Motor Company has been integrating the research into the sound-quality evaluation and design of the company's future cars—using the DSP system to determine how the human ear responds to a particular power-train noise, for example.

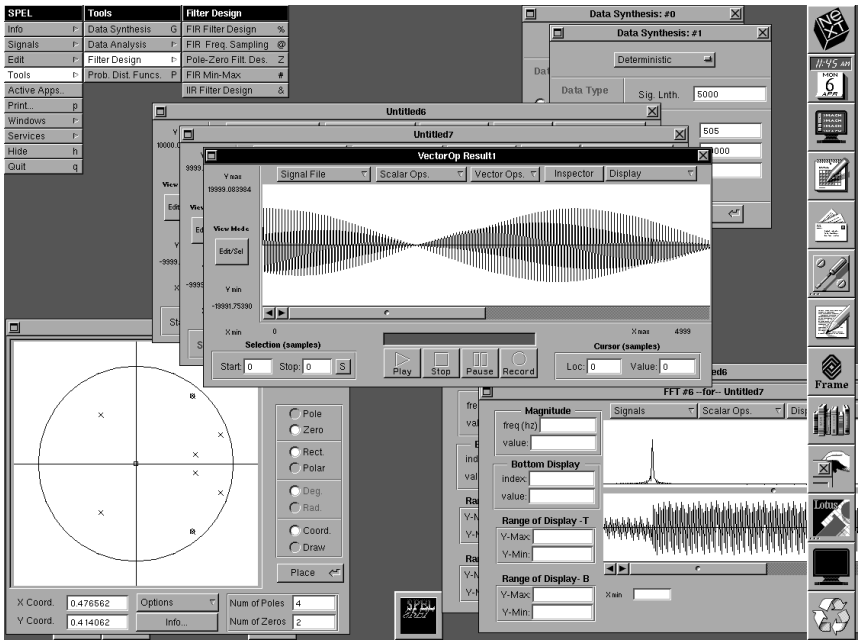
"We've helped Ford close the loop on several auditory design questions," says Wakefield. "The project has had tremendous impact on the car designs we'll be seeing in the future."

Back in the classroom, Wakefield has developed customized software using NeXTSTEP to teach his seniors and first-year graduate students about signal processing. Called Signal Processing Educational Laboratory (SPEL), the application is an exploratory tool used for signal analysis, design, and visualization. SPEL is organized around a set of applications that run within the SPEL environment. Each application is tracked by a SPEL manager that permits the user to transfer results from one application to another. For example, the user can edit the temporal representation of a signal, then play it, perform basic algebraic and transform operations on it, and then save it.

"SPEL provides a very flexible way for students to explore sound," says Wakefield. "They can see and hear signals, change and manipulate them, and then immediately view the outcome. With textbooks, students are only provided with a simple picture of signals. There's no opportunity for trying out alternative filter designs and seeing what happens."

Wakefield further credits the flexibility of the NeXT environment for helping him get the SPEL project off the ground: "The most difficult thing about writing an educational application is creating a good user interface," he says. "It takes a lot of revision. There's just no systematic way to do it the first time—and I didn't have a lot of time to spare. I had seen other windowing environments which were flexible, but took three pages of code to get the words 'Hello, World' to pop up on screen. That's not a productive use of my time.

"In creating SPEL, we've really taken advantage of Interface Builder," he says. "We can lay down the algorithms and just play them out on the screen, thereby experimenting with a number of alternatives. This isn't possible in other development environments."



SPEL allows students to see and hear signals, manipulate them, and then immediately see the results.

Wakefield says he originally attempted to create the SPEL application on an alternative UNIX workstation, but the project never got off the ground because of "the long development cycle involved in designing a student-proof application on that workstation."

"SPEL could have taken years to create," he says, "but on a NeXT machine, the development cycle was two months. If I didn't have Interface Builder and the object kits, I would not have been able to create SPEL in the time I did."

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ENGINEERING

NeXTSTEP and Mathematica: A boon for teaching and learning civil engineering

Columbia University

Although Gautam Dasgupta, associate professor of civil engineering at Columbia University, has been teaching Computer-aided Engineering Graphics and Computational Methods in Structural Analysis to undergraduate and graduate students for nearly 15 years, he says students have never been as excited about the courses as this year—when he incorporated NeXT technology into the required class assignments.

"Students find the NeXT setup to be more effective than the Sun environment we'd been using before," he says. "Specifically, NeXT machines are very fast and easy to use. Plus, all the software students need to complete assignments comes bundled with the machines. And it's easy for students to combine the outputs of several different applications in NeXT's multitasking environment."

Students now use *Mathematica* in the engineering graphics course, which emphasizes the mathematical aspects behind computer graphics applications, including two- and three-dimensional geometric transformations, shading and rendering, hidden-line and surface elimination, and clipping algorithms. For their term project this semester, students are working on displaying three-dimensional surfaces from the measured data of human skulls. The purpose of the project is to use graphical considerations to identify abnormal growth.

"There is no computer-mathematics environment that even comes close to the power of *Mathematica* combined with NeXT's ease of use and UNIX utilities," says Dasgupta. "This year, using the Notebook front end with the NeXT, we've been able to do 10 to 12 times more examples than ever before. It's so easy for students to work them out with *Mathematica*. Problems I had spent a lot of class time on in previous years, I don't even review in class now. Students work them out on the computer as hands-on class work. One project that involves 3D biological modeling using computer graphics used to be a term project. Now it's a homework assignment."

In the computational methods course, Dasgupta covers flexibility formulations, stiffness generation, coding for axial and bending members, Poisson's equations, and truss and frame analyses and solutions. Students perform matrix algebra applications and solve differential equations. For their term project, they use Fortran to develop individual programs to mix finite- and boundary-element concepts.

"Most of the students learned Fortran a couple of years ago," Dasgupta says, "but they learned on the IBMs or Macintoshes, which don't have particularly attractive operating systems. In this course, we do serious structural analysis and, consequently, students need to use a UNIX system. NeXT presents a good introduction into the sophisticated world of UNIX. Students are able to work in a UNIX operating system without knowing too many details about UNIX at first. All the software and utilities that come with the NeXT are very helpful for getting the students off the ground in a UNIX environment. They don't have to learn a lot of complicated commands."

Dasgupta also uses TEX and *Mathematica* to prepare his research papers. "TEX," he says, "provides an efficient way to generate research documents that contain text, equations, graphics, and even sound."

Dasgupta says that since being exposed to NeXT machines, his students have started to use the platform to complete assignments in other engineering courses. "They've even spread the word about NeXT to their friends at other schools," he says. "They've brought their friends to our NeXT lab because some schools don't have as attractive a setup. In fact, I've been advising engineering and mathematics departments in other universities to develop NeXT labs like ours. As a developer of *Mathematica* applications, I know that I intend to carry out all of my future developments on the NeXT. Nothing comes close to the NeXT envi-

ronment for *Mathematica* to prepare engineering research papers."

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ENGLISH

Learning business writing skills with NeXT computers

University of Kentucky

In the semester-long Business Writing course at the University of Kentucky, Coordinator for Computers in Composition Nancy Foreman not only wants her students to develop strong business writing skills—she wants them to become proficient NeXT computer users, too.

This academic year, Foreman made the switch from teaching with a Primos operating system to NeXT computers. Working from the 22-machine cluster in the university library's NeXT lab, students prepare marketing presentations and corporate policy briefs and write correspondence, proposals, and peer reviews using WriteNow and Lotus Improv (for generating graphs and charts). They also use NeXTmail to communicate about assignments with one another as well as with Foreman.

"For so long, in English and humanities classes, we've used computers solely as word processing tools," says Foreman. "NeXT's multitasking environment allows us so many other options. With NeXT, students are able to interchange applications easily—from writing with WriteNow to creating charts and graphs with Lotus Improv—and then meld a variety of applications into a single document. Thanks to NeXT, business students are now able to create documents that are as professional as those they'll need to create in an actual business environment."

Foreman adds that in Business Writing, students in classes that use NeXT machines have higher grades than those in classes that still use the old systems. She says that students are "now signing up intentionally for the NeXT-based classes."

"I think students are doing better with the NeXT machines because they're so much easier to use," she says. "Because NeXT machines have freed students from dealing with the mechanical aspects of getting the computer to do what they want it to do, they have more time to concentrate on their writing. They can devote more time to developing the information that goes into the document rather than worrying about how to make the document look good."

Next fall, Foreman will use NeXT machines to teach Writing: An Accelerated Course. In the course—which will be linked with the Geography Department's Cities of the World course—students will use their geography text and a collection of selected readings as springboards for class discussions and for developing major writing assignments.

"Reading, thinking, and writing in both sections will allow students to develop connections between seemingly disparate courses," says Foreman.

Foreman outlined the content for the NeXT-based application and then turned the information over to Wayne Beech, senior scientific analyst/programmer at the university, to create the actual application using Interface Builder. Beech's application allows students to locate hemispheres, continents, countries, and cities and to obtain key information about each as they study and write.

In the course, students will also use NeXTmail to communicate more frequently with their instructor about assignments, Lotus Improv to develop bar and line graphs and pie charts and WriteNow to bring applications together and produce completed assignments.

"I feel that students will be able to take their knowledge of NeXT computers and apply it not only in my classes but in all of their other classes as well," says Foreman. "Students seem to be learning more and responding better with the NeXT machines. In fact, some of my students plan to buy NeXT machines for their personal use."

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FOREIGN LANGUAGE

Stay Tooned for better language learning

Stanford University

Students typically learn a foreign language by studying grammar rules and applying them through translation or rote practice. It's not surprising, then, that most computer software applications developed to help students master a second language emphasize extensive drills and repetition.

John Barson, professor of French at Stanford University, created Stay Tooned—a NeXT-based multimedia language-learning application—because he wanted to move beyond using computers solely as "drill masters."

"With computers," he says, "I felt that students could be constructively coached on a wide range of language concerns. I wanted students to be able to explore the language, experiment with it, and create with it rather than just be corrected with respect to grammatical accuracy or pronunciation in the abstract."

Stay Tooned is designed for presenting and creating talking comic books or picture story books. The application displays pictures and text, plays recordings, and lets users enter new text, record their own voices, play back their voices, connect the recordings with text, and annotate a pictorial story.

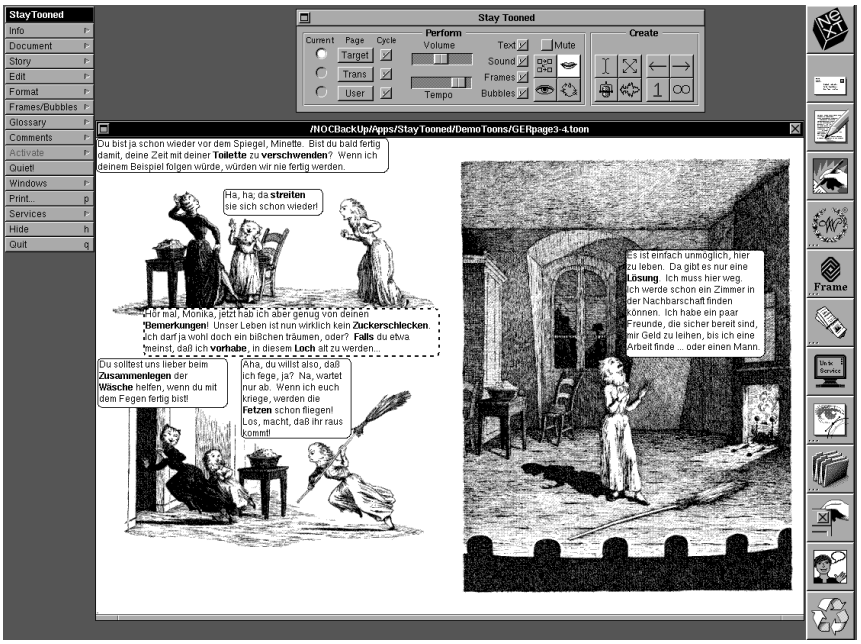
Barson says creating Stay Tooned would have been impractical without NeXTSTEP. "NeXT provided a number of new standards that were necessary for this application to be effective, including a large, clear screen, the capacity to store hours of speech on a single computer, built-in recording and sound playback, and a library of software objects that saved many months of programming time. NeXT is the first machine to make such capabilities standard—and at a reasonable cost—and that helped to inspire the project."

"The object-oriented programming environment dramatically reduced programming time and effort," says Brodie Lockard, Stay Tooned programmer and member of Stanford's Academic Software Development group. "Because programming with software objects lets one programmer reuse pieces of programs already written and tested by others, we were able to reduce errors and duplication of effort."

To use a Stay Tooned document, students click speech balloons in the document's picture to see and hear what the story's characters are saying. By continuing to click the speech and narrative balloons for a given document, students hear and see the story unfold both in the target language and in translation. Students can also access glossaries connected to each document by highlighting words they want to look up. The dictionary mechanism also includes a more global user dictionary in which students can place all vocabulary of interest to them.

In addition, a comments panel in the form of a pop-up window attaches to any narrative frame or dialogue balloon so the instructor has a highly interactive way to critique students' work. Comments can be oral, written, or a combination of both. Creation of a comment automatically highlights the portion commented on, so students know which part of their work needs further attention.

"Using Stay Tooned, students study and produce the foreign language in a meaningful context with attention to broader discourse features, including attention to style, dramatic veracity, idiomatic appropriateness, and artistic effectiveness of both narrative and dialogue," says Barson. "This is far more in keeping with 'real language use' than filling in blanks, repeating sentence fragments mindlessly, or memorizing trivial dialogue written expressly for the presentation of specific grammar or vocabulary."



Stay Tooned allows students to use faculty-created lessons as well as create their own stories in a target language and an English translation.

Currently, Stay Tooned is being used at Stanford in the instruction of several languages, including French, German, Spanish, and Polish. Materials for Russian and Czech versions of the application are being developed.

According to Barson, "Student response to Stay Tooned has been very positive. They point repeatedly to the excitement they experience from creating a story and watching it play out in front of their eyes. They appreciate the opportunity provided for reading dramatically, with emphasis on appropriate intonation. Students also enjoy the collaborative group-oriented atmosphere in which the stories are put together."

In the future, Barson hopes to use Stay Tooned to set up an interactive collaborative learning experiment among students in various universities. The students would prepare stories, swap them via e-mail, and critique one another's work.

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FOREIGN LANGUAGE

NeXT provides 'ideal learning environment' for language students

Johns Hopkins University

It takes most students at least three years of courses to become even minimally proficient in writing and speaking a foreign language. Consequently, those who decide to major in a language are left with just a year to squeeze in the more analytical classes on the country's literature, history, and culture.

"We ask a great deal of our language students," says Milad Doueihi, associate professor of French and Humanities at Johns Hopkins University. "They're faced with time constraints in their learning environment not encountered by students in other disciplines."

For the past two years, Doueihi has been the driving force behind a restructuring of the language and literature curriculum in the Johns Hopkins French Department to "give students more time to learn humanistic skills, such as interpretive techniques and good writing practices." The goal is to induce language proficiency in two years and provide more literary and cultural material in the department's introductory courses.

Knowing that learning with the aid of video and audio helps students become proficient in a language quicker, Doueihi sought to create an interactive, multimedia learning environment for French students.

"People learn languages not by passively absorbing lectures, but by forming and trying the various constructions themselves," says Doueihi. "The ideal learning experience is still a native speaker—in a native environment—who can both pose problems and serve as a potential library of information and culturally appropriate responses. Our challenge was to produce such an interactive textbook in our classroom."

Doueihi came up with the idea of creating an electronic classroom in which he would use computers to develop interactive multimedia instruction tools. He considered IBM, Macintosh, and NeXT platforms for the project.

"The choice was an easy one," he says. "The NeXT workstation was the only one with multitasking, video, and superior sound capabilities. It had exactly what we needed. In NeXT's multitasking environment, we can use text and video programs simultaneously. We can run slides and audio together. It was the only platform that would allow us to do these things with ease."

By mid-1992, the French Department will have an innovative electronic language classroom. The classroom will be equipped with 15 NeXTdimension™ workstations, fitted with CD-ROM drives to run electronic language textbooks (created with Digital Ears and Digital Eyes) and headsets so students can listen to the pronunciation of native speakers. The language staff is also using TheClassroom—an interactive multimedia application—to create an electronic library of texts, films, slides and soundfiles.

"We are constructing an electronic library of French cultural artifacts to serve as a medium in which students can learn French," says Doueihi. "In the very earliest stages of their language-learning experience, students will interact with written and visual text. This will help break down the barrier that

now exists between learning to speak or read a language and being able to interact with the literature and culture."

"With NeXT machines, we're creating the ideal learning environment for our language students. We are providing the simplest access—user-friendly to the point of transparency—to an extremely large quantity of cultural information. NeXT computers—with their speed, easy-to-use graphical interface, and large monitors—serve as the perfect tool for our language students. We estimate that students will learn about a third to a half more in first-year French than under traditional textbook-plus-language lab courses."

Doueihi adds that this "electronic classroom" can also be used in non-language humanities courses, including, for instance, art history, film studies, and anthropology.

"I believe we will build a powerful humanities-oriented computer network structured to compliment the way humanists think and work. We can begin much earlier in students' careers to teach them properly humanistic skills and orient them toward independent thinking rather than rote learning."

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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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HISTORY

Government-sponsored Arts and the New Deal

George Mason University

In 1935, President Franklin Roosevelt introduced the Works Progress Administration (WPA) that provided jobs for as many as 3.5 million unemployed men and women. Included in the WPA plan were artistic projects for musicians, writers, painters, and historians. Through the Federal Writers' Project, young writers like John Cheever and Ralph Ellison were put to work gathering and writing first-hand accounts from people living in the Depression era. Through the Federal Arts Project, unemployed actors performed the works of then-unknown playwrights, including Arthur Miller and Tennessee Williams, in theaters rented by the project. The plays often focused on the social themes of the day, including blighted farms and waste of natural resources.

A great deal of this work—scripts, oral histories, theater designs, and books—is available to students and historians in its original form. However, because the material is stored in numerous college and government archives throughout the United States, it is often difficult to get at.

Using NeXT technology, John O'Connor, associate professor of English at George Mason University (GMU), is creating an interactive multimedia library of WPA arts projects called, "Government-sponsored Arts and the New Deal." The library will also include commentary on a variety of issues, including government-sponsored art, the role of art in society, and the dynamic between art and documentary. The library will be used by GMU's theater, literature, and American studies classes.

"This is a way for students to explore material without having to seek out the actual physical artifacts," says O'Connor. "Students might want to explore material on the Machine Age, for example. Using a NeXT computer, they'll be able to review images of works on the production line as well as oral history statements from the workers. This is a way for students to work through the images and oral history together."

O'Connor is currently scanning images and text using OCR software into his NeXTcube.™ Using MediaStation, he is setting up a series of archives, arranged by subject. With the instructional design application Knowledge Tool, he plans to set up interactive tutorials on the material. In one instance, O'Connor might have students review information on government control in the arts. He will then ask students to work on a tutorial that compares issues in the arts during the Depression era with the recent NEA controversy. Students might then be required to write a paper comparing and contrasting the activities in the 1930s with those of the current era. O'Connor says he plans to have several tutorials completed by the summer of 1992 for use with students in the fall.

"The NeXT machine has been very easy for me to use," he says. "MediaStation, has the capability to combine CD-quality sound, photographic quality images, and text, making it a terrific tool for this project. It's made it much simpler for me to connect the various materials."

He continues, "I started this project with an MS-DOS machine last summer, but it was so clumsy to use. I kept getting more and more frustrated and eventually just stopped pursuing the project,

until I got a NeXT machine. NeXT is so much more flexible than either the DOS or the Macintosh machine."

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HISTORY

GEO: Teaching Historical Geography

y

n their introductory Western Legacy courses, the history faculty at St. Mary's College of Maryland was faced with teaching freshman students—most of whom had limited geography skills—the role geography played in shaping the legacy of the Western Hemisphere.

According to Associate Professor of History Sam Lambroza, "Students didn't understand the fundamental principles of latitude and longitude and didn't have the skills to read a map. Many lacked knowledge both about site locations and about spatial relationships. They couldn't tell us the location of the International Date Line nor could they tell us if Moscow is further north than New York."

To get students up to speed, faculty incorporated wall maps and overhead projections into class lectures and discussions. They assigned map-reading projects and outside reading on historical geography. With a high student-faculty ratio for the course, however, faculty were limited in the amount of individual attention they could give to students—and consequently students still had a tough time making connections between geography and history.

"The problem we faced was how to teach basic geography skills to such a large group of students and have them apply this knowledge to history," explains Lambroza.

Lambroza thought a possible solution was to incorporate a software tutorial into the Western Legacy curriculum. Unfortunately, the software on the market was not customizable and either had little pedagogical value or was too simple or too complex for the department's purposes. In short, the department was unable to find a package that met its needs. Convinced that a software tutorial would be the most effective means to help students, Lambroza, along with Sunil Punnoose, director of academic computing, decided to design their own application for the curriculum. After evaluating several platforms, They decided to create the application using NeXTSTEP.

"NeXT has an easy-to-use graphical user interface, exceptionally good software development tools, and multimedia capabilities," says Punnoose. "The object-oriented environment offers us the opportunity to share classes and objects with developers from other schools, thereby significantly reducing development time for future modules."

By the fall of 1991, Lambroza and Punnoose had created GEO: Teaching Historical Geography, a multi-module program for the traditional Western Legacy course. Now, the 300 students enrolled in Western Legacy each semester can log onto a NeXT machine in St. Mary's public access lab and, at their own pace, complete the modules available on GEO.

"With its multitasking environment and graphical interface, a NeXT machine running GEO provides an effective way for students to become

GEO, an application for learning about historical geography, is a multimedia custom application created with the NeXTSTEP development environment.

comfortable with basic concepts of geography very quickly," says Lambroza.

The introductory module of GEO uses text, graphics, and animation to teach students the structure and logic of latitude and longitude, as well as the difference between globes, projections, and site location. As students read through the interactive program, they are asked to complete a variety of tasks to enhance their knowledge of geography. For example, they learn how to construct a latitude and longitude grid and how to read map coordinates. Students are also encouraged to print out the module and bring it to class so instructors can refer to the GEO assignments in their lectures.

A second module incorporates text, audio, map graphics, and photographs to help students understand the rise of Naziism and the geography of the Holocaust. As students read through the narrative, they select maps and photos that help them better understand the spread of Naziism.

"The maps and photos give students a much deeper understanding of how Germany was able to invade and occupy most of Western and Eastern Europe," says Lambroza. "The program also helps them visualize the tremendous efforts expended by the Nazis in transporting Jews and other victims to ghettos and concentration camps."

By summer 1993, Lambroza hopes to have a set of six modules available for both the first semester and second semester Western Legacy courses. In the first semester, students will have the opportunity to work on modules that show the rise and fall of the Roman Empire, the travels of Marco Polo, and the spread of Islam from Spain to India. In the second semester, students will learn about the colonization of the Americas and the geo-political aspects of the Cold War.

"In developing future modules, says Lambroza, "we intend to fully utilize the capabilities of NeXT's state-of-the-art multimedia workstations for audio and video segments, animated graphics, and photos of artifacts and works of art. The modules would be very difficult to create in such an advanced form if it wasn't for NeXT's object-oriented programming capabilities."

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INFORMATION ACCESS

Archie—the server's server

McGill University

The Internet is a collection of more than 750,000 computers at universities and research institutions around the world. Many of these sites are information servers that offer mailing list managers, bulletin boards, and even expert systems for technical assistance. More than 1,000 are archive servers—sites that make files available to other users of the Internet. These archives offer software, technical reports, research papers, mailing list archives, and archives of many Usenet news groups. With the Internet growing 100 percent a year, the biggest problem facing its 3 million users is "wading through the mounds of files available to track down what they want," according to Peter Deutsch, manager of the UNIX Support Group at McGill University in Montreal, Canada.

To simplify locating files on the Internet, Deutsch leads a group of volunteers who have developed and manage an archive-server indexing system called Archie, a "server server" that lists, tracks, and updates the 2 million-plus files of information at 1,000 anonymous FTP archive sites. These FTP sites offer software, data, and other information that can be copied and used without charge by anyone on the Internet. (Deutsch says Archie currently receives 50,000 inquires per day—a 500-fold increase over last year.) Archie lets users search for specific program names or strings and find which server contains the program, or list all the software on the server at a particular site.

Archie also permits access to the "whatis" description database that includes names and synopses of more than 3,500 public domain software packages, datasets, and informational documents located on the Internet. Deutsch says, in the future, Archie will provide the names and locations of online library catalog programs, publicly accessible electronic mailing lists, and a compilation of frequently asked questions.

The Archie server code runs on UNIX workstations, including Sun and IBM RISC 6000 machines. However, NeXT user Scott Stark, a University of Delaware graduate student in chemical engineering, has developed a NeXTSTEP user interface so he and his fellow NeXT computer users can also access Archie.

Says Stark, "I like the look, feel, and usability of NeXT's object-oriented programming environment. NeXT pro-

vides a ready set of interface objects, including windows and scrollers, and it's easy to modify and change the function of objects. It took me only two weeks to create the original version of the Archie interface on the NeXT, and it's easy to continue to upgrade it."

Stark, who has also created applications in the X-Windows environment, says, "What's different about X-Windows is that you need a lot of expertise with the library before you can create anything. To create an object in X-Windows is a tremendous amount of work. Even though I've used X-Windows quite a bit, I wouldn't feel comfortable creating an object in that environment. But I found it very easy with NeXTSTEP. Also, NeXT's Interface Builder made it simple to construct an interface, so I was able to focus much more attention on the function of the program. With X-Windows, you have to work with text files to build the interface, which is very difficult."

Eventually, Deutsch hopes to also use Archie as part of a larger electronic publishing service. He says college faculty have already begun to make their research papers available on the Internet. During the coming year, he plans to create a series of additional archive indexes that he'll segment into a variety of academic disciplines, including history, philosophy, and mathematics. Via this method, an Archie user who wants to obtain information on the War of 1812, for example, could turn to the history archive index. Deutsch also hopes to provide a list of abstracts of all the papers available on Archie.

Archie is currently offered as a network resource by 13 sites in countries including the United States (Maryland), Finland, Australia, England, New Zealand, Israel, Japan, and Canada, its original home.

To use Archie, NeXT computer users can telnet to quiche.cs.mcgill.ca (132.206.2.3) and log in as archie. Users can also find additional information on the Archie anonymous FTP archive. To access this information, FTP to the host archie.mcgill.ca (132.206.2.3) and log in as anonymous. (Use your e-mail address as a password.)

Among other available items are Stark's NeXTSTEP Archie client (in the subdirectory archie/clients) and a collection of papers describing Archie and how to use it (in the subdirectory archie/pub).

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MATHEMATICS

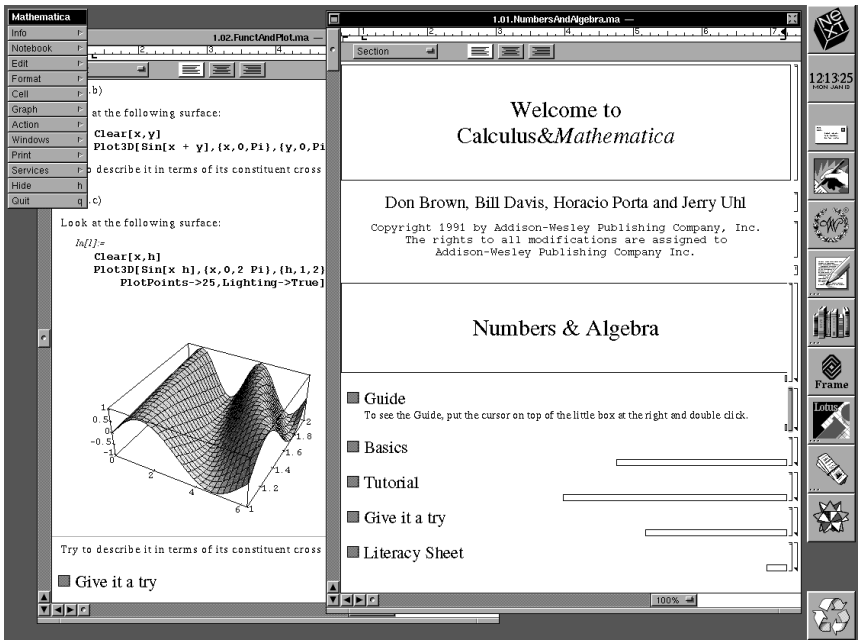
'What does this have to do with a student learning calculus?'

Ohio State University

That's the question three mathematics professors—William Davis of Ohio State University and Horatio Porta and Jerry Uhl of the University of Illinois—repeatedly found themselves asking one another as they created Calculus &*Mathematica*, an innovative calculus-learning device.

"From the beginning," says Davis, "the project has been primarily concerned with the teaching of calculus. All content and design decisions were based on that one fundamental question."

Originated by Porta and Uhl at the University of Illinois, the Calculus&-



Calculus&Mathematica is a one-year course taught in a lab setting. Lessons are in 60 Mathematica Notebooks that students complete at a rate of 2 per week.

Mathematica project is supported by the National Science Foundation at both the University of Illinois and Ohio State University. Currently, calculus instructors at more than 20 institutions use Calculus&*Mathematica*. Half the schools use the application on the NeXT platform— including Ohio State, which has a 40 NeXTstation *Mathematica* lab.

"We chose NeXT computers for our lab for several reasons," explains Davis, "primarily the value-per-dollar of the machine. All the features we needed for our lab situation come with the NeXT. The critical software—*Mathematica*—is bundled along with TEX and NeXTmail. Networking that is built in and easy to use and maintain is also essential for a learning lab. NeXT includes the physical Ethernet connections as well as NetInfo, NFS®, and TCP/IP for file and traffic management. In addition, we are quite pleased with NeXT's friendly user interface, easy networking, true multitasking, and virtual memory."

Calculus&*Mathematica* is presented through 40 *Mathematica* Notebooks that students complete at a rate of about one a week. Each Notebook is divided into three sections—Basics, Tutorials and Give It a Try. Basics and Tutorials provide completed exercises that illustrate the principles students will learn about in Give It a Try. According to Davis, the Give It a Try problems, which allow students to discover and then apply the basic principles of calculus, are the "centerpiece" of the course.

"Everything is there in Give It a Try," he says, "the experiences introducing ideas and topics, the challenges to intellect and patience, the excitement of beating the course and solving a very difficult problem. There is no more rote manipulation in this class. Problems are open-ended. Students no longer simply memorize a formula and then plug it in to solve a particular equation.They play, conjecture, test, conjecture, play more, and almost always come to the correct conclusion."

Davis teaches Calculus&*Mathematica* completely as a lab course—there are no lectures although the instructor typically devotes 10 minutes of class to answering student questions. Students are then assigned lessons and exercises and spend class time and one to two hours after each class working on a Notebook. During the class session, Davis walks from student to student answering any individual questions they may have.

Adds Davis, "With NeXT, we're finally able to tell students that all of their work will be preserved on our network. Other platforms provide irritating features that make it mandatory that students carry their own work with them on floppy disks. Inevitably, the floppy disks fail, students forget to save their work to their disks as they leave the lab, they forget to bring their disks to class, and so forth. With the NeXT, students receive their lessons from the lab's server and turn in homework via NeXTmail. Now, faculty can grade assignments while sitting at remote machines with the lab's server mounted. That was not possible in our previous labs."

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MATHEMATICS

NeXTSTEP brings calculus to life with Mathematica

University of Missouri, Columbia

These days, Professor Elias Saab's Calculus II class at the University of Missouri, Columbia, seems more like a think tank for experienced mathematicians than a lower-division college course. During a recent class, 25 students learned about Fourier Analysis, used series expansion techniques to solve differential equations, and solved a system of 24 simultaneous equations—problems typically reserved for their upper-division classmates.

When Saab pops into the computer lab, most evenings he finds a group of his Calc II students hovered around NeXT computers interpreting the results of their homework problems. "Students are actually discussing calculus theory with one another," says Saab. "Thanks to the computer, undergraduate students are talking to one another about mathematics, and they have a greater understanding of what calculus is all about."

To concentrate more heavily on calculus theory and less on technique, Saab decided last year to teach Calculus II as a NeXT computer-based course. Saab replaced his traditional textbook with Calculus&*Mathematica*, an innovative curriculum developed at the University of Illinois. Students now solve all homework problems and submit all assignments to Saab via e-mail, something he never thought he'd be doing.

Saab says he opted to teach on NeXT machines for several reasons: "The biggest plus is that the NeXT machine comes equipped with *Mathematica* at no extra cost. The speed of the machine is also an important factor. Other platforms, running at the speed of NeXT, would have been much more expensive and would have lacked a good user interface for students. NeXT is an easy machine to learn because of its user interface; students grasp it quickly."

Saab adds that because NeXT machines can easily compute solutions for a variety of calculus problems, his students can dedicate more time to learning about calculus concepts than students enrolled in traditional mathematics courses. "It is no longer necessary for me to go into lengthy detail about the technique of integration because the computer can compute such problems faster and more accurately than students can by hand. Instead, we have time to emphasize the theory."

Saab also spends a good deal of class time focusing on practical—albeit complicated—applications of calculus theory. "There is a lot more opportunity for students to solve interesting problems that pertain to real-life situations. I wanted to get away from textbook examples, most of which are dead examples. Examples on the computer are alive. One can change them over and over to develop an infinite number or examples. Students now solve problems with 100 unknowns. They can't do that using the tables in a textbook, but they can do it with a NeXT machine running *Mathematica*."

Saab says the computer-based course is initially "more work" for the students, but that their effort is paying off. To test current students' knowledge against former students, Saab gave one pencil-and-paper test during the semester. In past semesters, students earned an average score of 65 percent on the test while this class averaged 80 percent.

The winter of 1992, Nakhle Asmar, an assistant professor of mathematics at Missouri, also tried *Mathematica* and NeXT machines in his Applied Analysis course. Although his students still solved problems with pencil and paper, he held several computer-lab sessions during which he solved partial differential equations, for example, using *Mathematica* on a NeXT machine.

"I was skeptical at first about using computers to teach the class," Asmar says. "That's why I didn't have the students use *Mathematica* to solve equations. But in the end, I was amazed at what *Mathematica* could do in terms of graphing and how quickly equations could be solved. Consequently, I've decided to incorporate NeXT computers and *Mathematica* into the class next fall."

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MEDICINE

Creating the clinician's workstation for better decision making

University of Minnesota Medical School

Hospitals are data-rich environments. Doctors can turn to numerous sources to determine a patient's diagnosis and treatment. Unfortunately, this information is typically spread across many areas of the hospital and arrives in bits and pieces throughout a patient's stay. That makes it difficult to access data quickly or to review key data that might be buried in a flood of paper.

"Forced to make speedy decisions, doctors often find themselves relying heavily on the vagaries of memory, making decisions with less than all the available and relevant data," says Donald Connelly, M.D., associate professor of laboratory medicine and pathology.

Recently, though, Connelly and other medical information scientists in the Department of Laboratory Medicine and Pathology at the University of Minnesota Medical School have begun to develop a method for doctors to obtain more quickly the objective information they need, as well as feedback that encourages student physicians to follow practices that are recommended by the medical staff. With funding from the National Institutes of Health and the University of Minnesota Hospital and Clinic, a team of medical informatics researchers, physicians, nurses, and laboratorians are creating a NeXT computer-based clinicians' workstation to provide doctors and nurses with ready access to a variety of information—in this case, pertaining to transfusion medicine and clinical laboratory test results.

"Our intent is to provide our clinicians easy access to laboratory results in a form that makes the data easy to review and use," says Connelly. "We then hope to improve transfusion medicine practices at our hospital."

The workstation is connected to the hospital's laboratory information sys-

tem and automatically receives and stores results as soon as they are completed in the laboratory. Physicians can review a patient's status at a glance and order platelet transfusions and other laboratory tests for patients with hematological disorders. The workstation then gives instant feedback on the appropriateness of the order, based on clinical guidelines developed by the local medical staff. These guidelines have been incorporated into the knowledge base of the workstation's expert system, ESPRE (Expert System for Platelet Request Evaluation).

According to co-investigator Bruce Sielaff, Ph.D., "As with many expert systems, ESPRE was originally developed in LISP. The flexibility of the LISP environment greatly simplifies the incremental development characteristic of expert systems. On the other hand, to simplify integration of the expert system into the clinical workstation application, when the design stabilized, ESPRE was rewritten in Objective C. The object-oriented environment allowed the conversion to be relatively painless."

After analyzing the situation, ESPRE indicates which laboratory-based criteria for transfusion have been met. If no laboratory-based criteria seem to be satisfied, the expert system asks for additional clinical information that might satisfy other criteria for transfusion. Since guidelines cannot cover all possible clinical situations, physicians can also type in a reason why transfusion might be necessary.

Connelly says the development team has relied extensively on NeXT's Interface Builder in working with physicians, laboratorians, and nurses to develop the application. "Interface Builder has been very valuable in working with clinicians," he says. "We bring our workstation prototype to introductory meetings with our clinicians. Within 20 minutes we can cover the basic concepts underlying the project and be actively working on critiquing and improving the prototype. It's much easier for busy clinicians to consider and critique a model of the workstation than having to wade through a long list of technical specifications."

He continues, "We wouldn't be able to complete the workstation in time if we were working in any other development environment. We'd have to do everything on paper first; get people to sign off on specifications; and then, six months later, come back hoping we had created what was asked for, as well as hoping they asked for what they needed."

Connelly says, "The modern hospital environment is too complex and dynamic for conventional development approaches." He adds that because of the flexibility of the NeXT platform, the development team has incorporated a comments button so clinical users can easily send developers suggestions for improvement.

This summer, the workstation will be implemented in four patient-care units at the University of Minnesota Hospital. A crossover trial will be conducted to determine the effect of feedback on interns' knowledge of transfusion medicine principles and on platelet transfusion practice. The acceptability of the workstation to clinicians will also be assessed.

Connelly adds that the application is not limited to use in transfusion medicine, but can be adapted to other areas of medicine as well. "We have already expanded it to ordering and scheduling laboratory tests that are part of bone marrow transplantation research protocols," he says. "This is the beauty of working on the NeXT machine. We develop building blocks in a short amount of time and can then use them for other projects. Interface Builder has been a real lever for us. If we had been working on any other system, I'm sure we'd still be specifying functions and worrying how we were going to implement them. Instead, we are concentrating on how we can help our clinical colleagues do their very important tasks better and easier."

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MUSIC

Learning sound synthesis with the help of NeXTSTEP

Skidmore College

Using NeXT's Interface Builder and Music Kit, Associate Professor of Music Anthony Holland and several students at Skidmore College have developed two software applications—Audio Challenger and Bessie—to help train students in electronic music and sound theory.

"With NeXT, we have everything we need to create music software applications," says Holland. "There wasn't a need to purchase any additional hardware. With the DSP chip and Music Kit that comes with the NeXT, our user

base has a known minimum level of hardware that's all the same. With any other system, we'd have to put together a mix of hardware and software from several different vendors to achieve what we have on the NeXT. It's the first time applications could be written so easily for musicians.

"Interface Builder and Music Kit are very powerful tools. They provide a programming shortcut. We don't have to build programs from scratch. We can just build and connect objects someone else wrote and modify them to suit our needs. Everything works so much faster."

Audio Challenger is an ear-training application for music students. The software randomly generates 14 ascending and descending melodic musical intervals. Students use them to improve their ability to identify musical intervals, by clicking on a button on the screen to guess a new interval or repeat a particular interval. To practice a specific interval, students just click that interval in a list provided by Audio Challenger.

"It can take students anywhere from two months to two years to become proficient at identifying the distance between notes," says Holland. "The advantage of using a computer—instead of having a person play the notes on an instrument—is that there is no end to the patience of a computer. Students can try the exercises over and over again."

About creating the application on the NeXT platform, Holland says, "Audio Challenger features real-time synthesis on the DSP chip of the NeXT. That gives it the advantage of a more natural and lively musical timbre than ear-training programs that currently exist on the Macintosh or PC platforms. Plus, the Macs and PCs aren't multitasking. These exercises can get pretty tedious for students. So on the NeXT, they can take a break and work on other applications while Audio Challenger is still running or even read their mail while they're practicing with Audio Challenger."

To overcome the problems of learning sound synthesis with conventional electronic keyboards, Holland has also created an interactive tutorial for teaching the basics of sound creation using frequency modulation (FM) synthesis. The application, funded in part by the Keck Foundation, is called Bessie.

The tutorial provides historical background, an explanation of FM, and a glossary of terms. Users also conduct experiments with various parameters involved in FM synthesis and then hear the results in real time. For example, in one exercise, students re-create how noted electronic music expert John Chowning discovered FM synthesis. Bessie also provides information detailing the value of this discovery.

MARS (Modal Acoustic Analysis for Recording Studios) is currently being developed by Holland and Skidmore music student Robert Hoffman. When completed, the application will perform an acoustical analysis of a recording studio, pointing out any possible problems and then making recommendations on how to correct the problem areas. MARS will run through 66 different calculations of possible problems for a studio to help prevent inaccurate recording or mix-down.

Concludes Holland, "NeXT has brought programming tools to a level that makes them accessible for amateur programmers who are professionals in other fields, to create useful programs. I have a long list of music education programs I plan to produce on the NeXT."

Audio Challenger and Bessie are available via anonymous FTP from nova.cc.purdue.edu in /pub/next/2.0-release/binaries.

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PHILOSOPHY

Tarski's World supports leaning of first-order logic

Stanford University

First-order logic—the symbolic language at the core of modern logic—has become a requisite tool for studying a variety of disciplines, including philosophy, computer science, linguistics, and mathematics. In teaching first-order logic to students, Stanford University Associate Professor of Philosophy and Symbolic Systems John Etchemendy invariably encountered two problems.

"One," he says, "had to do with getting students to understand the central semantical ideas of first-order logic. The way these ideas are usually presented in textbooks makes them so abstract that students have a hard time understanding the point."

The other problem involved devising an efficient method for helping students who are having trouble expressing themselves in the first-order language. "That kind of help is difficult to give," says Etchemendy. "For example, when you give translation exercises, there is no single right answer: anything logically equivalent to a right answer is also a right answer. So someone has to read

the answers carefully and try to see if they are logically equivalent to the right answer—an undecidable question, of course."

Although several computer-based tutorials on first-order logic were available to supplement class work, most focused primarily on syntactic concepts while, according to Etchemendy, "The main lesson of the last 50 years of research in logic has been that semantics are by far the most fundamental concepts to consider."

To help students master the semantic side of logic, Etchemendy and Indiana University Professor of Mathematics Jon Barwise developed a computer-based application called Tarski's World, named after a pioneer in the semantic approach to logic, Alfred Tarski. "Tarski's World makes the learning of the basic ideas of first-order logic more interesting, fun, and efficient than any other method we've found," says Etchemendy. "The application helps make the concepts concrete and understandable for students."

Etchemendy and Barwise developed the application on Macintosh, MS-DOS, and NeXT platforms, but Etchemendy says, "The NeXT version was much easier to develop than the other two. With Interface Builder and all the other development apps in the NeXTSTEP environment, developing with NeXTSTEP was a dream come true—it took me no time to create the application. We worked more efficiently than we could have on any other machine. NeXT is just wonderful compared to the Macintosh—and the Mac is great compared to Windows. The app took forever to finish on Windows.

"I also think that students can work more efficiently on the NeXT," he adds. "Because of the machine's large monitor and multitasking environment, students are able to work with multiple windows of the application at the same time."

In Tarski's World, students build three-dimensional worlds inhabited by various geometric figures and then test sentences of first-order logic to determine whether they are true or false in these worlds. In one exercise, for example, students are given a series of sentences and asked to build a single world in which all the sentences given are true. Students are also assigned exercises on multiple quantifiers and their interaction with negation.

One of the main features of Tarski's World is its use of games to help students understand the concepts of first-order logic. Students might be asked, for example, to evaluate sentences in a constructed world. If their evaluations are incorrect, the applications provides them with a game that helps them understand where they went wrong.

"Tarski's World opens up many ways to teach what first-order sentences mean," says Etchemendy. "With Tarski's World, we're not limited to the abstract task of translating back and forth from English: we can directly describe worlds, use the language to identify objects and construct worlds satisfying a description."

In his introductory courses, Etchemendy uses exercises from Tarski's World in the classroom as well as for homework assignments. He frequently assigns additional exercises to students in the course who are having a difficult time with the first-order language. He also uses Tarski's World in his advanced logic courses to assist students who have yet to master first-order logic.

"Rather than let these students flounder, we wanted a tool that we could simply hand them and let them work through on their own. Tarski's World serves this function remarkably well."

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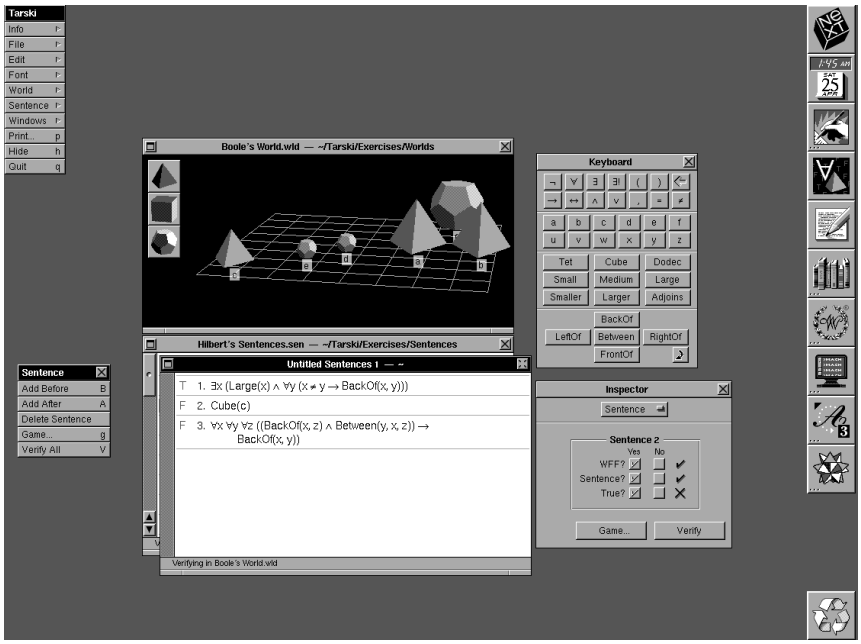


With Tarski's World, students construct block worlds and write sentences of first-order logic to express relations among blocks. A set of exercises is included with the program.

PHYSICS

Physics faculty create and share custom physics courseware

Davidson College

Davidson College, a small North Carolina liberal arts school, has no computer science faculty and offers no computer science major. Yet, many of the school's physics students decide to pursue careers in computer science.

To address this situation and provide students with the thorough grounding in mathematics required for upper-division science courses, the Physics Department purchased a cluster of IBM PCs in 1985 and began integrating computer-based instruction into its curriculum. A year ago, though, the faculty concluded that faster, more powerful machines were needed in their upper-division curriculum. After evaluating several workstation platforms, the faculty decided to establish a cluster of NeXT workstations.

In 1991, with funding from the Keck Foundation, the National Science Foundation, and Davidson College, the department founded the Davidson Center for Scientific Computation, a high-level computational facility containing 11 NeXTstations, used for advanced courses as well as faculty workshops and student research projects.

When the machines' arrived in the spring of 1991, within a week faculty and students began experimenting with NeXTSTEP and the Objective C language. In the classroom, many faculty members now use customized physics applications developed by Allegheny College (Meadville, PA), the Rose-Hulman Institute (Terre Haute, IN), and other institutions.

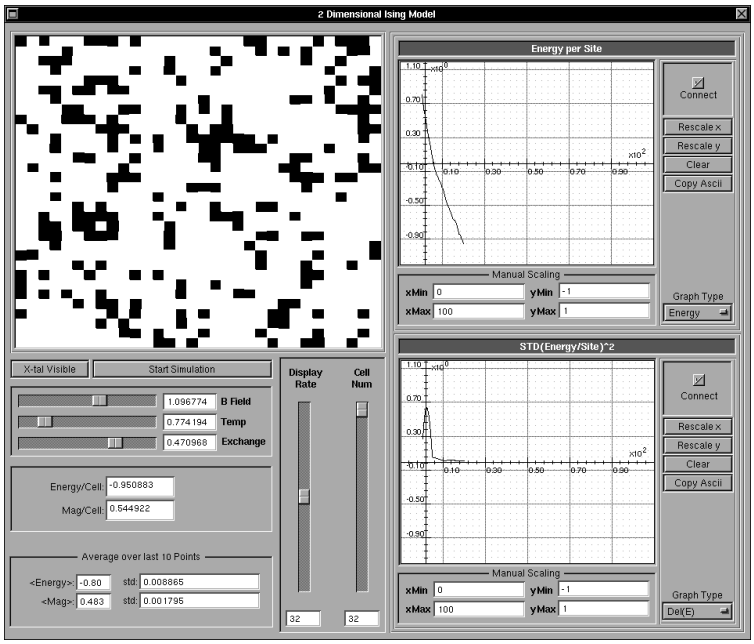
According to Associate Professor Wolfgang Christian, "NeXT computers are easy to install and are the machines best-suited for a department of computer nonspecialists. We don't have a computer science faculty or a technical staff, so we need workstations that are easy to configure and maintain. The inclusion of *Mathematica* and the availability of the standard campus word processor—WordPerfect—were also positive factors.

"Students now have the ability to cut and paste *Mathematica* graphics directly into a word processing environment," Christian says. "Their lab write-ups are neater and more clearly written since they incorporate data, equipment schematics, and the results of mathematical simulation."

Although faculty members had originally decided against creating their own customized applications on the NeXT, Christian says that "the power of Interface Builder and NeXTSTEP convinced us that a modest amount of effort could produce very effective and professional educational software. And what we create on our campus we can share with other campuses, as so many institutions now do with their custom-developed NeXT software."

This winter, Christian created a two-dimensional Ising model while a student developed a series of laser spectroscopy simulations as part of his senior thesis project.

Davidson faculty also worked with the NSF to sponsor a conference on "Computational Physics in the Undergraduate Curriculum" at the school in the fall of 1991. The meeting explored a variety of developments in computational physics, including symbolic computation, visualization, and object-oriented programming. During the conference, several attendees presented papers on physics applications they had developed on the NeXT platform. Jim Feagin, on the physics faculty at California State University, Fullerton, also led a *Mathematica* workshop, using 18



Ising Model predicts magetization effects in two-dimensional crystal lattice. Individual atoms interact through their spins thereby ordering the system as the temperature is

NeXT machines.

"After almost one year of working with the NeXT machines, we're more than pleased with the results," says Christian. "We would buy exactly the same hardware and software again if we had our money back in the bank. That NeXTSTEP is not outdated a year after we purchased the machines says a lot about how advanced the software is. Other vendors have yet to catch up with NeXT technology."

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PHYSICS

STUDENTS MASTER PHYSICS CONCEPTS WITH NeXT AND MATHEMATICA

Duke University

"Until NeXT and *Mathematica* came along, many students never thought of physics as fun," says Richard Palmer, professor of physics at Duke University. "With NeXT machines, they're having a very positive learning experience."

Since the fall of 1991, Palmer and other members of Duke's Physics Department have been implementing NeXT technology and *Mathematica* in more than 10 courses, including Introduction to Quantum Mechanics, Thermal Physics, Modern Physics, and Solid-State Physics. Students use NeXT workstations in Duke's *Mathematica* Lab for Physics to complete homework assignments, work on research projects, and review class materials.

"We're all impressed by NeXT's ease of use and its graphical interface," says Palmer. "I just give students a handout about the machine and an account on the network, and they learn how to use the machine themselves. We couldn't do that in an X-Windows environment."

For his Mathematical Methods in Physical Sciences II course, Palmer has developed a series of Mathematica Notebooks on complex algebra, elementary functions of a complex variable, Legendre functions, and Bessel functions. The Notebooks include text, figures, and exercises. Each semester, Palmer prepares six to eight Notebook assignments and announces their availability to students via e-mail.

Although Palmer prepares Notebooks for students to work through, he notes that other instructors prefer to present students with general instructions for an assignment and then have them translate the information into the *Mathematica* Notebook format themselves. In some classes—Quantum Mechanics, for example—students are asked to write their own Notebooks—the best of which are used by faculty in future classes.

"Pedagogically, NeXT works wonderfully," Palmer says. "Students are mastering concepts much better with *Mathematica* because they're able to play with hundreds of variations of the equations we give them. Right away, on the computer, they can tell if their solution works or not. Plus we're able to give them more realistic problems. Before, we were faced with finding problems that were simple enough to solve on the blackboard."

He concludes, "NeXT is without comparison in terms of price and performance. Because the machines come with bundled software, we were able to set up our lab at a reasonably low cost. Macintosh is the only other platform available that runs *Mathematica* Notebooks, but it just doesn't have the performance features of the NeXT."

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