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Apple University Arts

Profile:
UCLA's Project Appleseed
(supercomputing for the rest of us).

UCLA

Project Appleseed

A UCLA physics lab uses a Power Macintosh cluster to run parallel processing supercomputer software.

Plasma physics requires some serious number-crunching power, and UCLA's Dr. Viktor K. Decyk, an expert in applying parallel computing to physics research, regularly uses some of the country's biggest supercomputers to simulate the interactions of millions of particles in fusion energy devices. But access to supercomputer time is hard to get, so Dr. Decyk and a couple of colleagues created their own parallel processing "supercomputer"—using a cluster of Power Macintosh G3 computers, some commercial networking hardware, and some software they designed themselves.

"In the past, we always did our numerically intensive computing on large computers," says Dr. Decyk. "But suddenly, the Mac has become much more powerful and useful for numerically intensive computing." Power Macintosh computers are high-performance machines, but enabling them to run software designed for the parallel processing architecture of a supercomputer relied on some work done by Dr. Decyk; Dean Dauger, a UCLA physics graduate student; and Pieter Kokelaar, a UCLA programmer analyst. The team developed Project Appleseed, a way to transform a Power Macintosh cluster into a cost-effective and convenient parallel processing system.

The keystone for Project Appleseed is MacMPI, a Macintosh version of the Message-Passing Interface (MPI) library—a standard programming interface for parallel computing. MPI lets a user easily port applications, without modification, from parallel processing supercomputers to Macintosh clusters. Using his expertise in parallel processing, Dr. Decyk wrote MacMPI for the Mac OS using Absoft's Fortran 77 compiler, while Dean Dauger supplied substantial Mac programming experience. Pieter Kokelaar provided networking and hardware expertise to put the cluster together. The result: a cluster of eight Power Macintosh computers, linked with a Fast Ethernet hub, that lets Dr. Decyk and his team run many calculations in-house, at their own convenience, on Power Macintosh hardware they already use for data analysis and presentation.

Just how fast is the Power Macintosh cluster? The team found that a four-node cluster (four Power Macintosh computers linked with Ethernet and the MacMPI software) delivers performance comparable to a Cray Y-MP, a state-of-the-art supercomputer just eight years ago. "It was astonishing to us that calculations which required a $20 million machine eight years ago can be done on a Mac cluster costing about $11,000," says Dauger. "We believe the Macintosh platform has a price/performance ratio worth considering." Dr. Decyk adds, "This shows just how far personal

Strength in Numbers
Software and networking hardware can turn a cluster of Power Macintosh computers into a parallel processing system for numerically intensive applications.

Atom in a Box: A Dean Dauger Creation www.physics.ucla.edu/~dauger

Dean Dauger, a graduate student in physics at UCLA, helped write the software that turned UCLA's cluster of Power Macintosh G3 computers into a supercomputer, and he's an old hand at Macintosh programming. While still an undergraduate, he helped program Kai's Power Tools, a set of image processing and image generation filters for Adobe Photoshop.

More recently, he has turned his programming talents to educational software, such as "Atom in a Box," an award-winning shareware application (available at www.physics.ucla.edu/~dauger). Atom in a Box provides real-time visualization of quantum mechanical atomic orbitals for hydrogen atoms (it makes a nice screen saver, too). The "clouds" in the image represent the shape of the orbital—the probability distribution of an electron bound to a hydrogen nucleus—while providing a flexible user interface.

The program does more than just visualize, however; it lets users "interact" with hydrogen atom orbitals. Users can click and drag the visual representation to rotate the orbital, or raise and lower the energy state or angular momentum, and see the effect on the atomic cloud. (They can even see the orbitals in 3D: By selecting the 3D Red/Cyan mode from the View Type menu and using a pair of 3D glasses, users see the orbital image appear to float in three-dimensional space in front of the monitor.)

Atom in a Box, which Dauger wrote in C/C++ using Metrowerks' CodeWarrior software, recently earned him the student prize in the

Online Time Cards

A New Way to "Punch In" at Cornell

Internet Ready?
At Cornell, the task of inputting and processing hours worked is done over the Internet with a Java application.

Of the approximately 23,000 employees of Cornell University in Ithaca, New York, 10,000 or so are paid by the hour, including full-time, part-time, and student employees. Most of the steps required to cut those checks have traditionally been done by hand: filling out time cards, calculating total hours worked, and getting a supervisor's approval. The payroll process at Cornell was labor intensive, paper heavy, and time consuming—until the Ivy League school created COLTS (Cornell On-Line TimeCards).

COLTS I, deployed last year as a web-enabled application, worked well for the more than 3,000 hourly employees who used it. But according to Mark Mara, Cornell's associate director for administrative systems and distributed technologies, COLTS I wouldn't scale sufficiently to the entire Cornell employee population. "We really wanted an easy-to-use application that could support our Macintosh, Windows, and UNIX users," he says, "and that would be integrated with a new, universitywide PeopleSoft HR payroll/administrative enterprise application being deployed in December 1998. So we built COLTS II as a Java application."

Because the application is written in Java, COLTS II is easily deployable; because it uses CORBA-based middleware, it can be scaled for use by the entire Cornell workforce—more than half of whom are working on the Macintosh platform. COLTS II doesn't require a browser at all, appearing as an icon on the user's desktop, and can be used by any computer with a Java virtual machine, including Mac OS Runtime for Java (MRJ), which is built into the Mac OS. The team at Cornell is eagerly awaiting the release of MRJ 2.1, an enhanced and faster version of the Java virtual machine optimized for the Mac OS.

> The payroll process at Cornell was labor intensive, paper heavy, and time consuming—until the Ivy League school created COLTS (Cornell On-Line TimeCards). COLTS II, written in Java, will extend the project systemwide.

COLTS II also offers tremendous ease of use for workers and their supervisors, according to project leader Kelly Thompson. "COLTS II eliminates paper time cards and automatically and accurately calculates total hours worked," she says. "It enables supervisors and payroll representatives to review and approve time cards online, quickly and efficiently." In one department of 750 workers, the payroll process required two full days for processing; COLTS II reduced that figure to half a day, and delivers more information and a clearer audit trail to everyone who uses the system. COLTS II is linked to an Informix database that interfaces directly with the PeopleSoft application.

"We bit the bullet to go with Java," says Mara, "but we are really pleased with the application as a whole, and with one code base, we expect to see performance improvements over time." And Cornell can continue to benefit from the ease of use and power of the Macintosh platform even as it evolves its mission-critical administrative systems into the future.

Apple Information

Staying in Touch with Apple
We want to hear from you. Let us know how we are doing—and even more important, let us know what you are doing with Apple technology. Send us your story and be featured in a future edition of *Apple University Arts.* E-mail us at **universityarts@apple.com.**

To make it as easy as possible to get the latest news and information about Apple and its products, we've created Apple eNews. It's an electronic newsletter we can send directly to your e-mail address. Just sign up today at **www.apple.com/signmeup.**

You'll find more information on Apple and education at **www.apple.com/education.**

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On the Back Cover
Richard Feynman (1918–1988)
Physicist; born in Far Rockaway, N.Y. Feynman worked on the Manhattan Project at Princeton and Los Alamos, while continuing to pursue his interest in quantum electrodynamics. After joining Cornell University in 1945, he developed pictorial representations of space-time behavioral probabilities of particle interactions, now known as Feynman diagrams. Feynman shared the 1965 Nobel Prize with Schwinger and Tomonaga for fundamental developments in quantum electrodynamics. He applied his dynamism, curiosity, and intuition to linguistics, music, art, and teaching.

Java Applets

Online Research Tool

Cal State's Biology Labs On-Line represents a pioneering approach to instructional software development embracing Java and the Internet.

For the more than 10,000 biology majors in the vast California State University (CSU) system, at least some part of their academic career will take place in the laboratory. But lab resources are scarce and expensive. It's become a substantial challenge for universities to turn lab time into the kind of open-ended investigative and experimental environment that offers the best experience for hands-on scientific learning. CSU is beginning to address that challenge with Biology Labs On-Line, a pioneering approach to instructional software development that embraces Java and the Internet.

Biology Labs On-Line consists of a series of applets, created primarily on Power Macintosh computers using CodeWarrior Java development tools from Metrowerks. These applets provide students with a set of easily deployed virtual laboratories, where they can truly learn by doing, conducting a variety of experiments on evolution and genetics using any computer with an Internet connection and a browser. And the project is a pioneering effort in distributed learning technology.

According to Lou Zweier, program director for CSU's Center for Distributed Learning (CDL), Biology Labs On-Line represents a new approach to instructional software development. "Our focus is on improving learning through technology," he says. "We work with groups of faculty to identify large strategic needs that can be addressed with technology. And the Internet and Java represent an ideal way to distribute software as widely as possible and with as few technological barriers as possible."

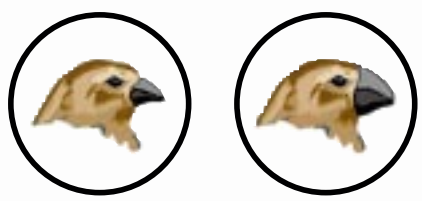
Java applets were also the key to making the experience truly interactive. The Internet by itself offered an excellent static publishing medium, a way of disseminating information, but Java has enabled the development of dynamic teaching tools.

Java is a key element of the Scalable and Sustainable Instructional Software Development Model initiative, developed as part of CSU's overall Integrated Technology Strategy. The mission, according to CSU's web site, "is to create distributed learning environments where students use the World Wide Web, and other relevant technology, to enrich their learning opportunities. . .and make choices that match their individual learning styles." That strategic approach has guided the creation of the Biology Labs On-Line's first applets—and others that will surely follow. CSU plans to have ten applets online by the fall of 1999.

CSU's Biology Labs On-Line: www.cdl.edu

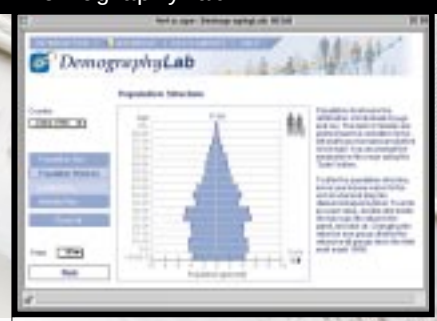
California State University's Center for Distributed Learning has worked with faculty teams to produce online, interactive learning tools in the form of Java applets, developed on Power Macintosh computers and accessible to anyone with an Internet connection and a browser. The first five applets are shown here.

EvolveIT! www.cdl.edu/EvolveIT



EvolveIT!
Allows users to manipulate various parameters (such as variability, heritability, and beak size) of a hypothetical species of bird, as well as parameters of the environment, such as precipitation and island size, then observe the effects of these parameters on the evolution of bird beak morphology over periods of 100, 200, or 300 years.

DemographyLab



DemographyLab
Enables students to examine various populations to investigate how differences in population size, age structure, and age-specific fertility and mortality rates affect human population growth.

In a virtual lab, you don't need test tubes or real-world samples. All you need is a Java-compliant browser and the curiosity to experiment and explore.

Biology Labs On-Line consists of a series of applets that provide students with a set of easily deployed virtual laboratories, where they can truly learn by doing.

The applets were produced by a team of faculty members working with the technologists in the CDL and its partners. From the beginning, the applets were designed to have applicability that went beyond one course, one professor, or one set of students. The technology embeds the science—for example, the FlyLab! applet creates a virtual genetics laboratory, enabling students to design experiments and run them from their own computers and get results in seconds instead of days. It also provides the flexibility that enables professors to tailor the applets to their teaching needs and experiment/homework requirements.

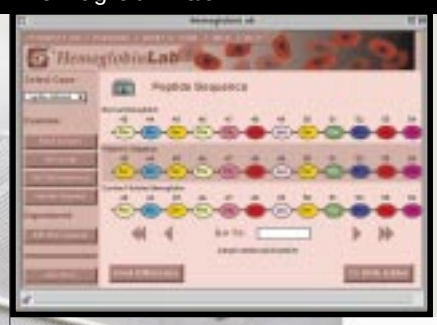
According to CSU/Chico Professor Jeffrey Bell, the biggest benefit of these applets is that they enable students to do experiments, not just learn by "passively absorbing information from the book or lecture." He uses the EvolveIT! applet in his coursework. "The process of planning experiments, analyzing results, and drawing conclusions is one of the most important objectives of a science class," he says. "EvolveIT! allows me to greatly increase the amount of time students are doing these activities. I believe simulations such as EvolveIT! are the real future of higher education."

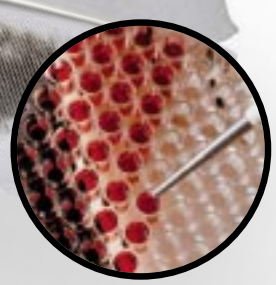
Students can visit the virtual labs whenever they like and conduct as many experiments as they wish. CSU also benefits: Virtual labs don't absorb nearly as much real-world resources and materials. And the fact that they are written in Java, with its inherent promise of "write once, run anywhere," means they are widely and inexpensively deployable and highly extensible. It's easy to modify or enhance a Java applet, and, since they are downloaded in real time whenever they are accessed, students are assured of using the most up-to-date version.

In addition, CDL is using Biology Labs On-Line as a prototype for another way of sustaining instructional software development. In conjunction with a textbook publisher, CDL is planning to turn the applets into commercial products. "By partnering with a publisher, we are working to create a revenue stream that makes it practical to sustain the value of these products over time and to build new ones." The publisher will provide the business expertise—for example, marketing and distribution—that CDL lacks.

As in so many academic settings, the information technology environment at CSU is mixed—another reason for using Java—but there are lots of Macintosh computers, and Zweier's team liked the process of developing on the Power Macintosh. "Creative people are inspired by Macintosh, its elegance and ease of use," Zweier notes. "And they bring these same values to the way they work and the learning products they build. Macintosh allows creative people to focus more of their energy on designing good products and less on maintaining technology. All of this adds up to greater creative freedom, more innovation, and products that better serve the needs of teachers and learners."

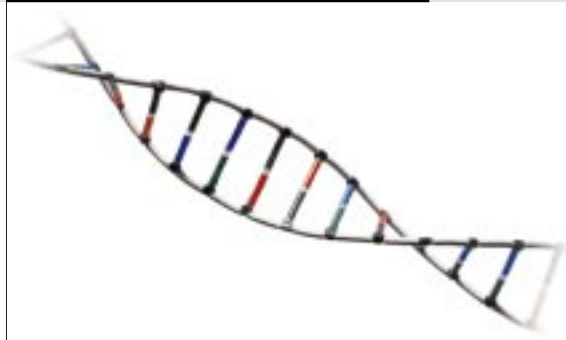
HemoglobinLab





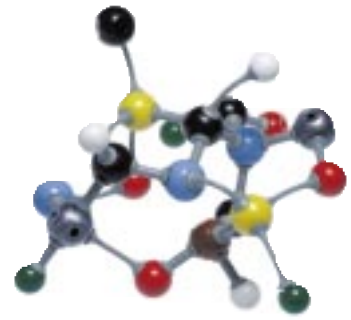
HemoglobinLab
Casts students in the role of genetic researchers as they examine clinical presentations of patient cases, then try to determine the type and location of the genetic mutation in the human hemoglobin chain that causes each disease.

FlyLab! www.cdl.edu/Flylab



FlyLab!
Turns users into virtual research geneticists, helping them learn the principles of genetic inheritance by designing matings between female and male fruit flies carrying one or more genetic mutations. Once the student selects the mutations for the two parent flies and clicks the Mate button, FlyLab! applies the rules of genetic inheritance to "produce" offspring.

TranslateIT! www.cdl.edu/TranslateIT



TranslateIT!
An interactive biology lab in which students create simple RNA sequences and synthesize new proteins using a virtual "in vitro" translation mix. By comparing the sequence of amino acids in the new proteins, students can "crack" the genetic code.

Java and Administrative Applications

Technology, particularly the Internet, is transforming higher education institutions into networked, campuswide enterprises for learning and administration. Working with emerging technologies, creating and managing networks on limited budgets, taking advantage of the Internet as an information-age learning tool, integrating disparate platforms, finding and creating cost-effective, cross-platform educational applications—these are just a few of the challenges and opportunities for educators, administrators, and technology professionals.

More and more institutions are focusing on the goal of platform independence; they are embracing technologies like Java that enable them to "develop once and deploy everywhere." In fact, many of the major administrative computing solution vendors are de-emphasizing future Windows-based native application development efforts and instead are adopting a Java-based technology strategy.

This technological evolution gives Apple a great strategic opportunity on campus, thanks to our strengths in Internet technologies and solutions and visual web development tools. Here are a few examples of how Apple is working to ensure the successful implementation and deployment of Java-based administrative computing applications.

Apple and Oracle

For many colleges, universities, and other organizations, Oracle Corporation's products are the foundation for the deployment of mission-critical enterprise applications. Mac OS Runtime for Java (MRJ) 2.1 is designed to support Oracle Java-based Network Deployed Universal Clients with its Oracle 8 Universal Data Server and Oracle Applications Release 11 technologies. Apple has been working closely with Oracle to certify the Oracle Developer Network Deployment through the use of the Network Computing Architecture (NCA) using MRJ 2.1, scheduled for release in late 1998. We see many opportunities to work together to provide superior enterprisewide and Internet-based computing solutions.

In September, Oracle introduced its new Oracle 8i, the Database for Internet Computing, with support for Java development and deployment using Apple's iMac as a client. With this introduction, Oracle showed renewed enthusiasm for working with Apple, based on the companies' mutual commitment to Internet-centric computing, and demonstrated that applications built with Java-savvy Oracle tools are 100% feature-comparable whether they are deployed on Windows, Macintosh, or any other 100% Pure Java Certified platform.

Apple and SCT Education Systems

Apple's Java engineers are working directly with SCT Education Systems on a Java-based version of the Banner2000 product line for student information, financial aid management, human resources management, financial records, and alumni/development programs. The market leader in higher education application software, with 48% of institutions with enrollments greater than 2,000 choosing SCT software, SCT is dedicated to the continued support of Apple as a hardware option for colleges and universities.

Since Banner2000 is based on Oracle development tools and databases, we expect a smooth path to certification of the Banner2000 Java client once MRJ 2.1 is final.

Apple and PeopleSoft

Apple Worldwide Developer Relations and Java engineers are working with PeopleSoft, a leading provider of enterprise application software, to develop support for PeopleSoft's web client under MRJ 2.1. This important new alliance should lead to substantial benefits for institutions with Macintosh user bases and PeopleSoft enterprise applications.

PeopleSoft delivers solutions that leverage Internet technology to extend application functionality and information to a wide range of users across an enterprise. Java's affordability, open architecture, and ease of use provide an ideal framework for delivering this kind of enterprise solution to the broadest possible user community.

Embracing the Internet: Mac OS 8.5

Apple's Most Web-centric Product Ever

Apple's latest version of the Macintosh operating system, Mac OS 8.5, provides a new level of integration of the Internet and the Macintosh platform as well as new levels of functionality, flexibility, and stability.

Feature Rich

Mac OS 8.5 is:

- Designed for speed. It's faster than Windows NT.
- Fast to install. It offers customizable, one-click installation and configuration; you can even push a system installation over the network to multiple clients simultaneously.
- Simpler and more effective to use. Sherlock makes searching for information—on your hard disk or the Internet—fast and simple. AppleScript makes it easier than ever to automate repetitive tasks. (And these are just two features of Mac OS 8.5.)
- Straightforward to network. The built-in Simple Network Management Protocol makes supporting Macintosh computers on a TCP/IP network easier than ever.
- Integrated with the Internet. Mac OS 8.5 comes with both industry-leading browsers (major plug-ins are already installed), as well as Microsoft Outlook Express.
- Easier to support. The Apple System Profiler application generates a clear picture of any computer on your network, greatly simplifying the job of the network administrator.

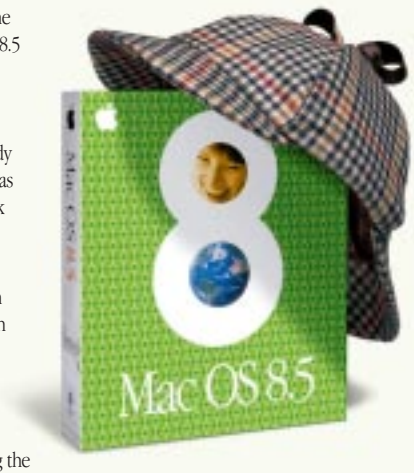
Java Ready

Apple has made a major commitment to Java, the new paradigm in open, platform-independent, web-centric computing that provides a powerful tool for education. Java is the key to creating and distributing educational resources that are low-cost, dynamic, interactive, object-oriented, accessible, and extensible.

Mac OS 8.5 was designed with Java in mind, and meets Sun's 100% Pure Java Initiative. Our Java virtual machine, Mac OS Runtime for Java, along with related plug-ins for the leading browsers, makes Java technology an integral, seamless part of the Macintosh experience. Any Mac user can run Java applets or full-fledged Java applications, created on any platform, within any Java-compliant web browser or on the desktop (using the Apple Applet Runner).

Sherlock
Your personal search detective

With the included QuickTime for Java, MRJ supports Apple's industry-standard, multiplatform, multimedia QuickTime software, which enables Java applications to create, edit, and play movies; capture audio and video; and perform 2D and 3D animations. Apple's Java Development Kit includes the tools and applications required to create your own applets and Java-based applications, such as WebObjects 4, the leading platform for building web applications. And in late 1998, we will ship MRJ 2.1, a superior Java virtual machine that will improve performance, reliability, and compatibility.



Ask Apple

Q: Where can I find the latest release of Mac OS Runtime for Java (MRJ)?

A: Check Apple's Java software page (developer.apple.com/java) for information on Java, Java development, and how to download the latest version of MRJ.

Q: I'm using Netscape Navigator to browse the web, but I'm having trouble running some Java applets. What's going on?

A: Netscape Navigator uses Netscape's own Java virtual machine, even if you've installed Apple's MRJ. We are working with Netscape to deliver a plug-in that will support MRJ within Netscape Navigator/Communicator 5.0.

Q: I want to use Microsoft Internet Explorer with MRJ. How do I do this?

A: Microsoft Internet Explorer supports MRJ as well as Microsoft's own virtual machine. To enable MRJ, choose Preferences in the Edit menu, then select Java (under the Web Browser category) in the Option directory on the left side of the dialog box. In the panel on the right, use the Java Virtual Machine pop-up menu to select Apple MRJ. Then quit Internet Explorer and restart the application to begin using MRJ.

Q: What Java development tools are available for MRJ?

A: A number of robust MRJ development tools are available from leading software publishers, including the following:

- Symantec Visual Café and Symantec Café
- Metrowerks CodeWarrior Professional
- GenieWorks SpotCheck (Syntax Checker)
- Zero G Software InstallAnywhere (Installation Toolkit)

For applet production, consider using any of the following visual design tools:

- PowerProduction Software's WebBurst
- Interactive Media Corporation's ActionLine
- RandomNoise's Coda

Q: How do I make standalone Java applications?

A: With Apple's JBindery tool. The MRJ SDK contains a rich set of features that allow you to exploit the superior user interface and ease of use of the Mac OS. Moreover, JBindery makes it easy to customize your Java application or add Java to your Mac application.

Q: I am interested in incorporating Java applets into my existing curriculum. Are there any applets I can use to get started?

A: In fact, there are over 2,100 applets available at one of the world's largest educational Java repositories—www.eoe.org—a joint effort of Apple and the EOE Foundation. Java applets in the library are catalogued by academic discipline, and many of the authors have given permission to the education community to download and use the source code in their teaching efforts.

With software created by Dr. Viktor Decyk (shown here) and his team at UCLA's Plasma Physics Lab, a cluster of iMac computers can be an instant and very attractive supercomputer.

computers have come in recent years. For someone like me, who once used the Cray Y-MP, this is quite shocking."

For a more contemporary comparison, the team figures that its typical configuration, an eight-node cluster, is comparable to eight nodes of a Cray T3E, one of the fastest parallel computers ever created, for the problems UCLA is working on. (Of course, most supercomputers have far more nodes, which ratchets up their power; the Cray T3E has more than 500.)

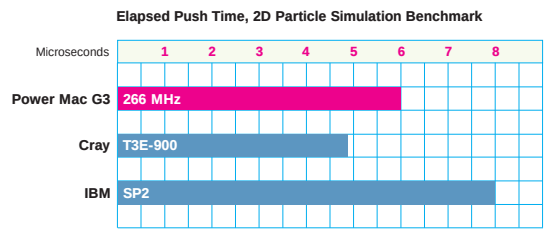
What can you do with that kind of power? Well, if you're Dr. Decyk and studying plasma physics, you can model the trajectories of millions of charged particles, each interacting with all the others through electromagnetic forces. He says that "the largest calculation we can run on our eight-Mac cluster is 32,000,000 interacting particles," adding, with classic understatement, "This is a very large calculation."

For Dauger, the Power Macintosh architecture is the key to outstanding parallel performance. "The PowerPC line is among the most balanced architectures, unlike [DEC] Alpha and Pentium," he says. "I mean balanced in the sense that its I/O and processing units are fast enough and the cache is substantial enough to keep up with each other." He also likes the ease of installation and setup of the Power Macintosh network: "After connecting your machines to a switch or hub, toggle a few switches in the Mac OS, compile your code with MacMPI, and run." Network creation will be even easier with a cluster of iMac computers, since Fast Ethernet is already built in. Dauger continues, "And maintenance is the same as for any other Mac network—that is, virtually nothing. We don't need a full-time systems administrator to maintain a Power Macintosh network."

The Power Macintosh cluster doesn't replace the supercomputer, but it offers more than adequate processing power to run smaller experiments and student problems, with tremendous convenience, allowing Dr. Decyk and his research team to get the most from the supercomputing resources they do need. "To get time on a supercomputing facility," he says, "we have to prepare a proposal. The Power Macintosh cluster provides supercomputer access for the rest of us." Future plans for the computing effort include enlarging the cluster to 16 nodes using 333-megahertz Power Macintosh G3 systems, for even greater performance. Also at UCLA, the Statistical Mathematics lab is turning an iMac cluster into a parallel processing dynamo for numerically intensive calculations.

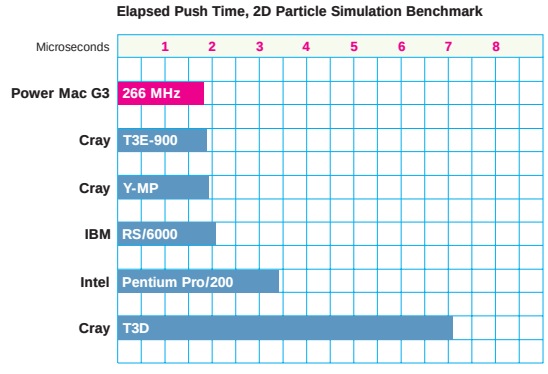
When the cluster isn't being used to run massive plasma physics simulations, the lab's Power Macintosh computers are put to work in the analysis, presentation, and dissemination of research results—a good part of the reason Dr. Decyk's team has been using the Mac platform for a long time. (In fact, the team is using an iMac as a web server.) "We are trying to unify the computing and presentation on the same computer," he says. "This is increasing our productivity. For example, we recently discovered how useful the built-in Apple Personal Web Sharing is for working with our collaborators. All we have to do is copy graphics or text files into a shared folder, and a colleague across the country can see it with his browser immediately. I am very excited about how much more productive we can be with the Macintosh." In creating a "do-it-yourself" parallel processing system, Dr. Decyk and his team are demonstrating that the productivity potential of the Macintosh is, well, unparalleled.

For more information on Project Appleseed, including the MacMPI software and a comprehensive description of the project, check out exodus.physics.ucla.edu/appleseed/appleseed.html.



This graph compares the performance of a four-node cluster of Power Macintosh computers (four machines linked in parallel) to the performance of four nodes of two supercomputers.

Source: UCLA Plasma Physics Lab



One Power Macintosh, functioning like a single node of a supercomputer, can deliver performance comparable to a single node of five well-known supercomputers.

Source: UCLA Plasma Physics Lab

Point of View

The Internet, Java, and Apple's Commitment to Higher Education

No one today denies the importance of the computer as a resource in higher education, and no company has done more to link the worlds of academia and information technology than Apple Computer. Our deepest roots are intertwined with those of the academic community, and our position on campuses—from dorm rooms to laboratories to the desktops (and laptops) of professors and administrators—remains a strong one.

Higher education continues to fill two essential roles: to lead the quest for new knowledge and to prepare today's students to be the knowledge workers of the 21st century. But the strategies and tactics for fulfilling those goals continue to evolve, driven partly by the unprecedented rates of change and advances in technology.

The Internet has altered nearly every aspect of higher education. Once the province primarily of scientists and researchers, the Internet and cyberspace have created new worldwide communities, new opportunities, and new ways of doing things in nearly every sphere, in higher education and elsewhere. The Internet offers new kinds of connections among faculty and students (and substantially broadens the definition of "student"), new opportunities to streamline administrative processes and improve service, new ways to research, discover, and share knowledge. It will enable the creation of effective, interactive, and distributed learning environments. It will substantially leverage knowledge and expertise. And it should make the complex task of administration and management more efficient, more productive, and more effective.

Apple is deeply committed to playing an integral role in harnessing the power of the Internet for the world of higher education, and is equally committed to Java, which promises to play a key role in an Internet-centric, web-enabled environment. Java's cross-platform, "write once, run anywhere" capabilities mean that programming efforts can be more easily leveraged, managed, and deployed in heterogeneous Macintosh, PC, and UNIX network environments. Java is transforming the Internet into a dynamic, real-time environment for teaching and learning, and is enabling the deployment of mission-critical enterprise applications.

In many, many ways, 1998 has proved to be a crucial year in Apple's ongoing evolution—and a very successful year as well. We introduced iMac, a revolutionary new product that has captured the attention of users around the world and become one of the most successful new computer product launches ever. We launched a significant new release of the Mac OS, version 8.5, which offers even greater ease of use and enhances the Internet experience. We are releasing a substantial new version of Mac OS Runtime for Java (MRJ 2.1). And not coincidentally, Apple Computer returned to profitability and growth and strengthened its financial and market positions—which means we have the resources to develop great technologies and products and to continue to serve our customers effectively.

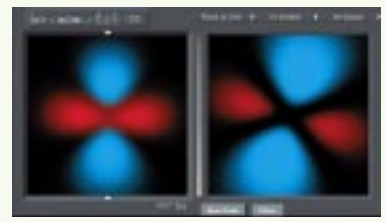
This year was also one in which we rededicated Apple Computer to the higher education enterprise. This newsletter, *Apple University Arts,* is just the first and most visible symbol of our dedication; it's designed to offer you a perspective on what students, administrators, faculty, and information technology professionals are doing with Apple products in colleges and universities around the world. We've also assembled a new team of marketing professionals devoted to the higher education market—to sharpen our focus and to answer the unique challenges and opportunities of the academic community. In the months ahead, our commitment to higher education will be proved in the form of new products, initiatives, and programs. Look for future issues of *Apple University Arts,* and please bookmark the education section of the Apple web site—www.apple.com/education—to learn more about what we're doing in education, as well as what the educational community is doing with Apple products and services.

So welcome to *Apple University Arts.* On behalf of the higher education team and Apple Computer, I thank you for your interest and confidence in our company. We plan to keep earning your trust in the years ahead.

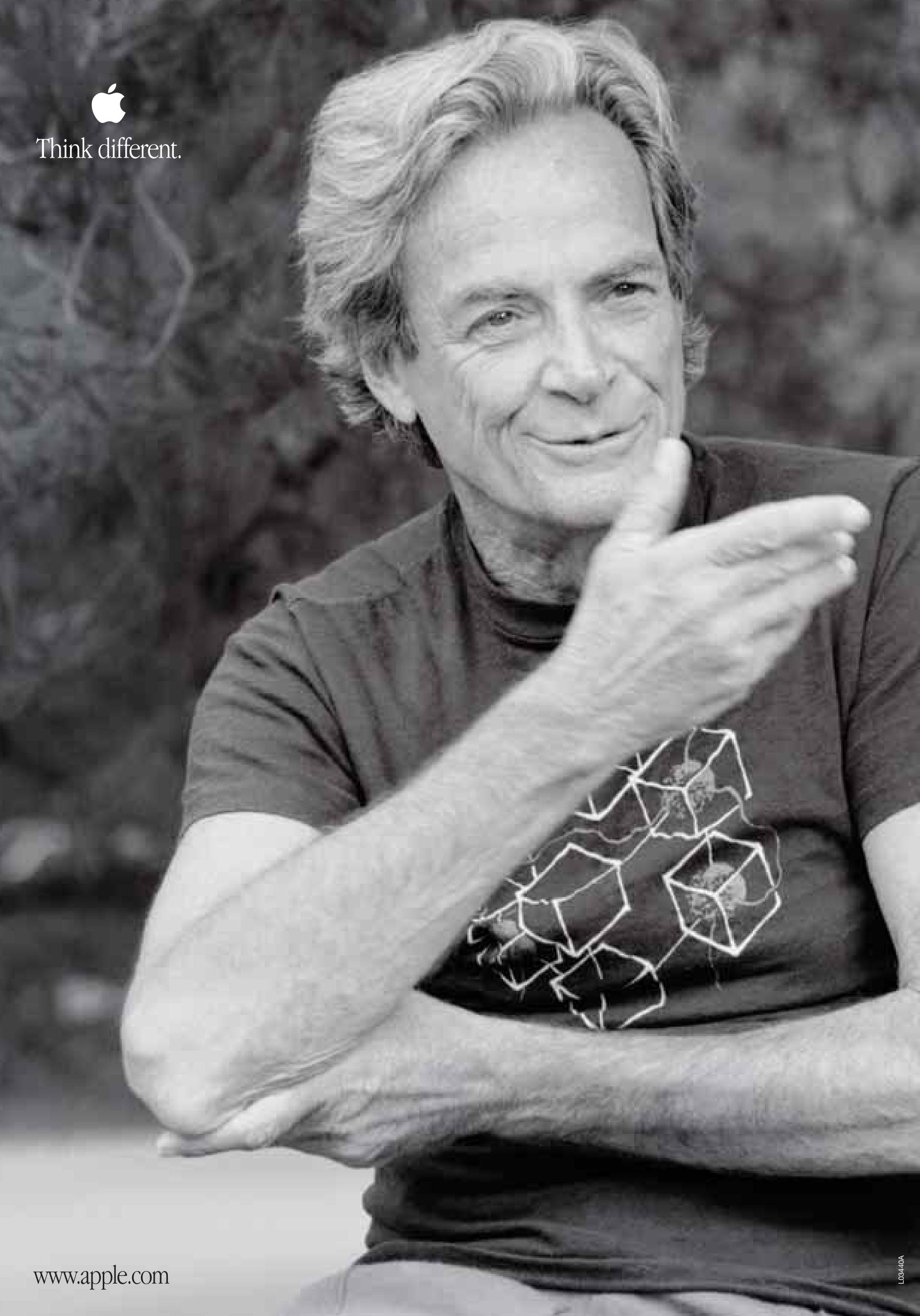
Val Greenlaw
Director of Higher Education Marketing, Apple Computer

P.S. We want to hear from you. Let us know how we are doing—and even more important, let us know what you are doing with Apple technology. E-mail us at universityarts@apple.com.

Computers in Physics' Ninth Annual Software Contest—the second time he's won the award. The program is currently being used by chemistry and physics professors at universities across the country.



Dean Dauger's Atom in a Box application aids students of quantum mechanics to "visualize" hydrogen's atomic orbitals—the state of an electron bound to an atomic nucleus.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