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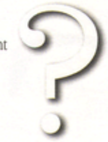

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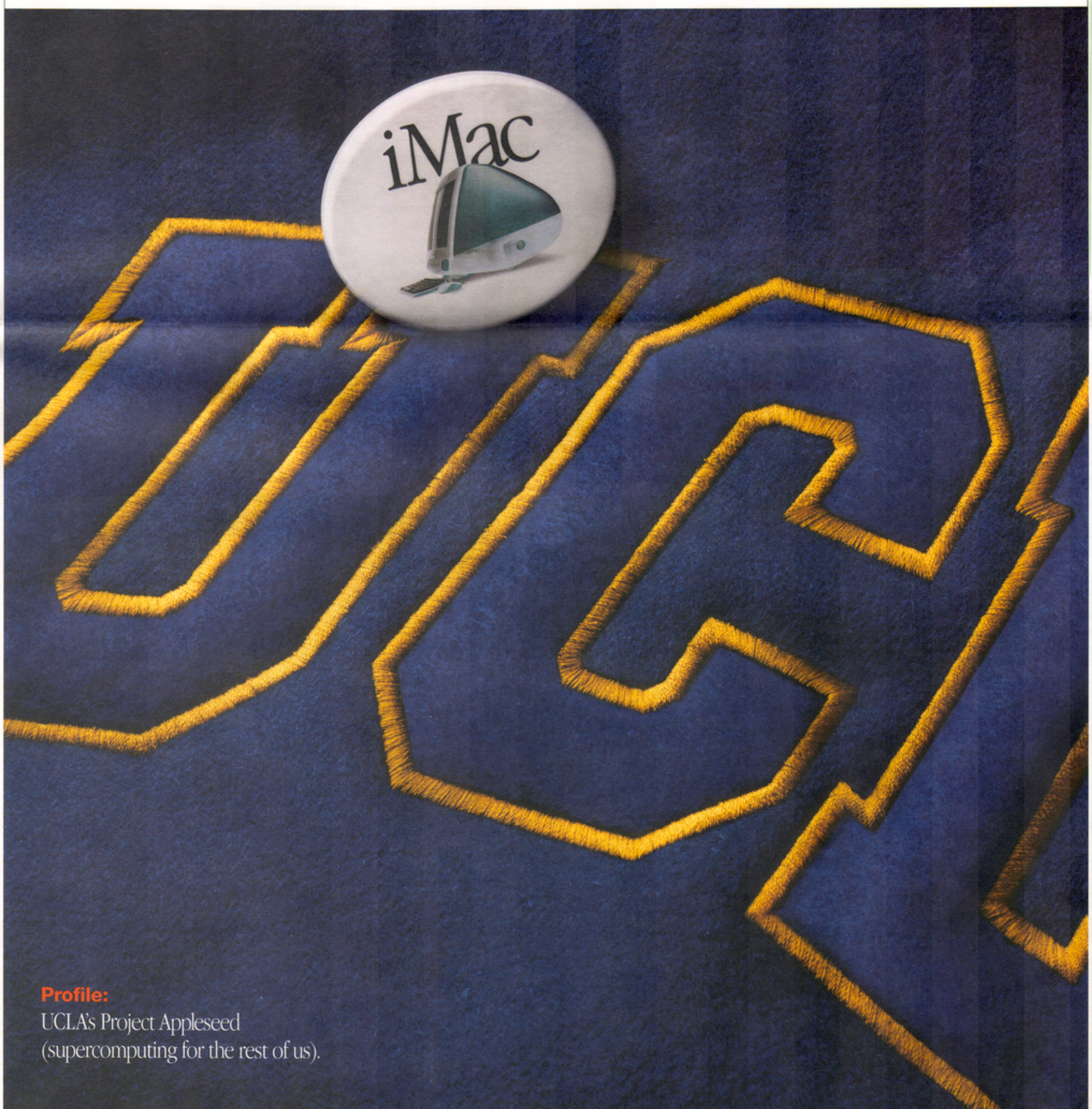


Profile:
UCLA's Project Appleseed
(supercomputing for the rest of us).

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

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.)

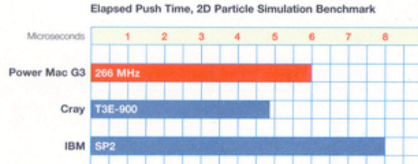
What can you do with that kind of power? Well, if you're Dr. Decyk and studying plasma physics, you can model the trajectories of millions of charged particles, each interacting with all the others through electromagnetic forces. He says that "the largest calculation we can run on our eight-Mac cluster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

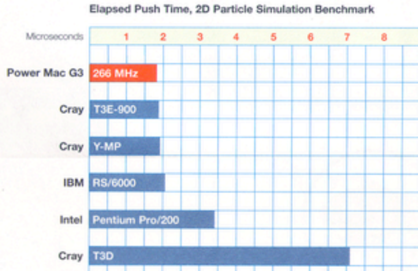
When the cluster isn't being used to run massive plasma physics simulations, the lab's Power Macintosh computers are put to work in the analysis, presentation, and dissemination of research results—a good part of the reason Dr. Decyk's team has been using the Mac platform for a long time. (In fact, the 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.

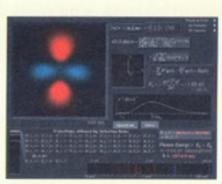
This year was also one in which we rededicated Apple Computer to the higher education enterprise. This newsletter, *Apple University Arts*, is just the first and most visible symbol of our dedication; it's designed to offer you a perspective on what students, administrators, faculty, and information 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.

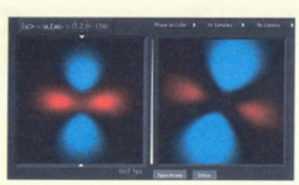
So welcome to *Apple University Arts*. On behalf of the higher education team and Apple Computer, I thank you for your interest and confidence in our company. We plan to keep earning your trust in the years ahead.

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.