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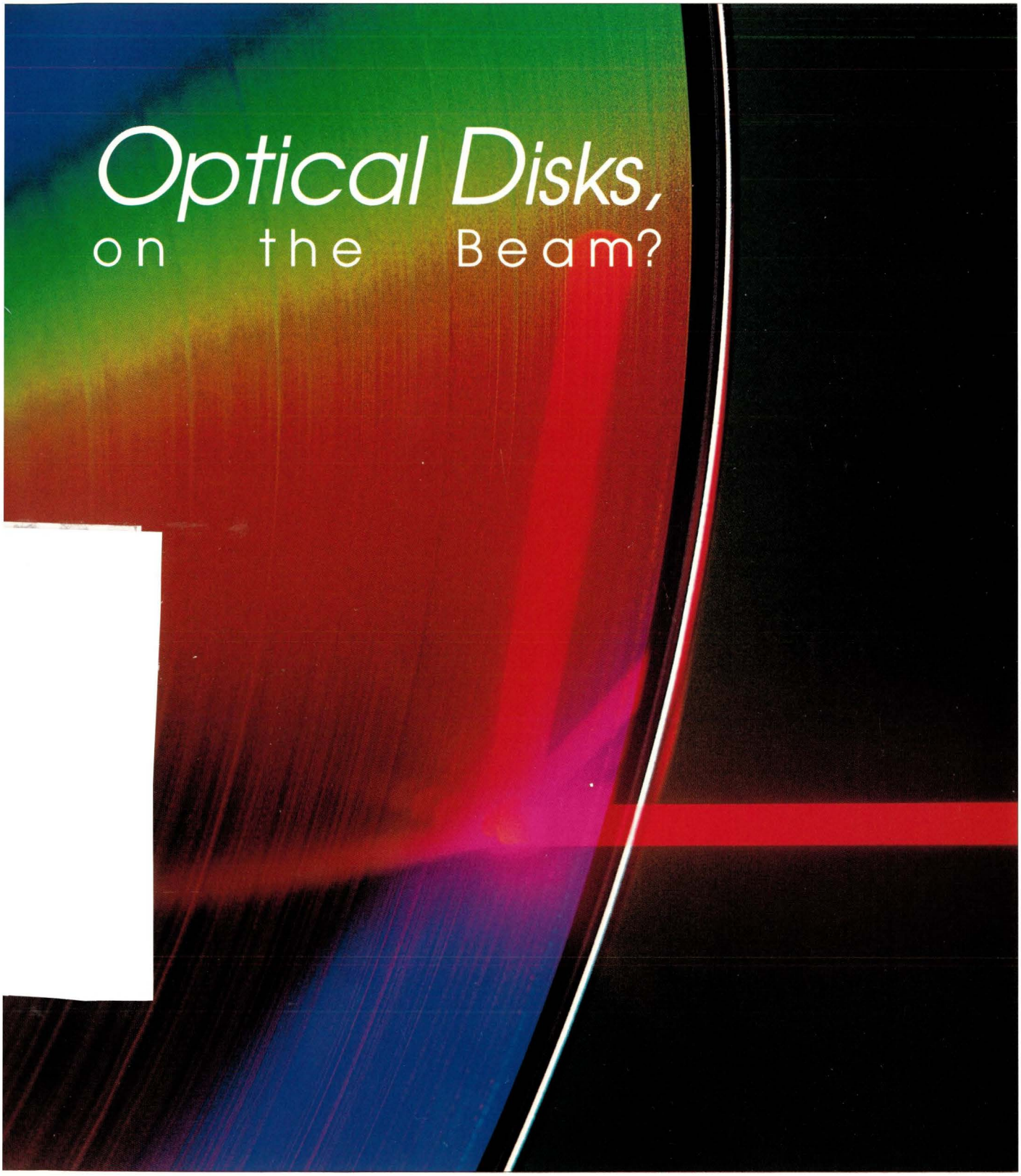
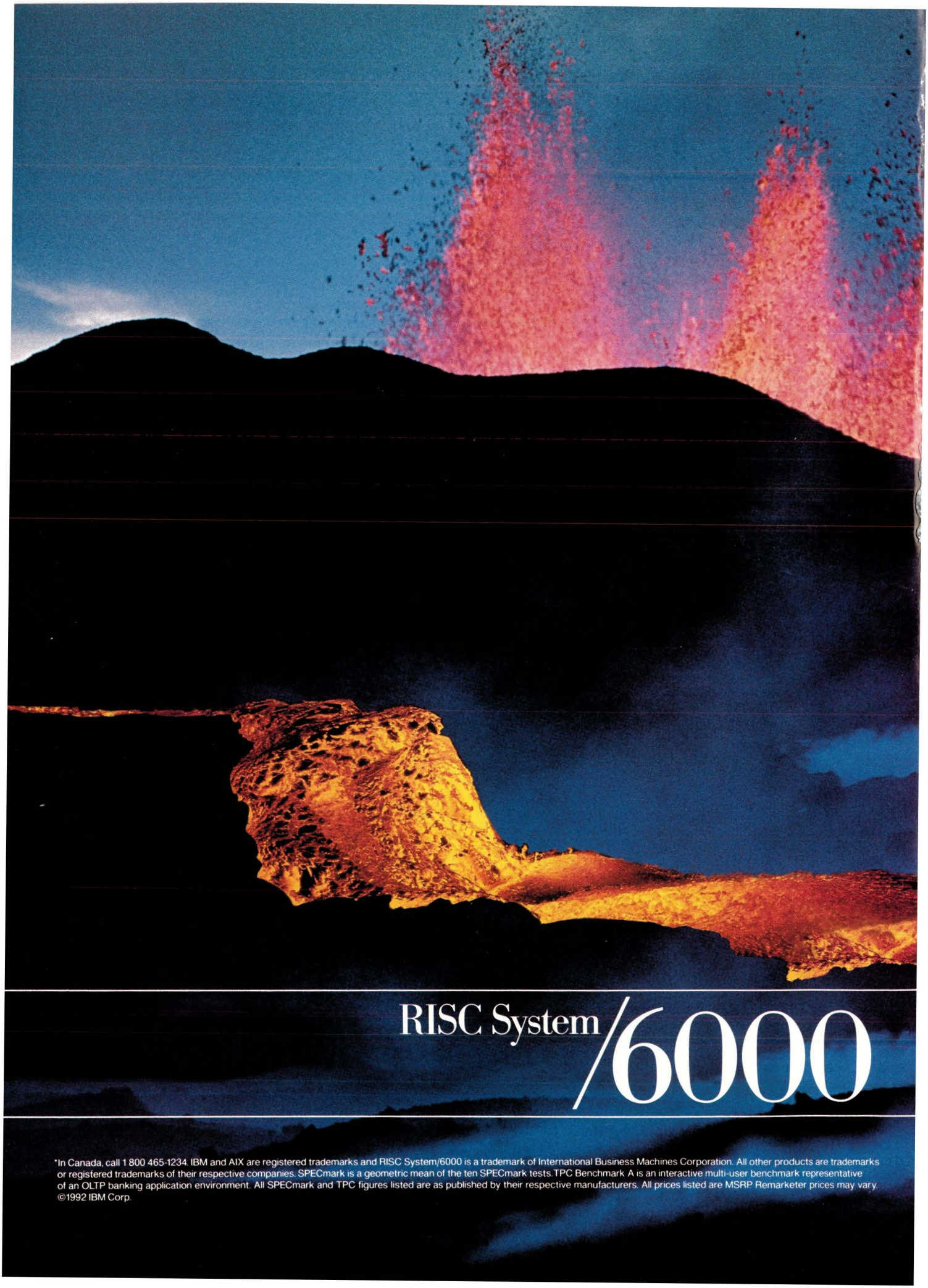


Solaris Two and You

News: SPARCstation 10

Parallel Universes



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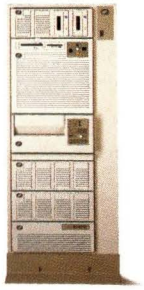

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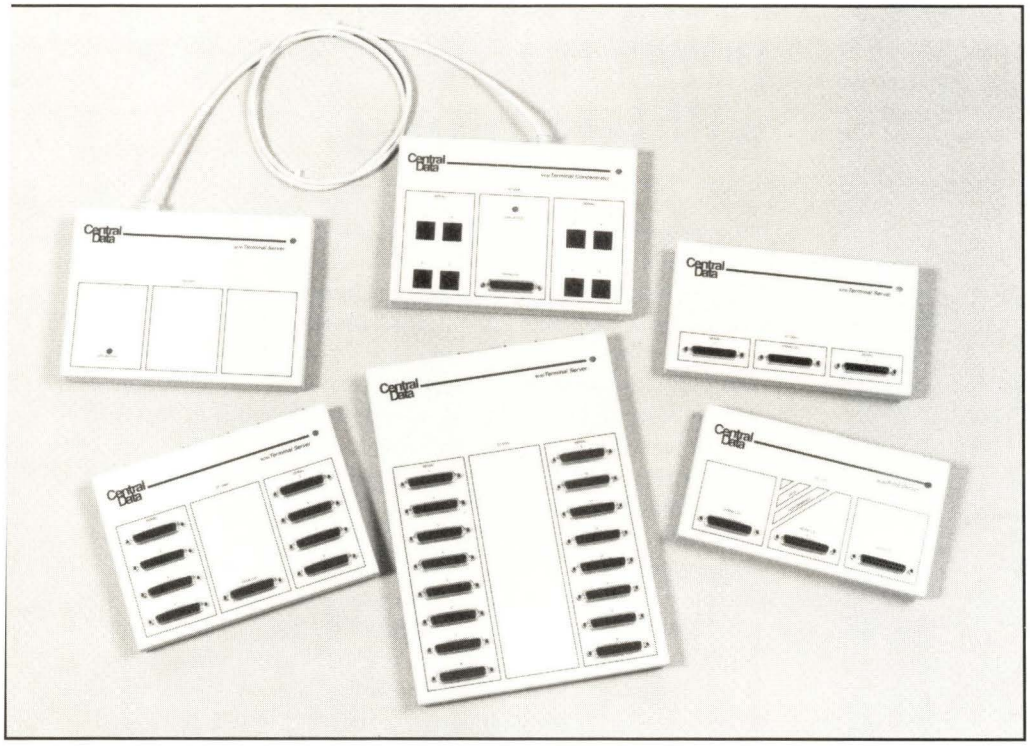

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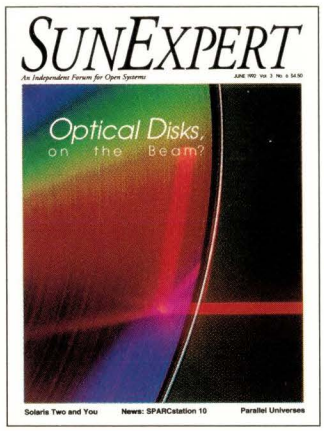

JONATHAN GOELL/The Picture Cube

FEATURES

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DEPARTMENTS

SUNEXPERT
serves the UNIX workstation environment, emphasizing Sun, SPARC and Sun-compatible systems.

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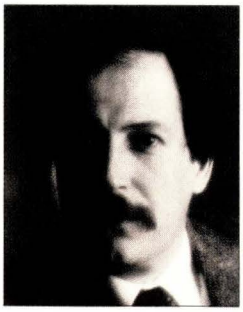
Editorial

AIMing at 300 MIPS

Just when I thought Sun had fallen off the AIM best-of charts for the foreseeable future, enter the clad-for-battle Viking systems–the SPARCstation 10s. Based on Texas Instruments Inc.'s superscalar SuperSPARC chip, the new machines will ship it the third and fourth quarters. Models include the 30, 41, 52 and 54. In case you haven't seen the latest *UNIX System Price Performance Guide*, published quarterly by AIM Technology, Santa Clara, CA, only the low-cost ELC appears. The listings, once peppered with Sun systems, will be again when AIM gets a look at Sun's new systems and pricing. Prices for the entire desktop line have been slashed dramatically to make room for the high-end 10, and a new IPC configuration that offers solid performance for under $6,000 debuts. See this month's lead story in the "News" section for all the details we could dig up at press time.



When they ship, some SPARCstation 10s will not be running Solaris 2.0, but, if you're ready to start planning a migration strategy, be sure to read "Solaris Two and You." S. Lee Henry, our systems-administration columnist, begins a series of articles devoted to Solaris watching. Specifics are still hard to come by, but she has uncovered enough information to get us (that includes *SunExpert*) in the mood. Please don't forget to respond to the questionnaire about your Solaris planning in May's "Editorial." The email address is `solar@expert.com`.

Because the SPARCstation Model 52 and 54 can be configured as multiprocessing systems, technical editor Barry Shein thought it might be a good idea to review this technology. For a primer on parallel architectures–what they can and can't do–see "Parallel Universes."

Doug Pryor

Doug Pryor

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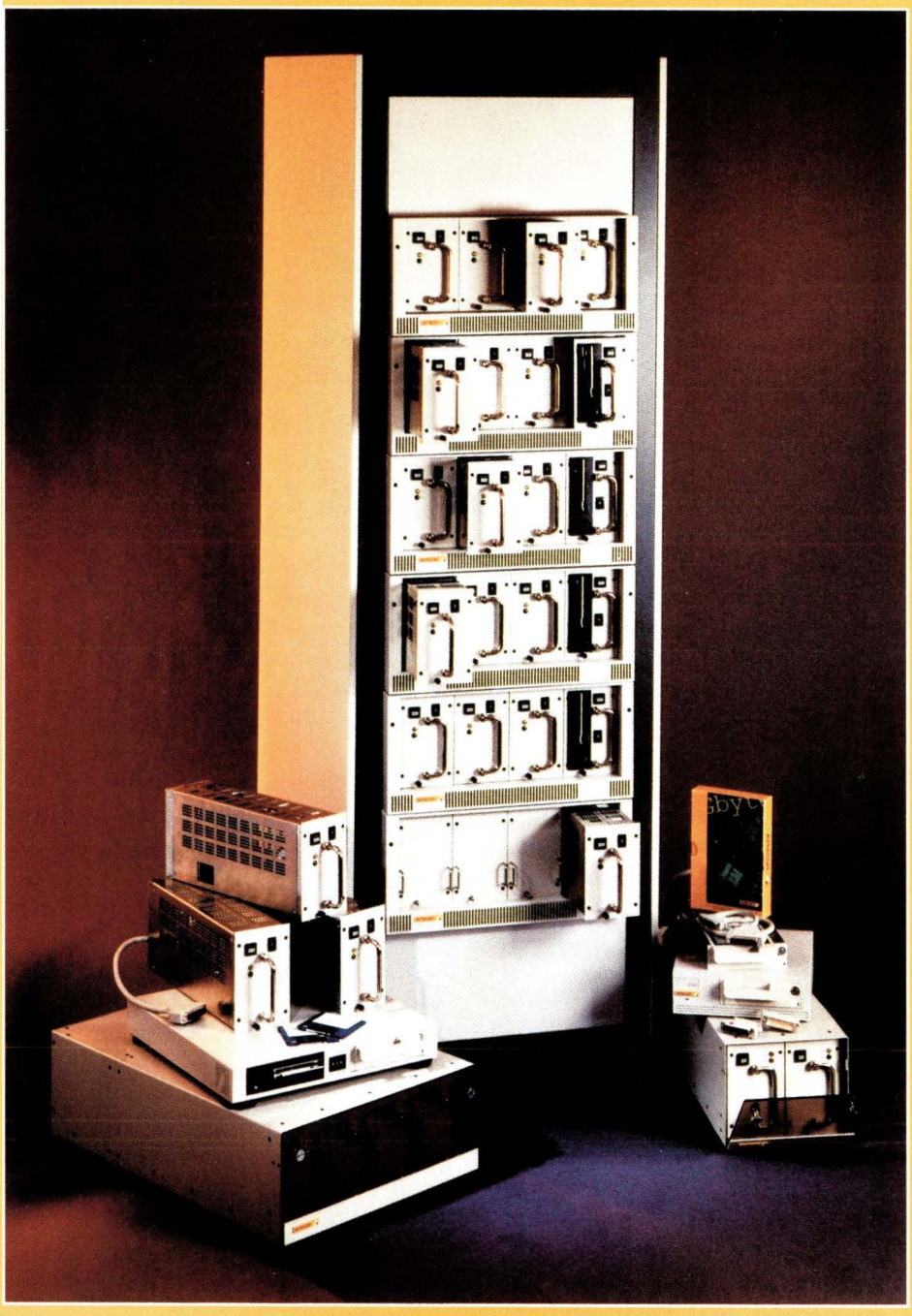

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NEWS

Stealth Stations: SPARC 10s

In what surely will go down as one of the most closely guarded system announcements of the decade, Sun Microsystems Computer Corp. unveiled in the middle of May its next-generation SPARC systems, the SPARCstation 10 and the SPARCserver 10. Up to two weeks before the machines' introductions, most industry pundits and nearly all Sun customers still were referring to the systems as the SPARCstation/SPARCserver 3. Although most market watchers either knew–or at least speculated–that the new machines would accommodate the Texas Instruments Inc. Viking (a k a SuperSPARC) processor, many other elements of the announcement were a surprise.

First, the SPARCstation 10 will be available in four models: the 30, 41, 52 and 54. The 30 and 41 are uniprocessor systems; the 52 is a dual processor; and the 54 scales to four processors. The 30 is built around a 36-MHz SuperSPARC, which is expected to have a 40- to 50-SPECmark rating, 35- to 40-SPEC integer (SPECint) rating and 50- to 60-SPEC floating point (SPECfp) rating. The 41 employs a 40-MHz SuperSPARC, anticipated to perform at 50 to 60 SPECmarks, or 40 to 50 SPECint, as well as Sun's 1-MB external cache module, called SuperCache. Model 52 features a pair of 45-MHz SuperSPARCs, each of which is capable of performing at 60 to 70 SPECmarks, or 50 to 60 SPECint, and two 1-MB external cache chips. And the 54 sports four 45-MHz SuperSPARCs, expected to clock at 60 to 70 SPECmarks each, and four 1-MB external caches.

Sun Pricing (Before and After)

Platform	Was	Now
ELC	$4,995	$3,995
IPC	$6,995	$5,995
IPX	$13,495-$14,495	$9,995-$10,995
SPARCstation 2	$18,495-$19,495	$15,295-$16,295

Source: Sun Microsystems Computer Corp.

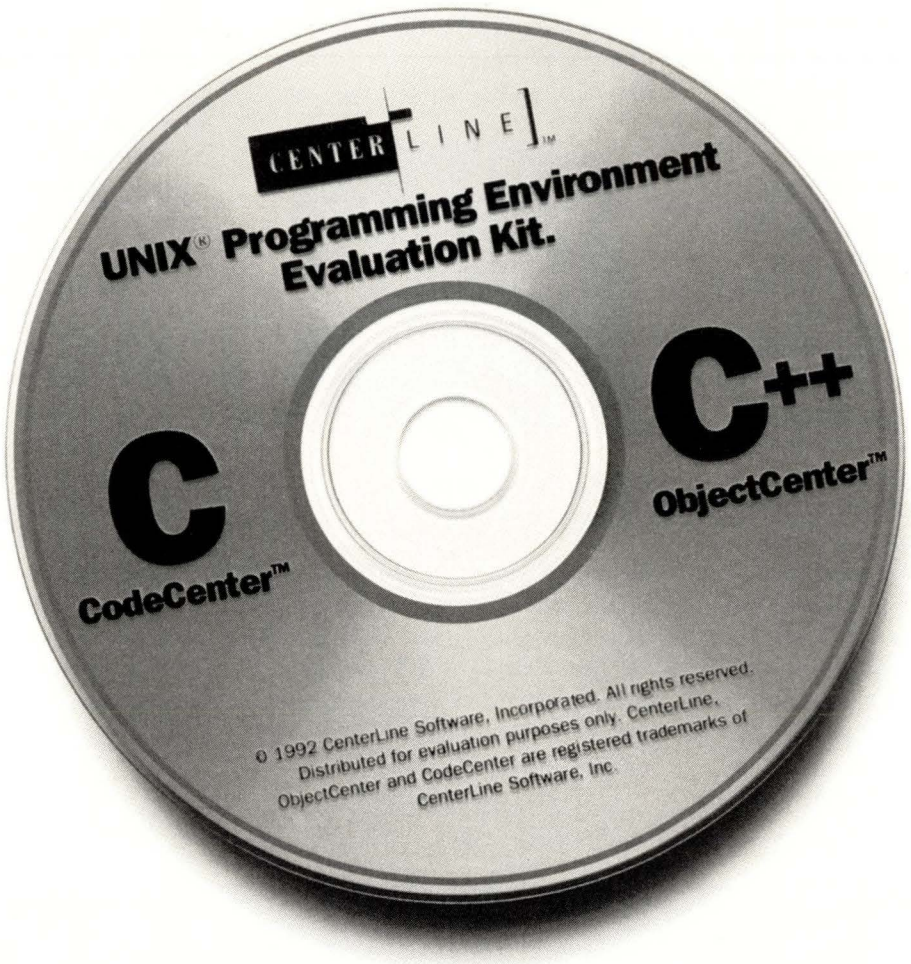
A family portrait (clockwise from center):The SPARCstation 10, SPARCstation 2, IPC, IPX and SLC make up Sun's revamped desktop line.

The first of the machines to ship will be the 30 and 41, both of which are slated to become available in the third quarter. Entry-level prices, at press time, were expected to fall in the $18,000 to $25,000 range. Since the 45-MHz SuperSPARCs from TI won't begin shipping until the third quarter, it makes sense that the Models 52 and 54 won't be available until sometime in the fourth quarter. But SMCC is already talking about customers' ability to upgrade all of these systems with the 50-MHz SuperSPARC from TI–the 150 MIPS SPARC chip that TI also is promising to deliver in the third quarter. And SMCC is promising to deliver a 50-MHz SPARCstation 10 workstation and server model that can scream at speeds of up to 300 MIPS, 200 SPECint and 228 SPECfp before the end of the year.

All of the SPARCstation 10s come standard with two MBus slots, four SBus slots, two serial ports, one parallel port and 16-bit, CD-quality audio. The machines support 32 MB to 512 MB of RAM and offer Sun's GX, GXplus, GS and GT graphics options, as well as a choice of 16- or 19-inch color or 19-inch gray-scale monitors. The machines offer 10-MB/s SCSI transfer rates. All are promised to support up to 26 GB of external storage.

In addition, the SPARCstation 10 systems ship with built-in Ethernet and twisted-pair ISDN networking ports. SMCC is the first RISC workstation vendor to provide an ISDN chip on the motherboard. Sun says its European and Japanese customers are clamoring for ISDN.

SMCC also rolled out a complete line of SPARCserver 10 systems and revamped its 600MP server lineup. The desktop, pizza-box-style SPARCserver 10 Model 30 is a uniprocessor that makes use of TI's



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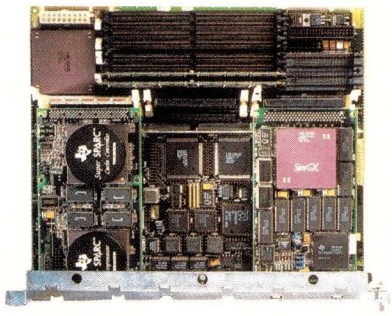
36-MHz SuperSPARC. The Model 41 is a 40-MHz uniprocessor with a 1-MB external cache; the Model 52 is a dual-processor with a pair of 1-MB external caches; and the Model 54 is a four-processor server with four 1-MB external caches. As is the case with the SPARCstation 10s, the SPARCserver 10s can be upgraded with plug-in 50-MHz SPARCserver chips.

The servers all offer four SBus slots; up to five 10-MB/s SCSI-2 bus controllers; 5-GB 8mm tape drive, 1/4-inch tape drive or CD-ROM drive; ISDN networking capabilities; and the capacity to link up to 34 terminals directly. SMCC says the servers ultimately will deliver more than 100 transactions per second (TPS) and 1,000 NFS operations per second.

Availability of the SPARCserver 10s parallels that of the SPARCstation 10s, with Models 30 and 41 due to ship in the third quarter, and 52 and 54 sometime in the fourth quarter. Pricing was unavailable at press time.

Simultaneous with the SPARCserver 10 announcement, SMCC made available the first SuperSPARC module upgrades for the 600 MP servers. SMCC is making the 630MPs, 670MPs, 690MPs available with SuperSPARC in three versions.



The SPARCstation 10's small-footprint motherboard.

The Model 41 is a 40-MHz uniprocessor with 1 MB of external cache; the Model 52 is a 45-MHz dual processor with two 1-MB external caches; and the 54 is a quad-processor sporting 45-MHz SuperSPARCs with four 1-MB external caches.

The uniprocessor models of the SPARCstation 10 and SPARCserver 10 (as well as the Model 41 600MP) will ship with Solaris 1.1. All other systems will be shipped with Solaris 2.0.

As part of this mega-rollout, SMCC also unveiled the SPARCengine 10, a board-level implementation of the SPARCstation 10 for embedded applications, such as factory automation, medical instrumentation, telecommunications, laptop computers and ruggedized command and control systems. The SPARCengine 10/Model 30 and Model 41 will be available with Solaris 1.1 in the third quarter.

At press time, a number of major Sun customers had been briefed by their SMCC sales representatives about "the next-generation SPARC desktops." But few knew the product's name, its performance ratings or its price. In fact, Sun customers seemed to know a lot more about Dragon–Sun's promised 20-processor SPARC system–than the SPARCstation 10.

Three weeks before the SPARCstation 10 announcement, SMCC made major reductions in its

pricing for all of its SPARCstation desktops. It also unveiled a newly configured, lower priced SPARCstation IPC, which SMCC says makes it the first major vendor to break the $6,000 price barrier for a fully configured RISC color workstation.

The new IPC includes the same features and packaging as the existing IPC. But it comes standard with a new, mid-range, 16-inch Sony monitor with 1,152-by-900 resolution. The system features 8 MB of memory and a 207-MB internal disk. The system lists for $5,995.

Sun slashed prices on all other models. It cut its ELC price by $1,000, to $3,995. The 16- and 19-inch color models of the IPX were cut by $3,500 and are now priced at $9,995 and $10,995, respectively. And the SPARCstation 2 price tag was chopped by $3,200. A 16-inch color version goes for $15,295 and a 19-inch color model sells for $16,295.

Finally, SMCC introduced a new, low-cost SPARCengine IPX with no memory. This replaces the previous SPARCengine IPX that included 16 MB of memory standard. All other features are identical.

All reduced-price models are currently available.–*mjf*

Twinhead's MP Punch

Twinhead Corp., Milpitas, CA, beat Sun Microsystems Inc. to the multiprocessing desktop punch. In April, Twinhead unveiled an MP upgrade to its Twinstation. The product, running Solaris 1.01 (SunOS 4.1.2) performs at 31 MIPS per CPU, according to Twinhead. Like the SPARCstation 10, the product is MBus-based.

A TWINstation-MP with a GX graphics accelerator and 32 MB of memory is priced at $17,095. Upgrades from the standard TWINstation start at $4,495.–*mjf*

UNIX Users Can Select PCs, Macs

Sun Microsystems Inc. has unleashed yet another business unit on the world. This one, called SunSelect, is "dedicated to integrating personal computing resources with open, UNIX-based client/server environments." Sun's intention is to let "users select the resources they need from either world [UNIX or PC]–and access them from whatever computer is on their desktop."

SunSelect's current product lines are the PC-NFS family, the SunPC family of emulation products and NetWare SunLink, software that connects Novell Inc. NetWare LANs to SPARC server systems. SunSelect is selling products through local Sun Microsystems Computer Corp. sales offices, SunExpress, SunSelect resellers and other distribution channels.

Of these products, the SunPC group is the newest. SunSelect introduced the first SunPC products in mid-April. These included SunPC emulation software, which allows Sun workstation users to run MS-DOS and MS-Windows applications in emulation mode; the 486SX-based SunPC Accelerator SX card for better DOS applications performance; and the 486DX-based SunPC Accelerator DX

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card for the most demanding floating-point and graphics-intensive DOS apps. Sun developed SunPC software in conjunction with Insignia Solutions Inc. (the SoftPC people), High Wycombe, United Kingdom. These products replace Sun's previous emulation products, DOS Windows and SunIPC.

U.S. list prices are $695 for the SunPC software product, $1,495 for the SX accelerator and $1,995 for the DX card. Both card products come bundled with SunPC software. Customers with previous versions of SoftPC or DOS Windows can upgrade to SunPC for $249.

In April, SunSelect also introduced Version 4.0 of PC-NFS and an enhanced version of the PC-NFS Programmer's Toolkit. With PC-NFS, users integrate PCs into UNIX-based environments by allowing PCs to access files and resources on all systems that support ONC/NFS. Version 4.0 features MS-Windows 3.1 integration, full support of MS-DOS 5.0, faster VT100 terminal emulation, support for 4/16-Mb/s token-ring drivers, closer integration with SunNet Manager, improved PC print services and various ease-of-use features, such as network browsing, icons and on-line help.

SunSelect is based in Billerica, MA. Sun is planning to consolidate all of its Massachusetts-based divisions in the near future and move them to an as-yet-unspecified location in the state.–*mjf*

Play It Again, Sun

In a move nearly concurrent with its introduction of 16-bit, CD-quality audio (see "Stealth Stations: SPARC 10s"), Sun Microsystems Computer Corp. (SMCC) has begun shipping a microphone with every SPARCstation it sells. SPARCstations now come with the microphone, built-in speaker and Multimedia Mail and Audio Tool software for playing, recording, receiving and sending audio. SMCC says there are more than 30 third-party software applications available for the SPARCstation that use audio (see box to the left).

All new SMCC workstation customers receive microphones free. Existing customers may purchase a microphone for $29 from SunExpress. Multimedia Mail and Audio Tool are included as part of OpenWindows Version 3.0.

In other audio-related news, two chip vendors have come out with audio chips for the Sun market. Analog Devices Inc., Norwood, MA, developed in conjunction with Sun an audio system-on-a-chip. Called the AD1849 SoundPort Stereo Codec, the chip provides CD-quality digital audio on a system motherboard. The AD 1849 consists of a pair of 16-bit analog-to-digital converters and a pair of 16-bit digital-to-analog converters.

Crystal Semiconductor Corp., Austin, TX, announced a stereo-audio coder/decoder (codec) for multimedia apps. The CS4215 also features both 16-bit A/D and D/A converters on a single chip. The chip was jointly developed by Crystal and Sun Microsystems.–*mjf*

Not So Casual X

It's no secret that the X Window System market continues to expand at a phenomenal rate. However, the segment showing some of the most remarkable performance is X on PCs, which had revenues grow at an astonishing 300% between 1990 and 1991, according to market research firm The X Business Group, Fremont, CA. The Group says that PC-X server revenues were $15.04 million in 1991, up from $4.05 million in 1990. Shipments of actual PC-X servers, meanwhile, were 58,022 units in 1991, up from 23,225 units in 1990, for a growth rate of 250%.

A PC-X server is software that allows a PC or Macintosh to emulate an X terminal. "It's going to be like the terminal emulation market," says X Business Group analyst Stephen Auditore. "There's going to be some big numbers."

What accounts for the success of X on PCs? "People are serious about PC-X because they already have PCs," answers Jan Adamek, vice president of marketing at Hummingbird

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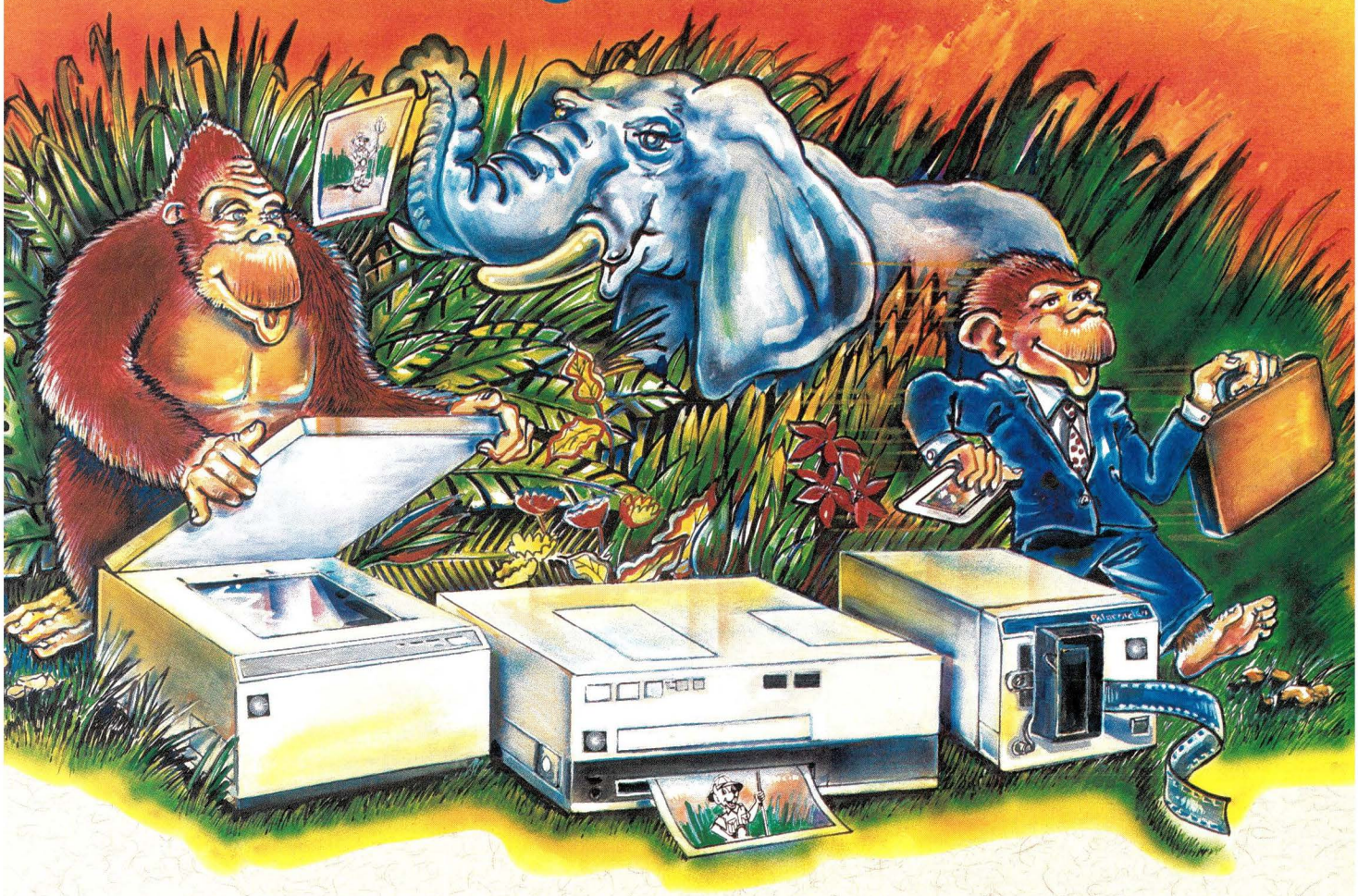

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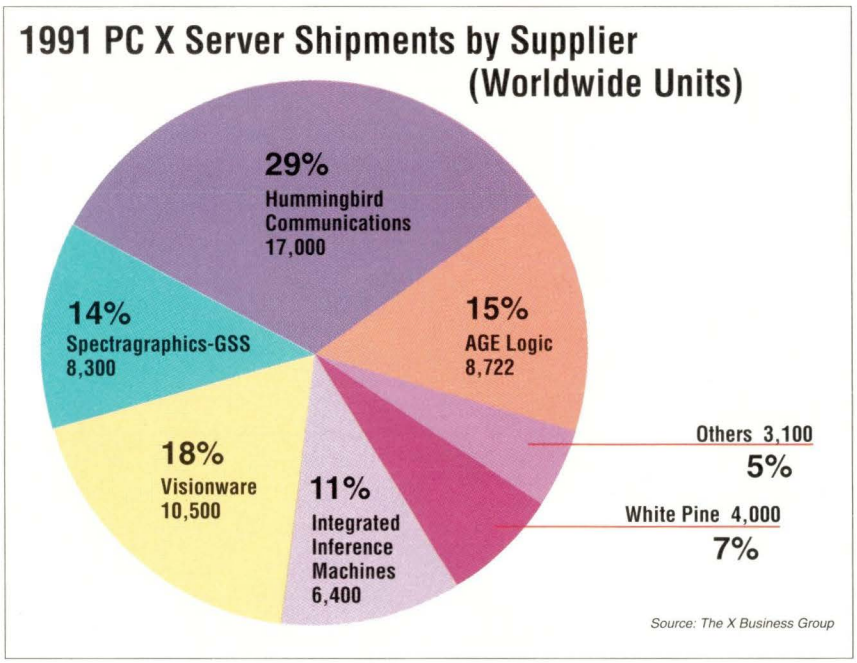
Communications Ltd., Markham, Ontario. He says the vast majority of his customers are people who are already DOS or Mac users, but who now long for some connectivity to UNIX systems sporting X-based interfaces. Most of them already have all the hardware necessary to run, including a high-resolution graphics board. "Most of the pieces are already there."

The X Business Group says that the PC-X segment remains relatively small compared with the rest of the X market. Out of a $510 million industry, PC-X sales accounted for only $15 million. X terminals, in contrast, counted for some $358.3 million. But the research firm feels that PC-X will continue to show strong growth, predicting that it will exceed $1 billion in revenue by the end of 1992.

Thus it is that the PC-X server vendors feel that their industry far outweighs its statistics. "The X terminal vendors call us 'casual X,'" notes Adamek, "but, the bottom line is that it isn't so casual."–*mjt*



The PC X market in 1991 was split among only six major vendors, with Hummingbird Communications leading the pack.

Cypress Shows hyperSPARC

Ending months of speculation, the Ross Technology Inc. subsidiary of Cypress Semiconductor Inc. has introduced a superscalar SPARC processor, called hyperSPARC. Cypress had been said to be working on a superscalar SPARC, rumored to be called Pinnacle, but had refused to confirm it until now. "Pinnacle was the name of the program," says Joe Nichols, the company's director of marketing, "and hyperSPARC is the name of the product."

hyperSPARC is a 64-bit, superscalar, superpipelined processor that performs (where possible) two instructions per cycle. The company says the processor will operate at a clock frequency of between 55 and 80 MHz. Depending on configuration, it will offer between 62 and 89 MIPs, and between 52 and 85 sustained SPECmarks.

Moreover, Cypress/Ross says that the chip is highly optimized for multiprocessor and parallel processing situations. "Our goal was to parallelize as many functions as possible," says Matt Gutierrez, an applications engineer working on the project. "That's within the chip, and between chips."

The processor will not be sold as separate chips. Rather, it comes in one of three different MBus modules. The first of these is the single-processor CYM6221, which is a three chip set with 128 KB of cache. Second is the CMY6222, a dual-processor chip set with 128 KB of cache per processor. Third is the CYM6226, a dual processor with two additional cache data chips and 256 KB of cache per processor.

Communication between individual chips is handled via a new, high-speed proprietary bus–the Intra-Module Bus. This is a synchronous, nonmultiplexed 32-bit address/64-bit data bus. It offers speeds of 444 MB/s at 66.7 MHz and 640 MB/s at 80 MHz.

The company says that the chips will be available in full production by the end of the year. Samples of the 66.7 versions will be available by the third quarter of this year.

hyperSPARC will help ease fears within the SPARC community about the lack of a superscalar version of the processor capable of competing with rival RISC processors (see *SunExpert*, April, Page 52). However, it is not clear how and if it will coexist with Texas Instruments Inc.'s RISC chip.

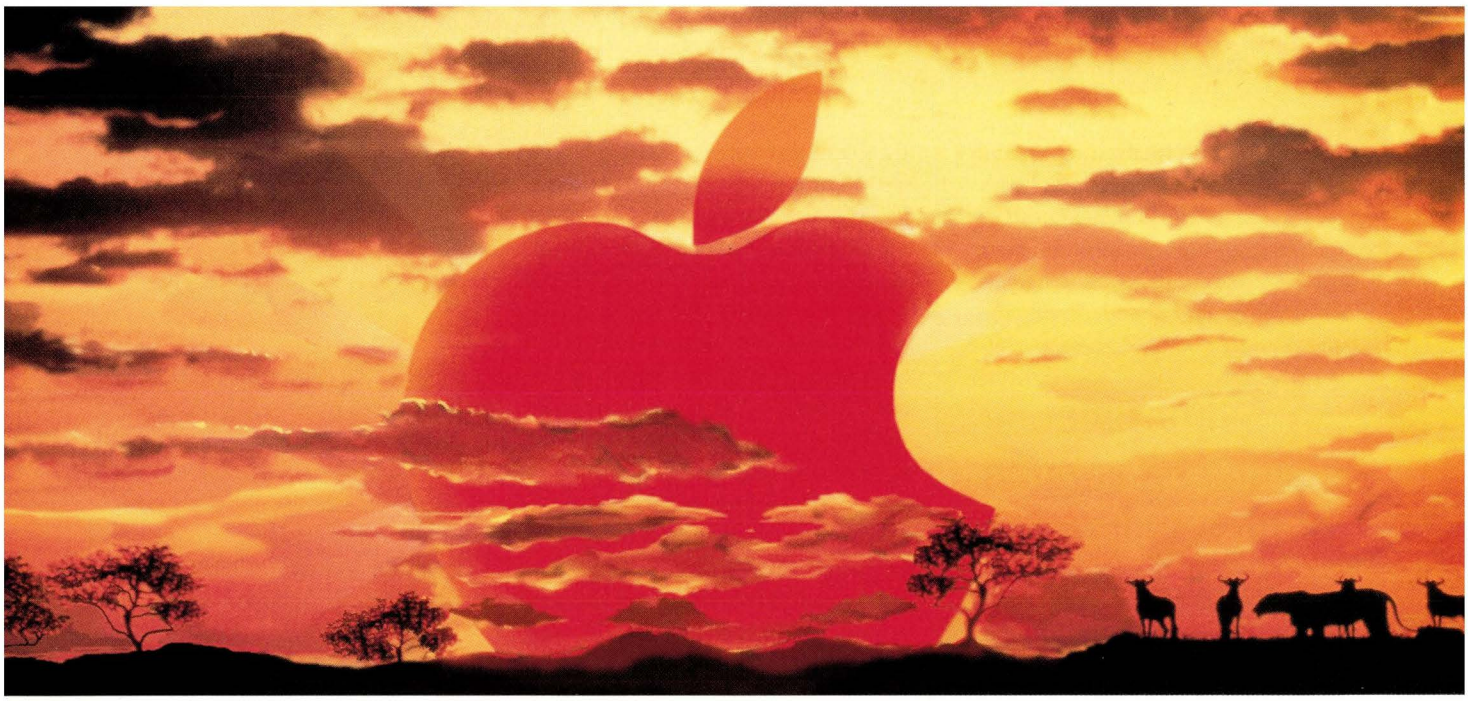
TI's chip, code-named "Viking," and now officially titled SuperSPARC, is also a superscalar processor, though one that launches three instructions per cycle. However, Cypress/Ross says that the performance of the two is not greatly different, as hyperSPARC operates at a higher clock rate.

Cypress also thinks its processor will be cheaper and easier to manufacture than TI's. But this will not alter the fact that Sun itself is buying TI's chips–and Sun remains the single largest market for SPARC.

Still, Cypress puts at least some of its faith in existing Sun customers–particularly users of the Galaxy multiprocessors–who want to upgrade their systems. Such users will be able to swap old MBus SPARC processor modules for hyperSPARC modules. "The answer," says Nichols, "is in the MBus."–*mjt*

New App for a New OS

CenterLine Software Inc. has taken the wraps off the latest version of its CodeCenter C development environment. Version 4.0 of CodeCenter (formerly Saber-C) includes several new features, such as fast object-code runtime error checking, advanced dynam-



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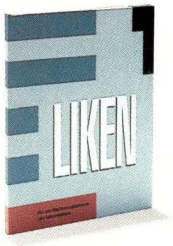

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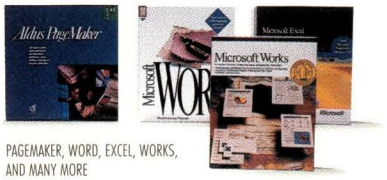

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ic code and data visualization capabilities and the ability to debug linked executables. "We're enhancing the capabilities of our existing product to improve programmer productivity, as well as the quality of code," says company president Sesha Pratap.

CenterLine unveiled a version of CodeCenter for Solaris 2.0.

Version 4.0 also allows developers to choose either Open Look or Motif user interface. (The prior version employed CenterLine's in-house-developed interface.) The product is now integrated with Sun's ToolTalk, Hewlett-Packard Co.'s SoftBench, IBM Corp.'s FrameWork/6000 and Digital Equipment Corp.'s FUSE frameworks. And with this version, CenterLine has made public its protocol interface to the CenterLine Information Engine, allowing developers to integrate existing tools into the CodeCenter environment.

CenterLine also unveiled a separate version of CodeCenter for Solaris 2.0. Under this version, developers are provided with a performance-analysis browser, a copy of–and full integration with–SunSoft's Pipeline porting tool and a choice of CenterLine's or SunPro's C compiler. (CenterLine plans to add the choice of the gcc compiler as a third option "once it becomes [Solaris] 2.0-compatible," says Pratap.) CenterLine says the product will be available concurrently with SunSoft's shipment of Solaris 2.0.

CodeCenter 4.0 is slated to be available on the SPARC platform in the summer. It will be ported to other major UNIX platforms by the end of the year, the company says, including DEC's DECstation 3000 and 5000, HP's 9000/700 and IBM's RS/6000. The product is priced at $2,995, which includes the first year of support and maintenance. Volume discounts are available.–*mjf*

Other Open Systems News

Digital Equipment Corp.

DEC has made public its future plans to develop a "GIGAswitch solution"–a network and cluster of VAX and Alpha clusters. DEC calls the GIGAswitch platform "an open intelligent crossbar switch" that can make more than six million dynamic connections per second. It will be able to provide point-to-point connections between systems and between switches, and will enable multiple FDDI nets to be interconnected. When will all this materialize? No dates were offered at press time.

DEC has formed an engineering and distribution relationship with Advanced Technology Center of Laguna Hills, CA, under which ATC has ported DEC PHIGS to multiple vendors' platforms. ATC has done

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ports to the HP 9000, IBM RS/6000, Silicon Graphics Iris, and various MIPS-, SPARC-, 88000- and i860-based workstations, as well as to 386/ix and SCO System V/386 PC platforms. ATC is marketing and selling the product as Grafpak-PHIGS and is making it available with C, FORTRAN or Ada bindings.

Hewlett-Packard Co.

Move over, SPARC International. The Precision RISC Organization–PRO– has been formed by Hewlett-Packard Co., Convex Computer Corp., Hitachi Ltd., Hughes Aircraft Co., Mitsubishi Electric Corp., Oki Electric Industry Co. Ltd., Prime Computer Inc., Sequoia Systems Inc. and Yokogawa Electric Co. The Cupertino, CA-based group's mission is "to advance and broaden use of the Precision Architecture-RISC (PA-RISC) technology."

HP's PerfView, a software tool for managing on-line performance of distributed systems, is slated for availability in July. The product monitors and controls "performance factors" from a single location, provides "management-by-exception" through alarms and helps users identify overutilized and underutilized resources on the network. The product integrates with HP's OpenView network management software. The first release runs on HP-UX servers and supports HP-UX, HP proprietary and Sun SPARCstation clients. HP says the next version will also support IBM Corp. and Digital Equipment Corp. UNIX systems. Finally, HP is planning to add Novell Inc. NetWare clients to its stable. The central analysis software component includes HP OpenView and HP Network Node Manager. The second component is the individual agent software.

IBM Corp.

The top-of-the-line RS/6000 server, the POWERserver 970, made its debut recently. The server doubles the expansion capability and disk-storage capacity of IBM's existing high-end system. The 970 clocks at 100.3 SPECmarks and sports a base unit price of $94,500. The 64 MB of memory is expandable to 512 MB, and the 2.7 GB of internal storage is expandable to 20.5 GB, with up to 132.9 GB possible through use of optional external expansion racks. The machine comes standard with two faster Micro Channel I/O buses. Each implementation operates in what IBM calls 64-bit streaming data mode, with peak transfer rates of 80 MB/s.

IBM formed a new service organization, the Center for Customer Solutions (CCS) based in Austin, TX, to customize and configure RS/6000 workstations. CCS will preload and/or install any of more than 100 programs for the RS/6000 offered by IBM; integrate IBM and OEM peripheral devices with the RS/6000 and perform related testing; and load OEM software and hardware onto customers' RISC systems.

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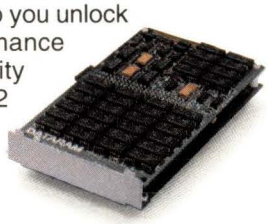

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Ask Mr. Protocol

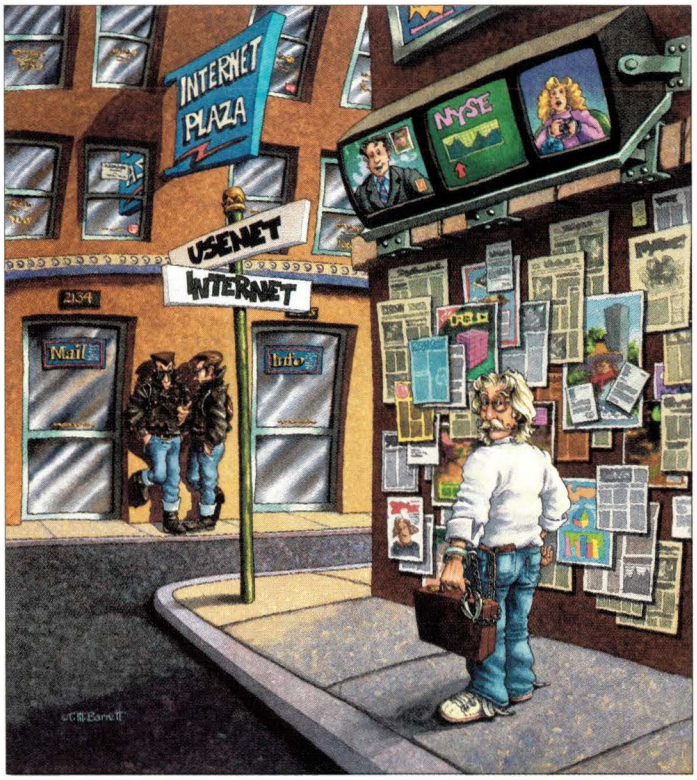

ILLUSTRATION BY TOM BARRETT

by MICHAEL O'BRIEN

Taking the Worry Out of Being Close

"Meddle? Of course I'm going to meddle! You should always do what you're good at."

–The Doctor

"I'm not supposed to be here. . . ."
–Text appearing on the console of the main research computer of The Rand Corp., one depressing evening, from an unidentified intruder (later identified, prosecuted and convicted), late '70s

"Don't even THINK of parking here."
–New York City traffic sign

Q: You've spoken most eloquently about the ins and outs of networking, both local and global. But why should I bother getting a connection to the outside world? Is it worth the risk?

A: Good question. And if you think I have an answer, then I have a large lot with an interesting view, down south, that you might be interested in.

Risk analysis is a particularly slippery area. Credentials must be so sterling that one can hardly tell any of the players apart–they're all at the top of the field. The field, seemingly, has no middle and no bottom. Mr. Protocol doesn't have either of those, nor any top if it comes to that, so he's eminently qualified. Hence this month's column.

This month, Mr. P. is going to look at the various types of networks from the point of view of the risks that they represent. He'll also sing the benefits, as usual, just so the column doesn't become a total downer. But the point of this month's screed is to advance the art of rational decision-making, which in most corporate environments seems to be on a par with taking dictation in Twenty-third Dynasty hieratic as far as "degree of lostness" of the art goes.

Most corporations whose executives have listened to enough radio commercials have decided that corporate networking is a Good Thing. Most of these, however, have no clue as to the changes in corporate culture that must take place to make the technology cost-effective.

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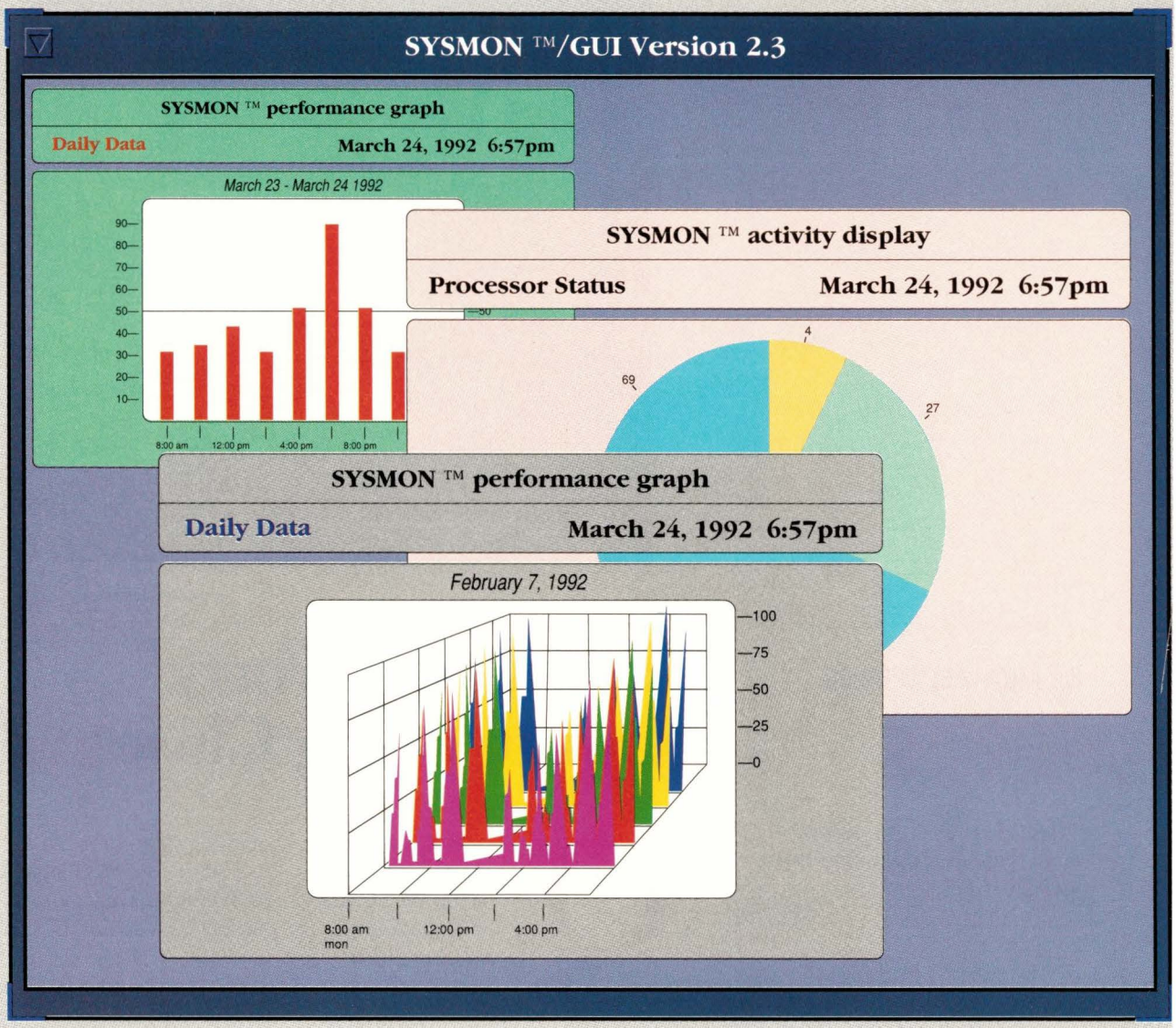

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records. To this end, they create paper trails that expand to the point where they strangle the incautiously bureaucratic manager. These paper trails, of course, are completely divorced from any internal corporate computer network. In general, of course, such nets are installed to partially or completely replace a paper trail. Network installations, though, are notorious for not going smoothly. Therefore, the usual wisdom given concerning machine installations applies manyfold to network installation–do not bet the farm on it! And don't depend on it until you know that it works right. However, in the case of a network, if it works right, it will replace the paper trail on its own.

The risk here is that the paper trail is usually highly structured, while the interactions on a computer net usually display far less structure, at least, if the net is left to its own devices. The first service brought up on a corporate net is generally some form of email, almost always in the form of a commercial email package. Research outfits usually come better prepared to the marketplace, and if any of them are reading this it must be for the jokes, God knows, because those birds have already been through the wars or they wouldn't be doing research, right guys?

Commercial email packages must of necessity be general-purpose packages to reach the widest possible market. This lack of constraint means that while the form of mail may be constrained to look like corporate mail, there is no constraint on content, and the stuff is now suddenly dreadfully easy to send. If the corporate culture is based upon rigidly controlled lines of communications, Steps Must Be Taken or the "corporate culture" is destined for the dustbin of history. Whether or not this is a good thing generally depends on who gets to vote in the poll: the employees or the managers. Since the managers generally foot the bill, they should beware in such cases. Repressive measures may or may not work at this stage; certainly they will lead to dissatisfaction.

The other side of this is, of course, abuse. Sadly, it is possible to spend all one's time playing with the mail system and getting no work done whatsoever. Fatuous as it sounds, somehow a balance must be struck, and that balance will be unique to each situation. It would be easier if it were simply that more capable mail systems invite more abuse, but this doesn't appear to be so. The mere novelty of any sort of electronic mail whatsoever is usually so great that even the simplest mail system tends to act as an infinite sink of time and attention–if it's used at all. If the mail system is *too* difficult to use, it will be looked on as a complete waste of everybody's time–please let's just go back to what we were doing and don't bother me anymore, I *hate* computers, why did I ever take this job, my cousin in Cleveland is doing so much better, and on and on and on.

Usenet is like a disease–you catch it from a neighbor who has it, and your life becomes a living hell.

It isn't the computer; it's the mail system. It just doesn't work.

These problems are compounded geometrically when an outside connection is forged. Once the outside world pokes its head in, things get complicated very quickly.

The first thing to consider is, why connect to the outside world at all? The answer is, because they know stuff you don't. The simple fact is that, the more you poke around the various networks, the more useful information you dig up. The problem is in the signal-to-noise ratio. Dynam-

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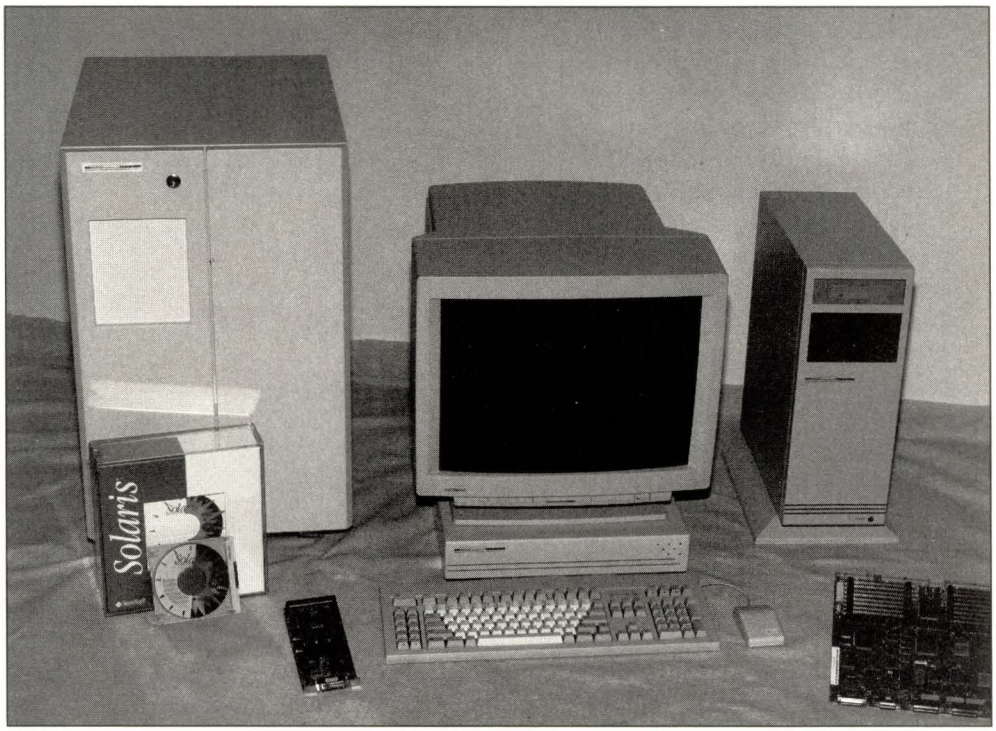

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ic, hard-charging, goal-oriented, marketing-driven companies would find it difficult to justify the time and expense of network membership.

Until, of course, nondynamic, soft-charging, means-oriented, R&D-driven Company B across the road leaves it in the dust because Company B understands the market far better than the other company ever will, because Company B is part of the marketplace, not just an address on a business card.

And that's the problem.

Increasingly, at least in the arena of what is still called the "computer biz," whoever has the information gets the market, at least, if the rest of the corporation is in place and more or less functional. And, increasingly, the information is most readily available on the net. Want to know what the TCP/IP folks are cooking up now? Better be on the net. Wondering where the networking troubles are thickest? Better be on the net.

And so it goes.

But membership in any of the nets brings a whole ratbag of troubles. Let's consider two cases: Usenet and Internet.

The major obstacle to membership in Usenet is that Usenet lacks administration and, in fact, lacks any real definition of membership. Usenet is like a disease–you catch it from a neighbor who has it, and your life becomes a living hell.

Usenet is only a network in the loosest sense. It does connect one machine to another, but it uses a wild variety of ways of doing so, from Internet sockets to tin cans and string. It passes articles seemingly written by anybody at random, divided into a tree-structured hierarchy of "newsgroups." The main problem with Usenet is lack of editing. Since most of the newsgroups are unmoderated, any random person can post arbitrary material. "Peer pressure" is the only means of preventing inappropriate postings and is of limited success.

The risk, then, is that in some newsgroups it takes a very long time to weed through the chaff. This can be minimized in some cases through the use of "moderated" newsgroups, whose postings must pass through the hands of a (usually volunteer) moderator before appearing in the newsgroup. This helps immensely.

Another risk is to the organization's own public reputation. Everyone who posts to Usenet projects an image by so doing, and that image is often seen as representative of the organization from whose machine the postings come…at least, by the organization! No one in his or her right mind, Mr. Protocol avers, thinks that Usenet postings have any relevance to the organization from which they originate. Postings are personal and are generally perceived as such. Some organizations require their employees to close all postings with ridiculously long disclaimers, usually when the legal staff has gotten a whiff of Usenet. This usually makes the organization look ridiculous, since, like it or not, a disclaimer is taken as a posting on behalf of the organization itself!

Security through obscurity is a terrible precaution if it's the only precaution, but it works a surprising amount of the time.

Some organizations prevent such problems by remaining invisible–they prohibit posting by some or all of their people. The problem created by this policy is that, in the first place, employees who want to post *will* post, from some other site, which is all to the good, but they generally make no secret of the fact that they cannot post from their normal site, which makes the site look fascist.

How can an organization make effective use of Usenet without run-

ning afoul of the risks? Mr. Protocol is glad you asked. One way and another, you can't. Something will always go wrong. Your feed will screw up. Your news manager will screw up. The news software will screw up with no help from anybody while your staff is out of town. One of your users will display a hitherto unsuspected psychotic streak in one of the major newsgroups. Something will go wrong. But once the information starts to flow in, the weeding process becomes semiautomatic...and invaluable. And if you restrict your feed to only a few groups, you'll be happy: blissfully ignorant of all the rest. Some claim that's a very positive thing. These people are either posing or victims of cognitive dissonance.

The fact is that there is a lot of very valuable information scattered all over Usenet, and what is really needed are tools to do the weeding. That, however, is a topic of current research. So far, most of the weeders have an awful tendency to throw the baby out with the bath water.

On Usenet, then, it's necessary to balance risks and gains. What about the Internet?

Same thing.

The Internet, in some ways, has both a more passive and a more immediate feel to it. While Usenet bombards the member site with information, the Internet merely makes it available, and it's up to the member site to do the digging. However, the Internet is a real-time network, while Usenet is not, and can generally pass much larger parcels of information. Mr. Protocol has mumbled on in the past about such services as Archie and WAIS, which can be used to dig out information on the whereabouts of Internet information. However, there are other benefits as well, mail being one of them. People don't pay as much attention to Internet mail as they once did, perhaps because the giant digests and lists have in large measure been subsumed by Usenet. However, personal email is still the most direct and in many ways the most fruitful way to use the Internet.

As far as risks go, however, Internet

is full of 'em. Oddball as Usenet may be, it generally cannot compromise the security of a machine. The Internet seems to specialize in ever newer and more esoteric ways of giving away the store, however, and it is a very real problem for organizations that wish to make use of the power of the Internet.

One way around the problem is to run obscure hardware. Those who, for example, run IBM mainframes with MVS for an operating system, are probably fairly safe from penetration, just because almost everyone else on the Internet is some sort of a UNIX weenie. "Security through obscurity" is a terrible precaution, if it's the only precaution, but it works a surprising amount of the time. The CMU campus was largely immune to the Internet worm because they hated `finger` and `sendmail`, and ran replacement software which did not contain the bugs exploited by the worm. Mr. P. will not go so far as to say that other bugs replaced the well-known ones, but whether they did or not, they were not exploited!

Crackers are the major risk of Internet presence, whether human or automaton. The Computer Emergency Response Team posts reports of vulnerabilities in various operating systems, but only after the vendor involved has developed an orchestrated plan for fixing it, which means that until the posting finally appears, it's open season. Mr. Protocol doesn't particularly like CERT's "security through obscurity" stance in this regard and notes that there are those who on this account will have nothing to do with them. He thinks that on the whole they do provide a valuable service, however.

One active measure that can be taken is to build a moat around the organization, allowing only one machine to have direct Internet access. This approach can be taken more or less strictly depending on the degree of paranoia involved. Some organizations sit invisibly behind their single Internet point of presence, and don't allow anything out. This invisibility trick usually works well but puts a real damper on interaction. Others are more creative in programming their routers. They have one and only one machine that may receive connections on the "privileged port numbers" (those below 1024), but all machines in the organization may freely make outbound connections. Hence, only one machine is available to outside penetration, and it may be run "fully armored." Since the other machines don't get incoming packets passed to the low socket numbers, they "aren't there" as far as penetrators are concerned. This gives a reasonable compromise, Mr. Protocol feels, though people with a legitimate need to log in from remote places do have to log in twice: once to the "bridge" machine and once to the real machine.

The final risk of which Mr. Protocol has heard is an unusual one: a legal risk. There are apparently those legal eagles who believe that making information available on the Internet gives up any reasonable expectations of copyright protection–one company, in fact, while it has an Internet connection, makes information available only via a dial-up BBS for this reason. Mr. Protocol feels that this is a real step backward. He notes that the legal aspects of networking are terra incognita and thinks that's a real and unexpected risk of networking. Your company may be eaten by monsters. ⊸

Mike O'Brien has been noodling around the UNIX world for far too long a time. He knows he started out with UNIX Research Version 5 (not System V, he hastens to point out), but forgets the year. He thinks it was around 1975 or so.

He founded and ran the first nationwide UNIX Users Group Software Distribution Center. He worked at Rand during the glory days of the Rand editor and the MH mail system, helped build CSNET (first at Rand and later at BBN Labs Inc.) and is now at an aerospace research corporation.

Mr. Protocol refuses to divulge his qualifications and may, in fact, have none whatsoever. His email address is `amp@expert.com`.

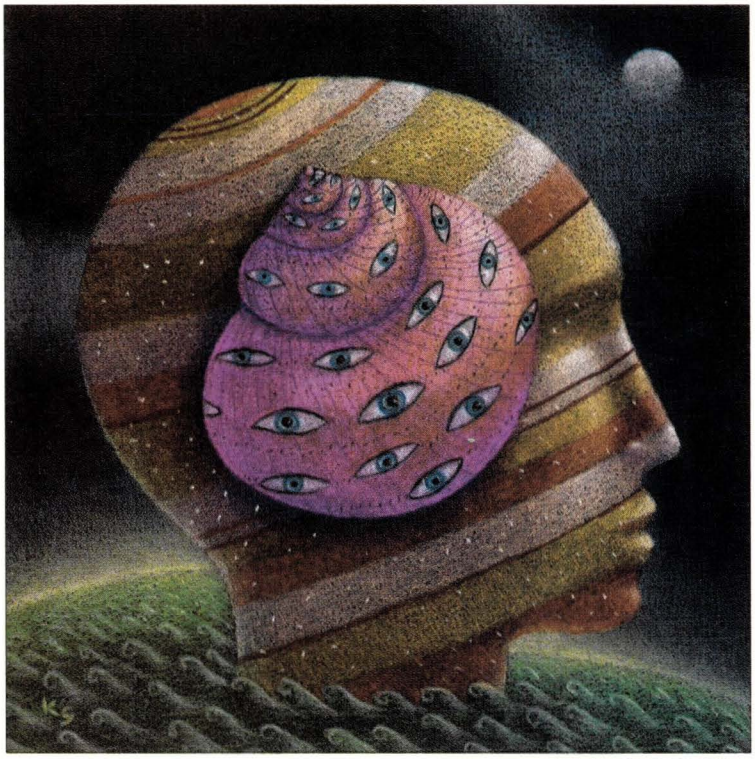

ILLUSTRATION BY KEITH GRAVES

by **PETER COLLINSON**,
Hillside Systems

Shell Programming Basics

The earliest shell scripts that you will write consist of several commands representing a concrete job that you frequently do. These sequences are often simple one-liners. You might consider using an alias rather than writing a script, if your shell supports that notion. I am going to ignore that possibility for the purposes of this article.

The easiest shell script to write consists of a sequence of commands that are identical to those that you would enter via the keyboard to achieve some task. The script is placed in a file, and the command

`chmod +x` *file*

is run to set the execute bits. You have created a new command that will take some private action. I tend to place all my private commands in a directory unsurprisingly called `bin` under my home directory. That way I know where all my private commands are to be found. They hide in a directory I rarely enter, so they are safe from misguided tampering and accidents. Also, I can place the directory in my search path, allowing my commands to become full citizens in my private UNIX world.

Simple Scripts

Let's imagine that you are worried about saving the state of some files on a daily basis. You might write a script like:

```
# backup script
cd /home/me/data
cp database database.sav
cp index index.sav
```

The idea of the script is to execute two copy commands to save the state of two files. It starts by changing directory to a known place in the filesystem tree. You don't need to do this, but it means that you don't have to explicitly move before executing the backup operation. You can run the command from anywhere and store it anywhere (like a private `bin`). You can also run the command from `at` or `cron`.

Also, it's a good idea to add the magic execute line at the start of the script to tell the system which program is used as an interpreter for the script.

```
#!/bin/sh
# backup script
...
```

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I am going to ignore that need for the rest of this article too.

All this is fine. What happens, however, when you discover that you want to do these same actions for a different set of files? Many people start by simply copying the commands into a new file and then editing the bits that are different. This works, but it isn't too elegant and doesn't scale. It's better to think that the script is a template of actions. It's a tiny shell program, if you like.

Let's imagine that you have similar sets of files in different directories. We want to make the initial `cd` command force a move to a different directory. We do this by putting the name of the directory into a variable, maybe:

```
# backup thought
cd /home/me/$DATA
cp database database.sav
cp index index.sav
```

If the `DATA` variable holds `data`, then the result is as before. The `$DATA` string is textually replaced by the contents of the variable and the resulting command executed. The `cd` command now hops into a directory depending on the value of the `DATA` variable.

Now the question arises of how DATA is set. One idea is to set it from the parameters of the script. We want to call the script like:

```
% backup db1
% backup db2
```

This can be done by simply replacing the `DATA` variable in the script by a `$1`. This is a piece of shell magic, a `$` followed by a number is a *positional* parameter and is replaced by the value of an argument to the script. The first argument is referred to as `$1`, the second as `$2` and so on. The file name of the script is referenced by `$0`.

We can now write the command:

```
# backup arg
cd /home/me/$1
cp database database.sav
cp index index.sav
```

This will work. It's not too safe. What happens if the script is called with no arguments? We need a little bit of programming. Luckily, the Bourne and Korn shells allow you to generate a default easily.

```
# (sh) backup arg
DIR=${1-data}
cd /home/me/$DIR
cp database database.sav
cp index index.sav
```

The first line sets the variable `DIR`, and this is used as the argument to the `cd` command. The `DIR` variable is set from a piece of shell syntax that says: "If argument one to the script is set, then use its value, otherwise use the string `data`." When the backup command is called with no arguments, `DIR` will be set to `/home/me/data`. Otherwise you can call the command with a parameter that specifies a directory where it is to be run.

For `csh`, you have to use an `if` statement to check if the argument list has the appropriate number of entries:

```
# (csh) backup arg
if ($#argv < 1) then
        set DIR = data
else
        set DIR = $argv[1]
endif
cd /home/me/$DIR
cp database database.sav
cp index index.sav
```

In the first line, the number of set variables in the `argv` vector (`$#argv`) is compared with one. Arrays are supported in `csh`, and the arguments to a script are simply loaded one at a time into the `argv` array. The value from the array is picked up in a conventional form by `$argv[1]` on the third line. The shell supports a shorthand for this notation: You can write `$1`.

Right. We know how to take a set of commands that you use frequently and make them into a simple script. I have worried a little about making things robust. It's always a good idea to consider this, even if you will be the sole user of the script. You can mistype too. A little thought now can save hours of unneeded work later.

Using the command line to control a script is common, but its applicability depends on the application. Often, the user interface is better implemented in a question and answer form. The script will print a question and elicit a response from the user.

Quotes

Printing a prompt seems easy–simply use `echo`.

```
echo Are you sure?
```

It's good practice to always quote arguments to the `echo` command. The example above shows you why. The last argument, `sure?`, will be seen by the shell as a string that needs expansion. The question mark expands to match a single character, so the shell will look in the current directory for a five-character file name starting with `sure`. This is not what was intended.

If you are a `csh` user and shell does not find a match, it will helpfully complain to maximize your confusion, saying:

```
echo: No match.
```

Unless you have said

```
set noglob
```

to turn off filename matching.

AND THEN THERE WAS ONE

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For the Bourne and Korn shells, the `echo` command will appear to be working correctly until you create a file that matches, say `sureX`. The command will suddenly print:

```
Are you sureX
```

to the confusion of everyone.

You should really write something like:

```
echo 'Are you sure?'
```

Notice that this also passes a single argument into `echo` rather than the three that were being used previously.

There is often misunderstanding about the difference between double and single quotes. Strings inside single quotes are not inspected by the shell. You can guarantee that any text that you place inside them will find its way to the output.

Double quotes permit the expansion of shell variables inside the quoted string, but star, question mark and square bracket (list) expansions are not done. This is mostly used where you want to control the grouping of data on the command line, so

```
echo "$0 - Are you sure?"
```

ensures that a single argument is passed into the `echo` command containing the name of the current command, a hyphen and the `Are you sure?` string. When looking at how this works, it's best to consider it a two-stage operation. First, the variable (here `$0`) is textually replaced by its contents, then the command is called with the newly derived argument.

As a further illustration of the creation of a single argument, look at:

```
VAR='Hello world'
# (csh) set VAR = 'Hello world'
echo $VAR
echo "$VAR"
```

The variable `VAR` is first set to contain a string with an embedded space. The first `echo` command will be called with two parameters, since `$VAR` is replaced on the line and *then* expanded. In the second case, the variable is enclosed in double quotes. After expansion, the shell will group the words back into one argument.

The use of the `echo` command here is a little misleading, I suppose. It really doesn't matter how its arguments are expressed, unless you want to ensure that a tab character is passed through intact. For example, if the space between the `Hello` and the `world` above were really a tab character, then it would only be correctly passed to the output if the whole string is quoted (as in the second command).

A further quoting mechanism exists in shells. If a character is preceded by a backslash, then it is passed through directly to the command. This allows you to get various shell metacharacters into the commands with a minimum of fuss.

Unfortunately, csh differs from the other two shells in the binding and use of the backslash character. For Bourne and Korn shells, backslash can be used in double-quoted strings to ensure that the character double quote can be passed into the command.

```
echo "$0 - \"error message\""
```

will print

```
backup - "error message"
```

depending on the command name. For csh, you probably need to write something like:

```
echo "$0"' - "error message"'
```

Should you want to use an exclamation point in some output and you use csh, you will find that you must always precede this with a backslash.

You may need to insert a backslash before dollar signs when you are writing portions of scripts in awk or sed. These programs use a dollar sign followed by a number for their own purposes. Again, be careful if you are a csh user. This does not work as expected. For example,

```
# csh
% set USER = pc
% echo "\$USER"
```

yields \pc as output. To me this is a little counterintuitive. It depends on what you are used to. The other shells will do:

```
# sh
$ USER=pc
$ echo "\$USER"
$USER
```

If you want a shell variable to contain a constant that spans more than one line, then you will need to insert a backslash before each line when you are using csh:

```
# csh
set long = 'More than \
one line'
```

I find this is a compelling reason to always use sh or ksh, where you can say:

```
# sh
long='More than
one line'
```

This makes multiline sed and awk scripts much easier to enter and read.

You have to be a little careful if you want to get a single quote into the output. Printing something like:

```
backup - I don't like that
```

can be done using double quotes:

```
echo "$0 - I don't like that"
```

But you will find that

```
echo 'don\'t do that'
```

doesn't work as you might expect. In csh it will provoke an error. In the other shells, the backslash replacement action is turned off by the first single quote. One way round this is to

You may remember that the square bracket construction in sh is a special shorthand for the test command.

realize that shells are text processing languages and will glue contiguous strings together. You can say:

```
echo 'don'"'"'t do that'
```

I use this type of trick a lot when writing scripts for awk or sed. I want to use single-quoted sections to ensure maximum readability of my program. I hate having to insert backslashes. Occasionally, I want to insert the value of a shell variable into one of these single-quoted sections, and I always use this concatenation trick to effect that.

Printing Prompts

Remember what we were trying to do? You are excused if you have forgotten. We were about to print a prompt, ready to get an answer from the user. There is one more piece of information that we need to know. The echo command will normally print a new line after it finishes. We need to suppress that, so that the answer from the user is echoed on the same line as the question. There are two ways of doing this, depending on your shell and the UNIX culture on your machine.

The echo command has some options in a BSD-derived system. One, -n, says "Don't add a newline after you print." Your version of ksh may also do this, depending on how it was compiled and what environment it considers that it is running in. The -n flag is considered culturally "in the Berkeley camp," and ksh will adapt.

With System V, you can add formatting characters into

the text string that echo prints. These are indicated by preceding some alphabetic character by a backslash. To suppress the printing of a newline, you add \c at the end of the text that is printed.

Our prompt is printed either by:

```
echo 'Are you sure? \c'
```

or:

```
echo -n 'Are you sure? '
```

Notice that in both cases, I end the text with a space. This means that there is a space between the text that the machine types and new data about to be input by the user. I prefer this, because it looks nicer.

Reading Data

At long last, we are ready to get some information from the user. Let's pursue the notion of asking the user for confirmation of some action by requesting a *yes* or *no* reply to a question. This is simple, you say

```
# sh
echo -n 'Are you sure? '
# use \c for System V
read ans
```

or

```
# csh
echo -n 'Are you sure? '
# use \c for System V
set ans = $<
```

This waits for the user to enter some text ending with a newline. The text without the newline is placed into the variable ans. Let's say we want to exit if the user types *no*. For sh we might say

```
if [ "$ans" = no ]
then
        exit 1
fi
```

You may remember that the square bracket construction in sh is a special shorthand for the test command. For sh, the test command does the comparison work and returns a success/failure result. These days, test is built into the shell, so there is no performance hit from this. In csh, the test is done directly

```
if ( "$ans" == no ) exit 1
```

In both cases, I have carefully quoted the ans variable to guard against the user typing two words separated by spaces. Without the quotes, the script breaks, because the test in the if statement becomes syntactically incorrect.

Actually, I don't consider that testing for just *no* is friendly.

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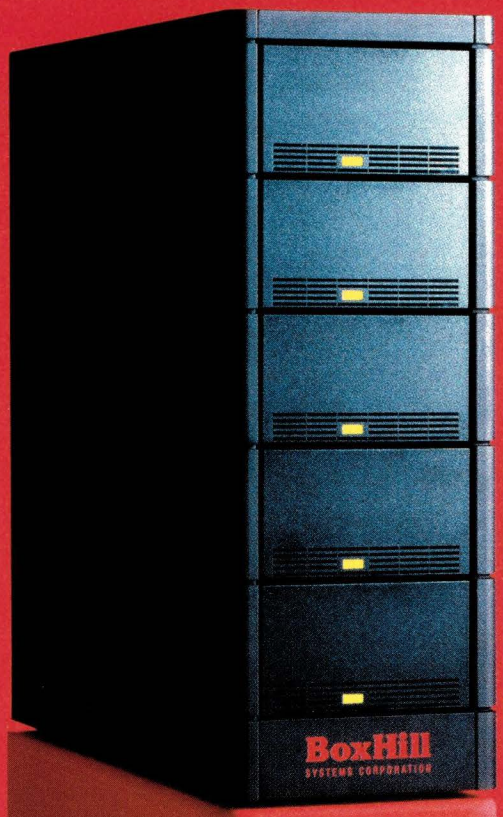

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I'd like to test for anything that the user might type to mean *no*. After all, we are asking whether the user wants something to happen or not. I will tend to use a `switch` or `case` statement because they both do pattern matching:

```
# sh
case "$ans" in
n*|N*)
  exit 1
  ;;
esac
```

This compares the source variable `ans` against the text matching string:

```
n*|N*
```

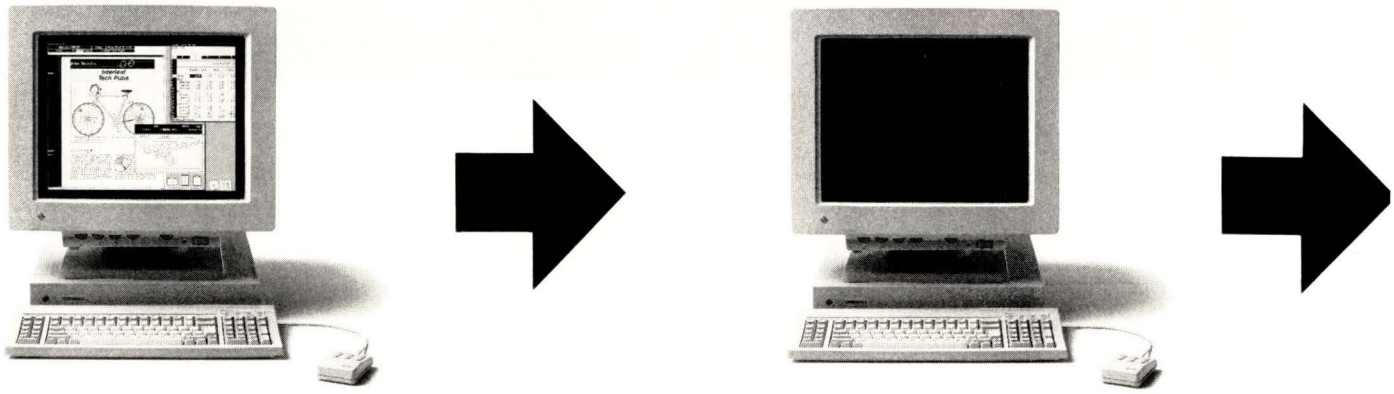
The star here obeys shell matching rules, so `n*` will match anything starting with the letter "n." The vertical bar denotes "or," the compound expression thus matches anything starting with "n" or "N." This should give us enough room for mistakes. If no match is found, then control simply drops through to succeeding lines of code.

When writing in `csh`, there is no "or" operator. However, the tests in the `switch` follow C semantics and "falls through" until a `breaksw` command is found:

```
# csh
switch ("$ans")
case y*:
case Y*:
  echo 'Got y'
  breaksw
case n*:
case N*:
  exit 1
endsw
```

We could easily go on to insist on a specific response from the user. Here's a `sh` function that I use frequently in my scripts.

```
# sh only
function yesno
{
  while true
  do
    echo "$1"'? \c'
    read ans
    case "$ans" in
    y* | Y* | "")
      return 0 ;;
    n*|N*)
      return 1 ;;
    *)
      echo 'Only y or n' ;;
    esac
  done
}
```



There is nothing too surprising here. The outer loop is executed until a valid response is entered. We have to do this because sh has no goto statement. It was created at a time when eminent computer scientists declared "goto's are considered harmful."

The first line of the inner loop prints the prompt, using the first argument to the function ($1). The routine returns success if the user types anything starting with "y," "Y" or simply a return. When a return is typed into read, the value of its arguments is the empty string, shown by """." It's typical to have default actions like this; I usually show the ability to do this by printing a prompt like

```
Are you sure [y/n]?
```

The routine returns failure if the reply string starts with either a "n" or a "N." The final case, just containing a star, matches everything. The default, then, is to print an error message and loop. You call all this by saying:

```
# sh
if yesno 'Are you sure'
then
  yes action
else
   no action
fi
```

which is neat and concise. One further sh trick is of use here.

```
# sh
if yesno 'Shall I continue'
then
  : null command
else
  echo 'I give up'
  exit 1
fi
more code
```

Here's a case where we want the *yes* answer to the question to drop into the following code while the *no* answer contains some useful statements. The trick is that the colon command does nothing. It is a command that is built into the shell and, effectively, a comment. All the data on the line following it is ignored. ➸

Peter Collinson runs his own UNIX consultancy, dedicated to earning enough money to allow him to pursue his own interests; doing whatever, whenever, where ever. ... He writes, teaches, consults and programs using SunOS running on a SPARCstation 1+. He is the Usenix Standards Liaison. Email: pc@expert.com.

I/Opener

ILLUSTRATION BY ROBIN JAREAUX

CD or Not CD, and Other Questions

by RICHARD MORIN, Technical Editor

CD-ROM has been slow to catch on with computer users. Most of the available disks are aimed at MS-DOS and Macintosh users, who balk at paying several hundred dollars for a CD-ROM drive. Prices are coming down, however (DAK sells a low-speed BSR drive for $200), so things may start to improve.

UNIX users have more money, but they don't have disks to motivate them. Most UNIX software vendors have avoided the CD-ROM market. If nobody can read the disks, they reason, why produce them? A classic conundrum, insoluble without drastic action.

Fortunately, Sun has taken that action. Offering discounted drives and sampler disks as a carrot, they applied a stick by eliminating all new tape distributions. If you want Sun's current software and on-line documentation, you have to have a CD-ROM drive.

In the typical Sun environment, this isn't all that big a deal. Sun bundles drives with its larger servers, so many sites get CD-ROM capability as part of the deal. Even if a special purchase is needed, the cost isn't all that high. A typical site can amortize a drive over a dozen or more workstations, making the average cost negligible.

Outside of the Sun market, the pickings are still pretty slim. The other workstation vendors have been slow to provide CD-ROM capability, and none have promoted it as forcefully as Sun has. Consequently, third-party CD-ROM providers have concentrated on Sun. Sun's competitors are working on the problem, however, and similar disks are starting to emerge for their machines.

CD or Not CD?

Assume that you have a pile of bits to distribute, and that your recipients have CD-ROM capability. Is CD-ROM is the right answer? Well, it depends.

If you need random access, plug-and-play, etc., CD-ROM is a big win. It doesn't require the recipient to use up valuable time or disk space, and it can be as idiot-proof as you desire. Finally, the chance of someone inserting a virus is vanishingly small.

CD-ROM is a clear financial win for large production runs. You can make a thousand CD-ROMs for around $3,000, plus or minus discounts, packaging, etc. Cartridge tapes cost nearly 10 times that much to produce. In addition, CD-ROMs are cheaper to ship, have low error rates and are immune to magnetic damage, humidity and most other shipping perils.

Even in smaller runs, CD-ROMs can be cheaper than cartridge tapes. A hundred CD-ROMs should cost less than $2,000 to produce, and you can't

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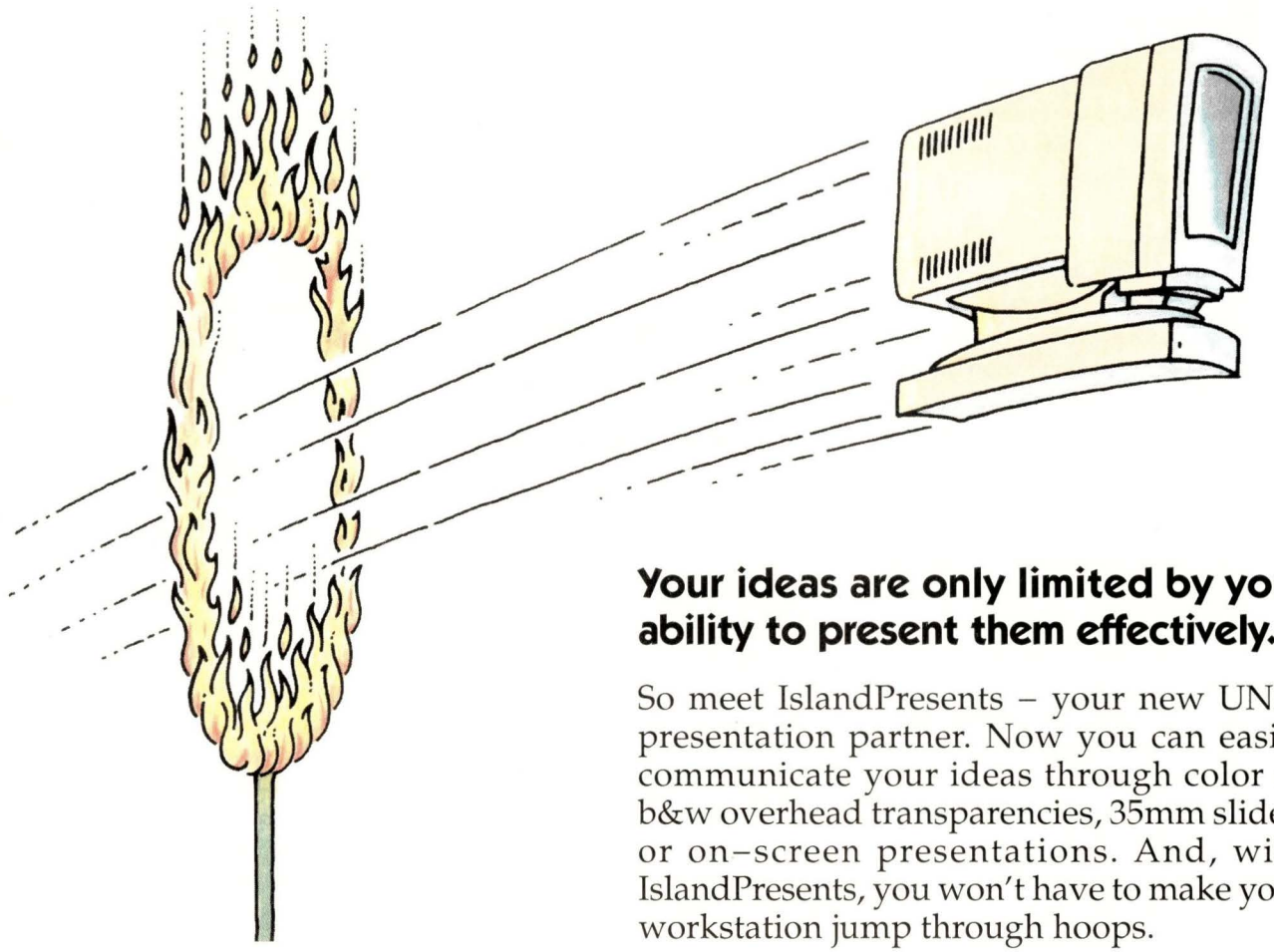

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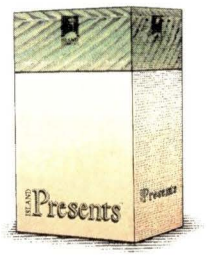

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ISLAND GRAPHICS

***Supported UNIX Workstations**: Sun–4, SPARCstations, and SPARC compatibles running OpenWindows™ 3.0 (more platforms to be added in 1992)

Circle No. 31 on Inquiry Card

write and verify cartridges for that price. Pre-mastering and mastering costs are going down, so CD-ROM is becoming economical for smaller and smaller runs. Andrew Young, president of Young Minds, contends that the current crossover point is under 50 units, and dropping.

File Systems

All CD-ROMs store raw data in the same format. Consequently, if you are distributing a single file, you can punt the file-system question entirely. Alternatively, if you don't need or want random access, you can store everything in a single `tar` or `cpio` archive. Most distributions, however, need some form of file system.

The current standard for CD-ROM file systems is ISO-9660. Based on a de facto standard known as "High Sierra," ISO-9660 is capable, efficient and widely available. If your users can live with MS-DOS file naming and semantics, ISO-9660 is a perfectly reasonable choice.

Most UNIX software distributors, however, find ISO-9660 to be overly restrictive. The file names are bad enough: eight characters or less, no case sensitivity, only one special character (_). Add the limit on directory levels (eight), and the lack of modes, symbolic links and other UNIXisms, and the situation gets unacceptable in a big hurry.

The other options aren't very wonderful, either. If all your recipients use the same OS, you can use the native file system. Sun does this on many of its disks, as do several third-party vendors. The main drawback here, aside from a complete lack of portability, is that hard-disk file systems are not well optimized for use on CD-ROMs. Your disk will require far more (slooow) accesses than it should, leaving the user with a less than optimal impression.

Fortunately, a solution is nearly at hand. The Rock Ridge Interface Protocol (RRIP) is upwardly compatible with ISO-9660, but provides full (read-only) UNIX file-system semantics. The gotcha is that only one UNIX vendor seems to have RRIP support in place. NeXT has announced it for the 3.0 OS release. Several other vendors have it in the pipeline. Only Sun has it now, however.

Sun supports RRIP for SPARC platforms in SunOS 4.1.2 and will support it for both SPARC and Intel in Solaris 2.0. The remaining UNIX vendors should have it in a matter of months. Thus, if you are selling into the SPARC market, or you can wait a while, the file-system problem is solved.

Testing ensures that you won't receive a thousand 5-inch coasters.

Young Minds provides RRIP support for several platforms, selling to both vendors and end users. In particular, they support the Sun-3 under SunOS 4.1.1, building on Sun's (unsupported) `sr` driver. Although it isn't likely that there will be many disks catering to the Sun-3 per se, RRIP capability will still be useful.

Making a Disk

There isn't much involved in producing a CD-ROM. Collect the bits onto a single disk partition, as a directory hierarchy. If you are using ISO-9660, make sure that the file names and types meet its limitations. If your recipients may be using System V, eliminate symbolic links and make sure that you have no file names longer than 14 characters.

Set all modes on the hierarchy to 555. Log in as a normal user and try out your software. If your software thinks it needs write access to the disk, now is the time to find out. Now remount the disk at a different location; the user may not agree with your idea of the appropriate mount point.

Acquire and study the directions provided by the pre-mastering firm. They will suggest a format (typically `tar` or `cpio`), block sizes, etc. They may also have local requirements, such as forcing all of the files to mode 777. Play along with them; UNIX is more flexible than most pre-mastering systems.

The pre-mastering process is somewhat chancy. Tapes may not read properly, for reasons of hardware or software, or the finished product may have a fatal glitch. Despite my careful perusal of the pre-mastering instructions, I was forced to write a series of tapes before the process could be completed.

I strongly suggest that you produce a pair of "one-off" CD-ROMs. These can be produced as the output of the pre-mastering process and can be used in a normal CD-ROM drive. After you have tested the one-offs, you can send one of them to the mastering plant. (Testing ensures that you won't receive a thousand 5-inch coasters; do it!) Retain the other one for peace of mind and play with it while you wait for the mastering and duplication.

If you have a local pre-mastering firm, use them. This will allow you to fix problems with a minimum of wasted time. A few firms can bring the pre-mastering system to your site. This is the ideal situation, as long as the cost is within reason. I paid $650 for pre-mastering, at my site, with two one-offs as output.

If you will be doing disks frequently, you may want to invest in a pre-mastering system. Young Minds has a very speedy system for under $20,000, and other vendors (JVC, OMI, Philips,) have cheaper (albeit slower) systems in the pipeline.

Cost and time are closely related for mastering and production. If you can wait a week or two for your disks, you can save a bundle. If you need them tomorrow, expect to pay for the privilege. This applies both to initial and follow-on production runs. A little planning can save quite a few bucks.

Packaging, etc.

CD-ROMs are most frequently packaged in plastic "jewel boxes." These cost about 25 cents each, in quantity. If you are planning to mail out large numbers of disks, jewel boxes may not be the best choice. The boxes are somewhat fragile, and their weight will increase your shipping costs.

Resources Mentioned in this Article

CD-ROM Professional
Subscription Department
Weston, CT 06883-9980
Circle 100

DAK Industries Inc.
8200 Remmet Ave.
Canoga Park, CA 91304
Circle 101

***MacWorld*, Back Issues**
c/o Snyder Newell Inc.
P.O. Box 7046
San Francisco, CA 94120-9727
Circle 102

Sun Microsystems Inc.
Catalyst CDware
P.O. Box 16487
Denver, CO 80216-9875
Circle 103

UniDisc Inc.
3941 Cherryvale Ave.
Soquel, CA 95073
Circle 104

UniVenture
P.O. Box 570
Dublin, OH 43017
Circle 105

Young Minds Inc.
1910 Orange Tree Lane
Redlands, CA 92374
Circle 106

To keep costs to a minimum, consider using a Tyvek or clear vinyl sleeve. The Tyvek sleeves cost about five cents each. Sleeved disks are normally inserted into cardboard mailers, along with brochures, etc. Sun's Catalyst CDware disks are packaged this way, as are some of the other "sampler" disks.

I like the UniVenture vinyl sleeves. They cost a bit more than jewel boxes, but they aren't fragile, and they don't weigh much more than a Tyvek sleeve. UniVenture has various models, some of which can be bound into manuals, etc.

Any flexible packaging begs the question of protection for the disk. UniVenture has tested the physical resilience of CD-ROMs and has determined that they are amazingly sturdy. CDs are almost impervious to crushing and deal very well with mild flexing. I have shipped several hundred vinyl-packaged CD-ROMs to date, and few have yet been damaged in shipment.

Printed inserts and booklets are typical and will add to your costs. They are useful, however, if only to tell the user how to mount the disk. Once you decide to do a booklet, of course, you will want to include all sorts of marketing information and other razzmatazz. Have fun, but be aware that the booklet can easily cost more to produce than the disk it accompanies.

You should also plan to create artwork for the disk label. The mastering houses will create a perfectly clean disk label upon request, but you can achieve snazzier results by commissioning your own artwork. Two-color printing comes for free; more colors can be added at extra cost.

Resources

Beg, borrow or steal a copy of Liza Weiman's article "How to Make Your Own CDs" (*MacWorld*, April). The eight-page article is loaded with photographs and tables and does a fine job of covering the CD-ROM manufacturing process, technical details, cost factors, etc. Understandably, there is a strong Macintosh slant, but the article is dynamite reading for anybody thinking about doing a CD-ROM.

CD-ROM Professional is a substantial magazine, containing a mix of technical articles, product reviews and industry announcements. The magazine, now in its fifth year of publication, calls itself "The Magazine For CD-ROM Publishers and Users." The magazine might be a bit intense for casual CD-ROM users, but I have no other quibbles with the claim.

Serious CD-ROM users may also want to get "The CD-ROM Directory On Disc," published by UniDisc. This semi-annual publication leverages the power of the medium against the plethora of information about it. The current disk catalogs over 2,200 CD-ROMs and over 2,500 companies. ➸

Richard Morin produces Prime Time Freeware, a semiannual CD-ROM collection of redistributable, UNIX-based source code. Between releases, he consults, writes and teaches on UNIX topics. He may be reached at CFCL, P.O. Box 1488, Pacifica, CA 94044, or by email at `cfcl!rdm@apple.com`.

Your Standard Column

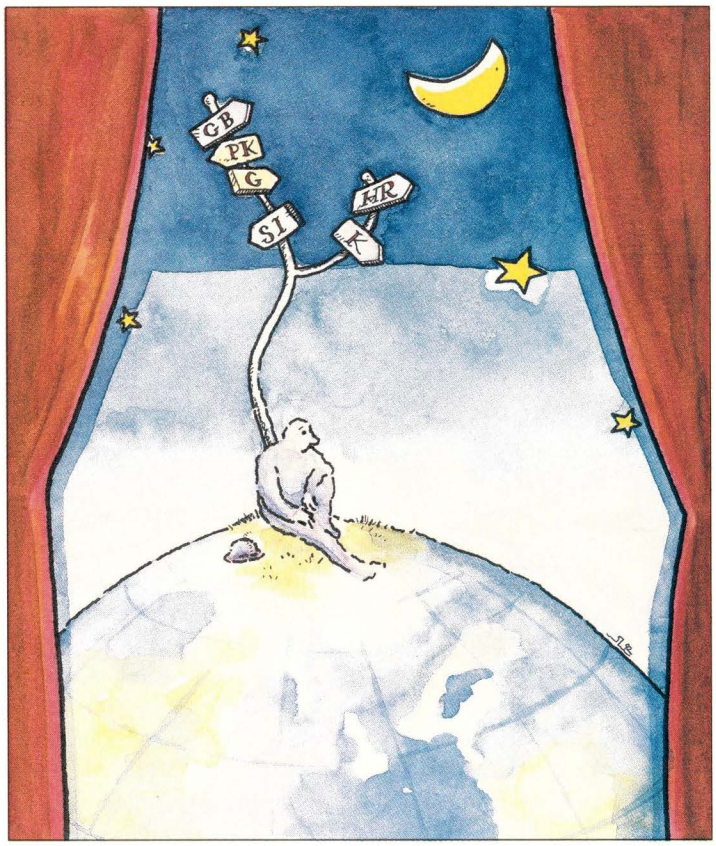


ILLUSTRATION BY S. H. LEE

by PETER H. SALUS

Freedonia and Ruritania

You'd have to be fairly isolated not to have noticed just how many new countries there are these days. And the creation of these political entities involves ISO 3166–two-letter abbreviations for national names. 3166 has DIN (the German National Standards body) as its maintenance agency: This means that work can be done without the necessity of rewriting the standard. While DIN is generally efficient, there is occasionally a need for a code prior to the assignment of an official one. AA, QM-QZ, XA-XZ and ZZ have been set aside as "available for individual use."

Well, DD (German Democratic Republic) and SU (Soviet Union) have gone the way of the continent of Atlantis and the towers of Ilium, and we now have:

Armenia	AM
Azerbaijan	AZ
Belarus	BY
Georgia	GE
Kazakhstan	KZ
Kyrgyzstan	KG
Moldova	MD
Russia	RU
Tajikistan	TJ
Turkmenistan	TM
Ukraine	UA
Uzbekistan	UZ
Estonia	EE
Latvia	LV
Lithuania	LT
Croatia	HR
Slovenia	SI

And how long, you might inquire, before DD and SU are available for recycling? Clause 6.4.1 of the standard tells us that we would have to wait a minimum of five years before Upper Slobovia could get SU (US is already in use).

These two-letter codes are known as the ISO alpha-2 codes. In general, they're the ones that you put at the end of an Internet address (except that `.uk` is used instead of `.gb`). Unfortunately, there are other sets of alpha codes.

For licensing, country identification on automobiles:

GB	United Kingdom
F	France
NL	Netherlands
CH	Switzerland
SU	Finland
CDN	Canada
D	Germany
I	Italy
E	Spain
P	Portugal
PL	Poland

Then there is a different set for sailboat sail-numbering codes:

K	United Kingdom
H	Netherlands
US	United States
KC	Canada

And there are also aircraft registration codes:

N	United States
PH	Netherlands
G	United Kingdom
PK	Indonesia
D	Germany
F	France

Clearly there is no overall consistency, but at least there is a way of identifying countries and adapting to the vagaries of self-determination and politics.

CORBA

Q: What is spiral-bound, 177 pages and costs $50?

A: *The Common Object Request Broker: Architecture and Specification.*

Yes, it could make strong standards bearers weep. Just at a time when ANSI's X3H7 (Object Information Management) committee has begun meeting, the Object Management Group and X/Open have come up with a document intended to provide the "mechanisms by which objects transparently make requests and receive responses." In view of the fact that the document has been endorsed by DEC, HP, HyperDesk, NCR, Object Design and SunSoft, it may well be too late for the technical community to begin looking at these specifications.

One of the goals of the Object Management Group was that the specification be available commercially with alacrity. The endorsers claim to be doing so, and DEC has already announced a CORBA-compliant product.

It looks to me as though the OMG and X/Open have defined a framework within which different implementations can provide common services and interfaces supporting portable clients and object implementations.

ANSI X3T3 (Open Distributed Processing) is working on a standard for ODP in terms of object technology, working with the ISO 10746 Reference Model. There are three normative parts to the RM: Part 2, Descriptive Model–concepts that could be applied to any distributed processing system; Part 3, Prescriptive Model–generic architecture for ODP; and Part 5, Architectural Semantics, Specification Techniques and Formalisms. Part 1 is the Overview; Part 4 is the User Model. Both of these are non-normative. X3T3 will be meeting in Boulder, CO, June 22-26; Portland, OR, September 14-18; and New Orleans, December 7-11, 1992. If you are interested in this committee, call Edward Stull, Summa International, (301) 942-4355.

ISO 9000

As most of you must know, it is now 1992. After this year, any company that wants to do business with the European Community will have to comply with ISO 9000-9004, which is a quality standard. It is no triviality to comply with this standard. Each country has (at least nominally) set up organizations to register compliance. The United States' version is ANSI/ASQC Q90-94 ($60 plus $6 handling, prepaid). I'd really like to know what various companies are doing to comply with this quality standard.

Peter H. Salus is the executive director of the Sun User Group. He has attended both ISO and P1003/P1201 meetings and expects remission of time in purgatory as a result. Email: peter@sug.org.

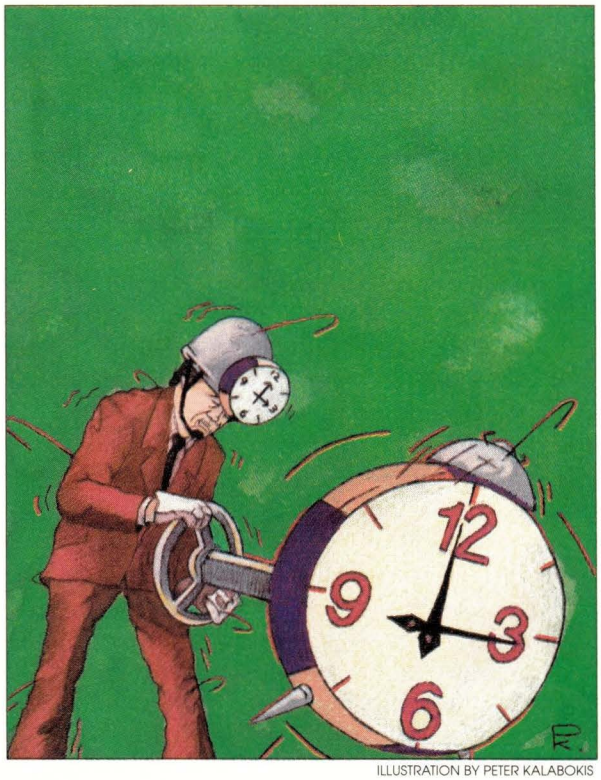


ILLUSTRATION BY PETER KALABOKIS

Synchronizing Clocks

by S. LEE HENRY

The image I have is of Maxwell Smart's repetitious "Let's synchronize our watches." The idea of timing a rendezvous down to the second seems so unrealistic. I have a teenage daughter. Vail is never on time.

So, naturally, I thought that the accuracy of system clocks wasn't a big deal. I was wrong. My users care a lot more than I thought; they even consider the accuracy of their clocks an indication of the reliability of our Sun hardware.

We'd long ago put an `rdate` command in our `rc.local` file, but apparently that wasn't enough. Our clocks were as much as 20 minutes out of phase, and a number of users were calling in and complaining. So, to keep my users from blaming the workstations when they're late to a meeting, I needed to get the clocks running closer to the same time.

The Rdate Command

The `rdate` command, which sets the time and date from the host whose name is supplied, must be run by superuser. So, `cron` seemed to be the natural place to run this command, and once a day seemed adequate.

To run the `rdate` command, you first need to select a host whose sense of time is reasonably accurate. Once you've selected that host, entering the command in `cron` is straightforward. I thought, however, that setting up a hierarchical system where servers would `rdate` off one reliable server and clients would afterwards `rdate` off their own server would be ideal. If you work on a network that spans time zones, or that is large enough that an occasional storm of `rdate` commands all running against one system would be a problem, running `rdate` against a local system is much better. So, I wrote a script to run the `rdate` command against the local server. The script first needs to decide which other host is its server (or if it is a server itself) then run the `rdate` command.

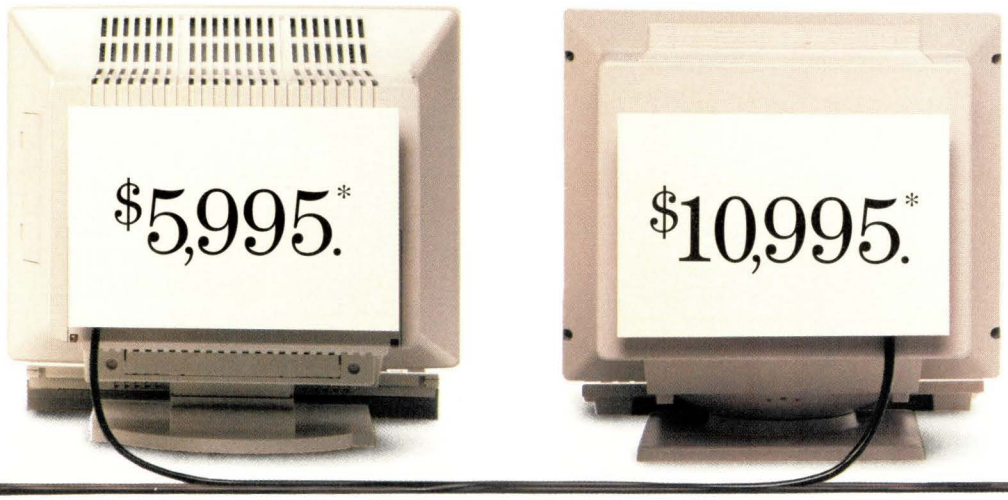
Who's My Server?

How does a client know who its server is? If the client is diskless, that question is answered fairly easily with another question. Where is its root file system? Running the command shown below would provide the server name by pulling it out of the `fstab` file.

```
cat /etc/fstab | grep -v "#" | grep root |
  awk -f: '{print $1}'
```

What's the only real difference?

$5,000.



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*Suggested U.S. list prices for 19" color models. Contact your local HP sales office for details. OPEN LOOK is a trademark of AT&T. MOTIF is a trademark of the Open Software Foundation. VUE stands for Visual User Environment. †IBM RS/6000 support available September, 1992. HP Vectra PCs running Santa Cruz Operation Open Desktop. CSPA001

Circle No. 24 on Inquiry Card

This command looks for non-comment lines with the word "root" in them and grabs the name of the host. From the line

```
magician:/export/root/merlin / nfs rw 0 0
```

it returns "magician."

If the command returns a null string, you know its root file system is local. Therefore, it's either a diskfull or dataless client.

The command:

```
cat /etc/fstab | grep -v "#" | grep sunos |
  awk -f: '{print $1}' | head -1
```

will tell you from where the client is getting its SunOS. This will return a value for diskless and dataless clients.

Assuming timekeeper is a system with a fairly accurate clock, the following script will run the `rdate` against the server for a diskless or dataless client or against timekeeper for a diskfull system. You could easily modify this criteria. For example, if you said `set server = `ypwhich``, you'd run against the host to which we're binding for NIS services.

```
#! /bin/csh
#
# for diskless and dataless clients
set server = `cat /etc/fstab | grep -v "#" | \
 grep sunos | awk -f: '{print $1}' | head -1`
# for servers
if ($server == "") then
  if (`hostname` != "timekeeper") then
    /usr/ucb/rdate timekeeper
  endif
# for clients
else
  /usr/ucb/rdate $server
endif
```

If you add your `rdate` command to `cron` by the procedure I described in March's column (`echo`ing to the end of the file, killing and restarting `cron`), you need to be careful of the timing to make sure the kill is complete before the restart occurs. If there's ever a question, you can reissue the `cron` command, but `cron` is a process that should not be run more than once–since it never exits. The `/var/spool/cron/FIFO` file, if it exists, will prevent another `cron` process from starting. The procedure below, startup, can also be used. It will start up a process only if it isn't already running.

```
#! /bin/csh
#
if ($#argv != 1) then
  echo "usage: startup </pathname/process>"
  exit
endif
# separate proc name from full path name
# (eg, cron from /usr/etc/cron)
set fullproc="$1"
if (! -f $fullproc) then
  echo "$fullproc does not exist"
  echo "usage: startup </pathname/process>"
  exit
endif
set proc = `echo $fullproc | \
  awk -F/ '{print $NF}'`
# check if proc is running, don't look
# at self set
EXISTS = `ps -ax | grep $proc | grep -v grep |\
grep -v startup | wc -l`
if ($EXISTS == 1) then
  echo $proc is already running
else
  $fullproc
endif
```

For a Real Time, Call...

NTP (Network Time Protocol) is an Internet standard protocol (RFCs 1059 and 958) which, via background daemons starting at boot-up, can keep two or more machines' clocks very closely synchronized (we have found, in practice, that they rarely drift 20 ms apart here). If your site has Internet access, instructions are contained in the freeware implementation on how to synchronize with Internet clock servers that keep time very close to the U.S. Naval Observatory's Atomic Clock via WWV (a radio distribution of the USNO's current time) and other sources.

The NTP software is available via anonymous FTP from `louie.udel.edu` in the directories `pub/ntp/`. You may want to try the closely related xntp. It has been tuned up for UNIX systems. There is also extensive information included in the software distribution on purchasing (vendor list and product descriptions) and setting up your own radio frequency clock (via either WWV, WWVB, Global Positioning System satellite information and other sources).

For those truly serious about the time, Hewlett-Packard will sell you a rubidium-vapor resonance cell oscillator/clock (Model 5065A) with a long-term stability of better than 170ns (that's billionths of a second) per day. It is reported that even without an external reference calibration source this unit will remain reliable within one millisecond (thousandth of a second) for over a year. The NTP documentation offers software to support this unit. An HP5065A will set you back $33,000, providing yet another meaning to the phrase "time is money."–*bzs*

```
# hilo -- calc diff between highest and lowest
values
#
BEGIN {
  MOST_DIFF = 0
  SLOWEST = 0
  FASTEST = 0
  SUM = 0
  AVG = 0
  HOST = ""
  SLOWHOST = ""
  FASTHOST = ""
  }
{
HR = substr($6,1,2)
MIN= substr($6,4,2)
SEC= substr($6,7,2)
TIME = HR MIN SEC
REF_HR = substr($9,1,2)
REF_MIN= substr($9,4,2)
REF_SEC= substr($9,7,2)
REF_TIME = REF_HR REF_MIN REF_SEC
SIGN = ""
if (TIME > REF_TIME) {
  SIGN = "-"
  D_HR = HR - REF_HR
  D_MIN = MIN - REF_MIN
  D_SEC = SEC - REF_SEC
  if (D_SEC < 0) {
    D_SEC = 60 + D_SEC
    D_MIN = D_MIN -1
    }
  if (D_MIN < 0) {
    D_MIN = 60 + D_MIN
    D_HR = D_HR -1
  }
}
else {
  SIGN = "+"
  D_HR = REF_HR - HR
  D_MIN = REF_MIN - MIN
  D_SEC = REF_SEC - SEC
  if (D_SEC < 0) {
    D_SEC = 60 + D_SEC
    D_MIN = D_MIN -1
    }
  if (D_MIN < 0) {
    D_MIN = 60 + D_MIN
    D_HR = D_HR -1
    }
  }
  SECONDS = (D_HR * 3600) + (D_MIN * 60) +
D_SEC
  SUM = SUM + SECONDS
  P_HR = substr("00",1,2-length(D_HR)) D_HR
  P_MIN = substr("00",1,2-length(D_MIN)) D_MIN
  P_SEC = substr("00",1,2-length(D_SEC)) D_SEC
  DIFF = P_HR P_MIN P_SEC
  if (SIGN == "-") {
    if (DIFF > SLOWEST) {
      SLOWEST = DIFF
      SLOWHOST = $1
    }
  }
  if (SIGN == "+") {
    if (DIFF > FASTEST) {
      FASTEST = DIFF
      FASTHOST = $1
    }
  }
  if (DIFF > MOST_DIFF) {
    MOST_DIFF = DIFF
    HOST = $1
  }
}
END {
P_HR = substr(MOST_DIFF,1,2)
P_MIN = substr(MOST_DIFF,3,2)
P_SEC = substr(MOST_DIFF,5,2)
print "Largest difference-- " HOST ": " P_HR ":"
P_MIN ":" P_SEC
P_HR = substr(SLOWEST,1,2)
P_MIN = substr(SLOWEST,3,2)
P_SEC = substr(SLOWEST,5,2)
print "Slowest Host Difference-- " SLOWHOST ": "
P_HR ":" P_MIN ":" P_SEC
P_HR = substr(FASTEST,1,2)
P_MIN = substr(FASTEST,3,2)
P_SEC = substr(FASTEST,5,2)
print "Highest Host Difference-- " FASTHOST ": "
P_HR ":" P_MIN ":" P_SEC
AVG = SUM / NR
print "Average (in seconds): " AVG
}
```

Listing. HILO awk script for calculating time differences

Pardon Me Sir, Do You Have the Time?

There are a number of ways to ask clients the time. If you're running NIS, you can interactively ask all the clients and collect the responses along with the asking system's time in a file as shown below:

```
wizard# foreach host (`ypcat hosts | \
  awk '{print $2}'`)
? echo $host
? set RDT = `rsh $host date`
? set DT = `date '+%T'`
? echo $host ":" $RDT $DT >> clocks
? endif
```

If you have a number of exclusions to code around (like non-Sun systems that don't know the `rdate` command), it's probably too troublesome to `grep` them out with a `grep -v`. In this case, you should probably install your selections in a script. I like to use a script like the "ask4" script below:

```
#! /bin/csh -f #
# C-Shell script: ask4
#
# This script takes 1 argument: the command
# to be run on each client
set command="$1"
if ($#argv != 1) then
  echo "Incorrect number of arguments"
  echo "Usage: ask4 <command>"
else
  foreach client (`ypcat hosts \
    | grep -v "epoch1" | grep -v "epoch2" \
    | grep -v 192.9 | awk '{print $2}'`)
    set r = (`ping $client | grep alive` )
    if ($#r == 0) then
      set answer = "No answer"
  else
      set answer = `rsh $client $command`
      set tm = `date | awk '{print $4}'`
    endif
    echo $client ":" $answer $tm
  end
endif
```

I can reuse this script for any commands I want to run against these clients. This procedure also time-stamps the response, providing the comparison time that I need to correct for asking the clients at different times.

Both the interactive commands and the script piped into a file create a log of entries that look like this:

```
sorcerer : Tue Apr 14 09:30:45 EDT 1992 09:31:44
merlin : Tue Apr 14 09:30:45 EDT 1992 09:31:46
magician : Tue Apr 14 09:32:54 EDT 1992 09:31:48
```

To then calculate the average difference and most out-of-sync of the hosts, run the output of these commands through the HILO `awk` script presented here.

Got My Drift?

Once you've got your clients running `rdate` occasionally, it might be interesting to measure how well they are staying in sync. If you have a lot of workstations, it's going to take time to ask them all for this information. If I start asking at 10:10 and don't finish until 10:32, the gap between the first and last asked is going to look huge in comparison with the normal error of my clocks. To offset this problem, I ask the system I am running the command from to tell me the time after I get this information from the client and compute how far off the client is by subtracting the two times. (There should only be a few seconds difference due to the delay between the two commands on fairly local systems).

To subtract one time from another, I need to be able to borrow minutes and hours. If your network crosses over the international dateline, I suppose you could worry about date changes as well, but it would probably be better to run your checks all within the time zone. I do all these calculations in the HILO `awk` script presented in the Listing.

You can also vary the response of the `date` command by providing it with a format string much like what you would give in a `printf` command in a C program:

```
wizard# date
Tue Apr 14 13:12:55 EDT 1992
wizard# date '+%T'
13:13:05
wizard# date '+%j:%T'
105:13:13:15
```

Running `rdate` on your clients once a day, you should probably not see more than about 10 seconds of difference, but this will vary with the size of your network and the accuracy of your timekeeper. You may not make your rendezvous with Maxwell Smart, but 99 might hang around a few extra seconds. ➸

S. Lee Henry is on the Board of Directors of the Sun User Group and is a system administrator for a large network of Suns in the federal government. Slee also heads her own firm, The Next Page Inc., specializing in software documentation.

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The Fabulous Closet of Fibber McGee

Optical disks are now a regular part of system storage. But there are still complexities when it comes to actually using them.

by **MICHAEL JAY TUCKER,** Executive Editor

Not too long ago, optical disks were a novelty at best, and a solution in search of a problem at worst. Today, though, they are widely employed for a variety of different missions–ranging from archival on write-once-read-many (WORM), to backup on magneto-optical (MO), to the distribution of software on CD-ROM.

But just because something is possible doesn't mean it is also easy. Or, at least, always easy. People who actually use them report that optical disks have their own unique, sometimes endearing, but frequently maddening little characteristics. They also report that the same can sometimes be said for the vendors of optical disks.

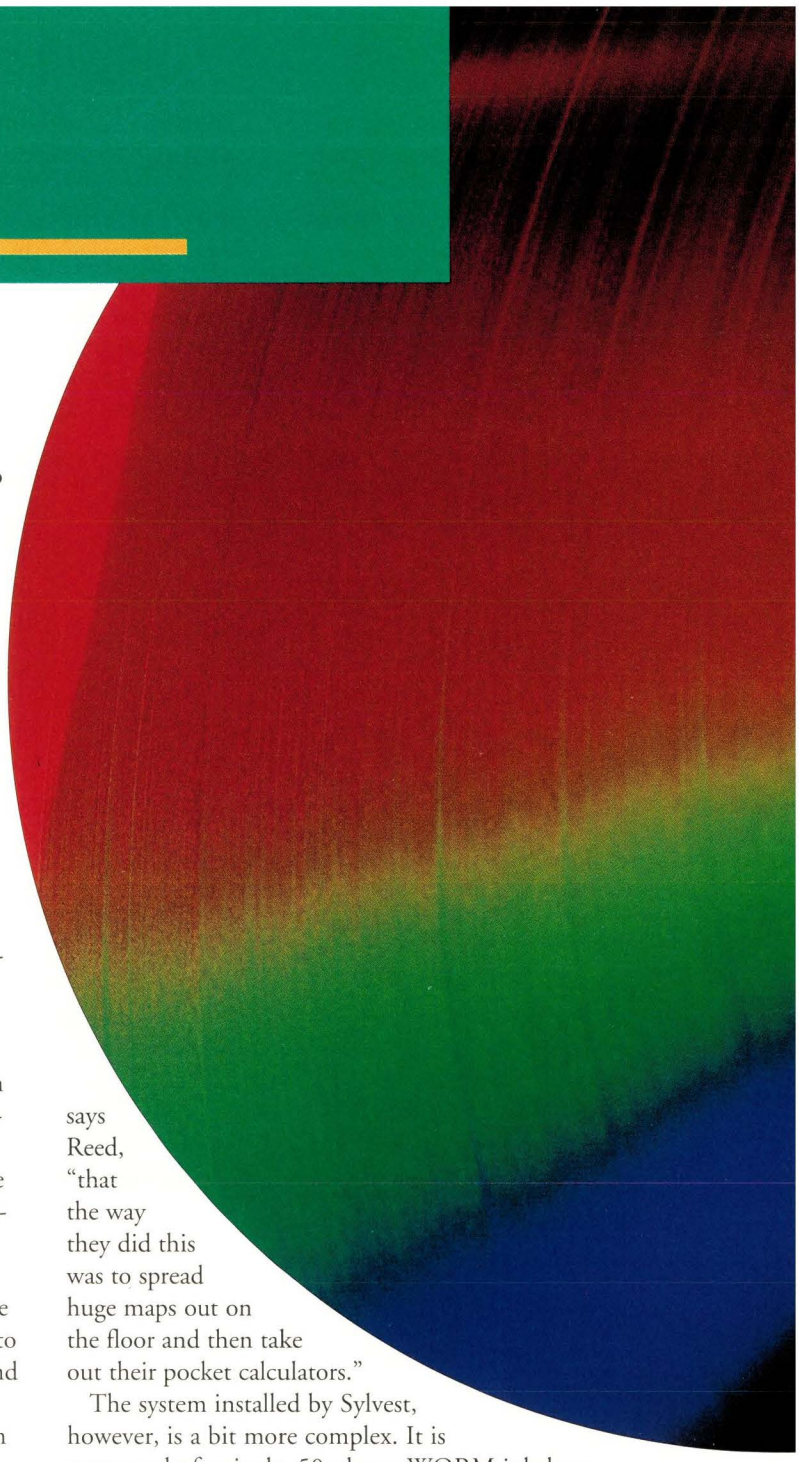
To find out a little about how optical disks are actually used, *SunExpert* recently contacted several users. Their experiences ranged from the positive, to the truly bizarre.

St. WORM and the George

WORM disks have had one of the stranger histories of any technology in computing. Originally hyped as a breakthrough, they were largely overshadowed by improved magnetic storage technologies and the subsequent development of erasable MO drives. But then, while market analysts were eagerly writing WORM obits, the technology perversely refused to die.

The reason for WORM's success was the same as the reason for its slow takeoff–the immutability of its data. If rewritability was a must for most applications, then so too were there apps for which the opposite was true.

"The idea is that the data isn't going to change," explains Richard Koseluk, vice president of the Woodlands Geophysical Group Inc., in Woodlands, TX. His installation is perhaps a classic application of WORM.



"What we do is transfer data [from tape] to workstation," he says, "mostly for the oil industry."

What Woodlands Geophysical does is take seismic data from tape and transfer it to a workstation-accessible form so that the oil companies can more quickly and effectively find petroleum underground. "We have over 3,000 miles of seismic data on 50 platters."

Sometimes Woodlands' customers want to walk away with the optical disks for use at their own installations. However, the company also maintains an archival service, so that its customer can be spared the business of storing the disks and have only the information it needs, on demand. "The customer may come in and say, 'Give me this particular spot in the Gulf of Mexico,'" explains Koseluk.

In fact, it was the need to be able to go through a great deal of data, rapidly, and then pick up a small section of it that helped dictate the choice of optical disk. "The main reason was random access," says Koseluk. "That, plus compacting of data"–the company deals with vast databases, hundreds of gigabytes–"and the integrity of the media itself."

He has, however, run across some curious problems with optical disk–not the least being that some optical-disk vendors put their directories someplace other than the optical disk. "When you choose an optical disk, you want to make sure that your platter is self-contained," he says. "Some systems actually put the directory, the file system, on something else–even on magnetic media. For us, that's impossible. We want to be able to pull a disk and ship it across the world, with the directory and the data together. We want to able to ship it to a client in, say, Nigeria, and have it up and running."

Woodlands uses a variety of WORM drives, chiefly from QStar Technologies Inc. and Optima Technology Corp. They are single-platter drives, attached directly to individual workstations, rather than a centralized, multiplatter jukebox. "In our case, we may not access a particular disk for weeks," he explains. "It'll just sit on a shelf. Other applications have to have more immediacy than that ...and they need a jukebox."

Just such an application is in the U. S. Department of Justice, Civil Rights Division, Voting Rights Section in Washington, DC. "It basically involves redistricting," says Darrel Reed, GIS manager of Sylvest Management Systems Corp., Lanham, MD, which integrated and now supports the system. As individual states draw up their voting district maps, they submit them to the Voting Rights Section, which checks those maps for signs of gerrymandering or other biases that could shortchange blocks of voters. "It used to be," says Reed, "that the way they did this was to spread huge maps out on the floor and then take out their pocket calculators."

The system installed by Sylvest, however, is a bit more complex. It is composed of a single, 50-platter WORM jukebox from QStar, a Sun-4/470 server and 50 Sun workstations. "Analyst/attorneys sit at the workstations and call down data from the server," explains Reed. This means he has some unique problems, including the fact that the jukebox is basically on all the time. "For most people, a juke is just an archive. But for our purposes, it has to be more like an on-line disk."

To make that possible, Sylvest had to write a significant amount of code–some of it pretty close to the OS itself. For the rest, Sylvest used the Arch-Info graphical information system from the Redlands, CA-based Environment Systems Research Institute. "We would take the command language [provided by QStar to control the jukebox] and embed it in Arch-Info."

In fact, as his suggestion to anyone who ever undertakes

such a task, Reed says, "You've got to have the software. You can get the box anyplace, but you've got to get the software." He says that optical vendors have to be able to provide buyers with enough control software to customize the jukebox. "The command software can be pretty simple, just things like 'read disk,' and the like, but you'd be surprised how often you can't get at it." He says that several vendors have wanted to sell him turnkey solutions that were too inflexible for his purposes.

His other major problem was his users–the analyst/attorneys. "They don't know DOS, and they sure don't know UNIX." The company had to write, therefore, with the assumption that the users would never even see the operating system, much less the network. "I am sure there are users who don't know there's an optical juke out there."

Diamond in the Sea

But, if WORMs confounded the analysts by surviving when all expected them to fail, then MOs too have had their surprises. Originally hyped as a replacement for magnetic media, then relegated to a backup function as an (relatively expensive) alternative to tape, MOs have in fact found multiple roles, with no one application dominant over another.

Frequently they'll be both backup media and mass storage for particular types of data, though not necessarily all. This is the role planned at Chemagnetics/Otsuka Electronics Inc., in Fort Collins, CO. "We make spectrometers for use in MRI," explains Timothy Hu, the company's product-design engineer. "We do it for the clinical market–medical imaging–and for the analytic market." The latter includes the analysis of nonliving samples for industrial purposes.

The company uses MO drives for its own purposes as a backup media. "I've got one on my desk right now," says Hu. He uses a drive from Ten X Technology Inc. attached to a SPARCstation. "I do a lot of code development. It is comforting to have that thing sitting on my desk."

He feels that optical's ease of use makes it superior to most other forms of backup, "Tapes are nice, but they're kind of a pain. And, if they're a pain, you tend not to use them."

He likes the Ten X drive for several reasons, among them its connectivity, and its ability to be used on many different platforms. But he has some unique difficulties as well. "I had one problem that I thought was in the drive, but I found it was actually in the operating system." Specifically, he found that while attempting to copy very large files from tape to the disk, "halfway through, it would just quit."

Many experiments later, Hu finally decided that the fault was not in his

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It's amazing what you *can't* learn from a spec sheet. Like the fact that, while seek time or transfer rate of a vendor's drive may appear comparable to ours on paper, it's likely they tested theirs for single user PC performance. Critical considerations like multidrive string performance and bus utilization probably aren't tested and optimized.

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some of your familiarity with BSD commands during the transition. Keep in mind that you will still need to accommodate the new file system layout and learn new sysadmin methods.

Try to get at least one diskfull workstation that you can install Solaris on immediately so that you and other systems administrators can begin to learn SVR4 and become familiar with the new file system layout. This system can also be used to begin transitioning your sysadmin scripts. The SVR4 commands often have different names, are located in different places and have different argument structures. It will be much to your benefit to begin to familiarize yourself with these differences. The *System Transition Guide for Application Developers–SunOS 5.0* has a chapter that provides a table of SunOS 4.1 commands and their status in SunOS 5.0.

Make sure you start your migration with the administrators in your group and plan to solve all the problems in this group before moving on to the next.

Some tools to assist sysadmins are now available, for example, `sed` scripts for moving NIS data to NIS+. These scripts will allow you to easily mimic your current environment. After completing the Solaris migration, you can go back and take advantage of the added functionality of NIS+.

Keep in mind that NIS and NIS+ can work together and that the new printing system–the SVR4 `lp` print subsystem–can accept and request printing support from other systems. These interoperabilities will simplify supporting your users during the migration. The BSD `lpr`, `lpc` and `lpq` command set can be maintained under Solaris 2.0, but you should use the new printing subsystem as soon as you are ready because it has rich subclassing, forms and filters that will add considerable power to your network printing options.

Acknowledgments

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S. Lee Henry is on the board of directors of the Sun User Group and is a systems administrator for a large network of Suns in the federal government. Slee is also president of her own firm, The Next Page Inc., specializing in software documentation. Her email address is `slee@expert.com`.

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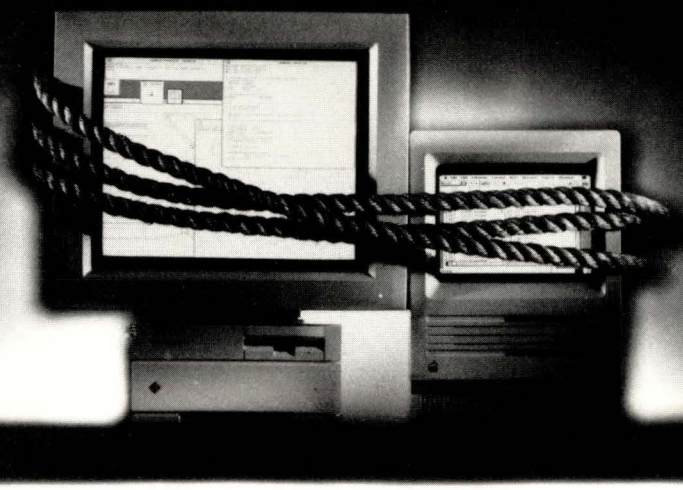

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Transition Issues

So...how do you make the transition easy? First, take a look at the transition document that Sun provides on the Migration Kit CD. Pull out copies of the transition forms and adapt them for your own site; you'll probably want to create individual forms with more entries than the samples from the document.

Second, begin to lay out your strategy. Identify work groups that share servers and applications. Outline the software and the types of Sun systems they are using. Planning for application availability is a major step. Deciding how availability dates affect your plan and when to run in binary compatibility mode is critical.

Consider this an opportunity to rethink some of your net management policies and practices and fold this thinking into your planning before you embark on your migration. If you follow the suggestions and guidelines offered, it will be easier for more of the work of systems administration to be automated and allow Solaris users to share scripts and tools that they build.

Determine when application upgrades will arrive for each piece of software–Sun and third party. Determine when internally developed software can be upgraded. Pipeline Tool can be used to approximate the time and effort required.

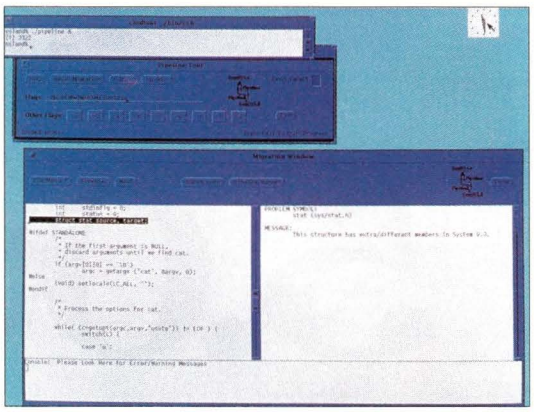
Depending on the hardware platforms in each of your workgroups, indicate those not covered by the first release of Solaris 2.0. For 690 servers and SPARCstations, the June product is all you need. If you have older servers and workstations (as most of us do!), you won't be able to upgrade them until September or after.

Depending on your architectures and software readiness, do you have applications that you will want to run in SunView compatibility mode? Keep in mind that this holdover should be considered an aid in helping you to manage your transition, but not a long-term solution. Some day SunView compatibility will no longer be supported.

Again, depending on your architecture and software availability, determine if you have software that you will want to run in binary compatibility mode until it can be upgraded to run native in Solaris 2.0. Make sure the software meets the criteria specified for running in this mode; it must be dynamically linked and must not trap directly into the operating system, rely on application-specific ioctls or drivers, write or read directly into system files (which may have moved), access or interpret kernel data structures via `/dev/kmem` or `libkvm` or use undocumented interfaces.

Note for any clients you might want to run as 4.1.X clients to a Solaris 2.0 server, you will have to install software to provide this support. This method may buy time for a critical application that cannot be upgraded or run under binary compatibility.

Decide if you will want to use the 4.X compatibility mode offered as an option with Solaris 2.0 to preserve



The Migration Kit: Pipeline Tool, white papers, planning forms and more

major step forward for international organizations and vendors with international products.

End users will find some new features in the DeskSet, like the addition of multimedia to the Mailtool and multibrowsing in Calendar Manager–tools that make it easier to work together.

Developers will appreciate lower application development and maintenance costs. Being able to move from single-source to multiple-source binaries will greatly reduce development time. Applications written to the ABI will work across all SVR4 platforms.

Systems administrators will appreciate the dynamically reconfigurable kernel. Device drivers will be loaded to the kernel as needed. Time-consuming kernel building is a thing of the past. The increased security of the Automated Security Enhancement Tool (ASET), which evaluates the security posture of your network, and NIS+ will also be well received. Systems administrators can use a shadow `passwd` file and take advantage of enhanced password aging and login controls as well as improved authentication.

ONC's public networking protocols and distribution services, like NIS+, make it far simpler to distribute data and applications transparently. NIS+ uses a hierarchical name space and is faster, better and more secure than NIS. It doesn't have to push out an entire map to update an entry and provides easier, graphically based data entry.

Where SunOS 4.X only has three run states (PROM level, single user and multiuser), Solaris 2.0 expands this notion by adding states that correspond to multiuser with no resources exported, rebooting and rebooting with prompts (i.e., the `-a` reboot option). State changes are invoked by sending signals to `init`. In addition, this new facility is table-driven (through `/etc/inittab`) and the crafty sysadmin can add additional states for diagnostic or other purposes.

Even Sun's documentation is turning glossy, task-oriented and more appealing, while AnswerBook in its new release provides a natural language query capability that will speed you through to the answers you need.

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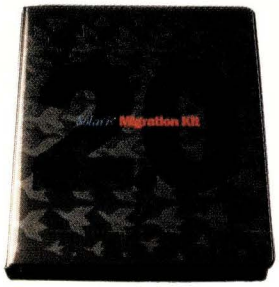
Even Sun Microsystems Computer Corp. acknowledges the transition to 2.0 will be tough. According to a recent *Sunergy* newsletter issued by Sun, "SMCC recognizes that the migration process is a demanding, long-term project for most companies. It can be an arduous, time-consuming and potentially expensive proposition. There are applications to port; device drivers, driver/kernel interfaces and windowing systems to convert; new libraries to add; users to re-educate; and more."



Solaris offers a jumping-off point for symmetric multiprocessing and multithreading.

Since December 1991, independent software vendors (ISVs) and some large end users have been working with the Early Access version of 2.0. As of early April, Sun claimed more than 550 developers had enrolled in the Solaris 2.0 Migration Program. The company promised more than 200 "of the most widely used applications" will be running on Solaris 2.0 when it ships.

SunSoft and SMCC are continuing to try to make the transition easier on developers, systems administrators and users. SMCC is giving away a *SunOS 4.1.1-to-Solaris 2.0 Migration and Compatibility Guide*, a range of technical white papers and release reports and product specs–as well as a software tool for checking code compliance with the System V Interface Definition Issue 3 (SVID-3) and SPARC Compliance Definition (SCD) 1.1/2.0 standards (see *SunExpert*, March, Page 8).

Start to Plan NOW

If you are a Sun support customer, you may have already received your Migration Kit. Chock full of white papers, a multimedia demo and planning forms, the CD in this kit also provides Pipeline Tool–a spellchecker-like tool that scans through your C code and suggests what you need to do to make your code System V and ANSI C compliant. Don't be intimidated by the amount of information on this CD. The transition will not be easy, but it can be straightforward if you follow Sun's guidelines. Carefully read through the two transition guides (one for developers, the other for systems administrators). The Q&A document may also be worth scanning for answers to other questions that you've probably been asking yourself.

Especially if you are not a Sun support customer and have not attended one of the Sun-sponsored Open Houses outlining the features of Solaris 2.0 and the upgrade strategy you should follow, talk to your local support office and keep reading *SunExpert*. In several follow-ups to this feature, we will detail some of the major enhancements (like NIS+ and the new printing subsystem) and help walk you through the changes you will need to make your site Solaris-ready.

Upgrading your site to Solaris 2.0 represents a considerable amount of work, especially for systems administrators who need to gauge the arrival of new releases of software, make their administrative scripts System V compatible and plan their installation strategies. For those of us with workstations and servers of many different models and a large collection of Sun, third-party and home-grown applications, there are a lot of planning, testing and inevitable late nights to come. We also have to become System V savvy while maintaining our networks and keeping our users happy. As we move into the Solaris environment, we will see that familiar system files will have moved, have different names and have some new functionality. New shells (including the Korn shell as the new default) will be available along with a number of new file system types. These will all take some time to get used to.

The Solaris Install

There are a couple of ways to install Solaris 2.0. You can boot off of a local CD or do a remote boot from a 4.X or Solaris server with a CD. Configuring clients under Solaris 2.0 is simplified. When you preconfigure a client on a server before you boot it, you will be asked during the client installation only those things that it cannot determine from the network. If you want, you can set up a template for building clients in a half hour or so. The beauty of the new installation routine is that all software from the OS to third party will be installed in the same intuitive way.

Selecting how much of the Solaris 2.0 software you want to install is also simplified. You select from among increasingly comprehensive packages–starting with the core system and progressing through end-user and developer packages, or you can load everything.

Solaris 2.0 will be available only on CD. This is *not* simply an effort on Sun's part to save money (since CDs are so cheap) or force you to buy a CD player. There is real elegance in being able to treat the installation media as a file system–the slick tools that you will see for installing, upgrading or deinstalling software owe their existence to this simple yet elegant feature.

Don't Worry, Be Happy

Though the transition to Solaris will be a lot of work, the benefits of Solaris 2.0 will soon put the pain of this transition behind us.

For folks interested in new technology, Solaris 2.0 offers a jumping-off point for symmetric multiprocessing and multithreading. The system features message-based application interoperability thanks to ToolTalk, which comes bundled with 2.0. Solaris' improved internationalization is a

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Solaris Two and You

by **S. LEE HENRY,** U.S. Government

Solaris 2.0, Sun Microsystems Inc.'s System V Release 4.0-compliant operating environment, is expected to ship before the end of this month, as Sun has repeatedly promised it would. Although most ISVs and systems administrators are enthralled with the possibilities of standards compliance, a dynamically configurable kernel and faster Network Information Service (NIS), no one thinks the migration is going to be a snap. In fact, there's talk that the first-version product that SunSoft delivers could be extremely buggy and lacking in certain features, including true multiprocessing.

Solaris 2.0 is shipping. Now what do you need to know before–and after–you unwrap your CD?

Company/Manufacturer Model	Manufacturer	Capacity	Form factor (inches)	Erasable (E), WORM (W) or Multifunction (M)	If removable media, price per one ($U.S.)	Media single or double sided	Drivers required	Operating systems/hardware	Interface type	Average seek time (ms)	Read speed (KB/s)	Write speed (KB/s)	Average access time (ms)	Data transfer rate (B/s)	Warranty (months)	Price
Tracer Technologies Inc. (continued)																
DE-128-S	MOST	128 MB	5 ¼	E	70	S	none	SunOS	SCSI	35.2	512	256	47.7	512 KB	12	$2,995
DE-256-S	MOST	256 MB	5 ¼	E	90	S	none	SunOS	SCSI	35.2	820	410	47.7	820 KB	12	$3,295
DM-1000-I	Panasonic	940 MB	5 ¼	M	W-149 E-245	D	none	SunOS	SCSI	90	990	990	106.7	990 KB	12	$5,495
DW-1280-I	Literal	1.28 GB	5 ¼	W	200	D	none	SunOS	SCSI	115	328	145	131.7	812.5 KB	12	$5,695
DM-1000-S	Panasonic	940 MB	5 ¼	M	W-149 E-245	D	none	SunOS	SCSI	90	990	990	106.7	990 KB	12	$5,795
DW-1280-S	Literal	1.28 GB	5 ¼	W	200	D	none	SunOS	SCSI	115	328	145	131.7	812.5 KB	12	$6,029
DW-6550	Sony	6.55 GB	12	W	550	D	none	SunOS	SCSI	180	600	300	180	600 KB	12	$33,195
DW-5600	LMSI	5.6 GB	12	W	695	S	none	SunOS	SCSI	80	700	700	130	700 KB	12	$39,495
WM-100	LMSI	5.6 GB	12	W	695	S	none	SunOS	NFS, TCP/IP	80	700	700	130	700 KB	12	$39,495
DJW-28000	LMSI	28 GB	12	W	695	S	none	SunOS	SCSI	80	700	700	130	700 KB	12	$53,695
WFS-100	LMSI	5.6 GB	12	W	695	S	none	SunOS	NFS, TCP/IP	80	700	700	130	700 KB	12	$54,950
WM-500	LMSI	28 GB	12	W	695	S	none	SunOS	NFS, TCP/IP	80	700	700	130	700 KB	12	$59,900
WFS-500	LMSI	28 GB	12	W	695	S	none	SunOS	SCSI	80	700	700	130	700 KB	12	$64,950
Trimarchi Inc., P.O. Box 560, State College, PA 16801. **Circle 259**																
TN-B110000-0	Ricoh	600 MB	5 ¼	E	250	D	none	SunOS	SCSI	50	450	150	66.7	476 KB	12	$3,715
TN-B120000-0	Sony	600 MB	5 ¼	E	250	D	none	SunOS	SCSI	95	—	—	—	620 KB	12	$4,500
Unbound Inc., 17951 Lyons Circle, Huntington Beach, CA 92647. **Circle 260**																
OPTISTOR-S	Sony	650 MB	5 ¼	E	190	D	none	SunOS, Ultrix, VMS	SCSI	65	7.4 MB	680	65	7.4 MB	12	$4,270
OPTISTOR-D	Sony	1.3 GB	5 ¼	E	190	D	none	SunOS, Ultrix, VMS	SCSI	65	7.4 MB	680	65	7.4 MB	12	$8,330
JukeSTOR-10	Sony	6.5 GB	5 ¼	E	190	D	Lightrieve	SunOS, Ultrix, VMS	SCSI	65	7.4 MB	680	65	7.4 MB	12	$11,060
JukeSTOR-56	Sony	36.4 GB	5 ¼	E	190	D	Lightrieve	SunOS, Ultrix, VMS	SCSI	65	7.4 MB	680	65	7.4 MB	12	$41,300
UNISON Information Systems Ltd., 21 Walsh Way, Framingham, MA 01701. **Circle 261**																
Opti/Max	Ricoh	600 MB	5 ¼	E	120	D	none	SunOS/SPARC	SCSI	—	—	—	7.6	1 MB	12	$4,995+
XYXIS Corp., 14631 Martin Drive, Eden Prairie, MN 55344. **Circle 262**																
XY128RW	Ricoh	128 MB	3 ½	E	75	S	XYXIS Sun Driver	SunOS/SPARC	SCSI	42	640	203	43	4 MB	12	$1,995
XY600RW	Ricoh	600 MB	5 ¼	E	225	D	XYXIS Sun Driver	SunOS/SPARC	SCSI	50	450	150	66.7	1.4 MB	12	$4,000
XY600RW-HS	Ricoh	600 MB	5 ¼	E	225	D	XYXIS Sun Driver	SunOS/SPARC	SCSI	28	1 MB	500	37	4 MB	12	$4,995
Zetaco Inc., 11400 Rupp Drive, Burnsville, MN 55337. **Circle 263**																
NETstor Subsystem Model 3030-020	HP	20.8 GB	5 ¼	M	200	D	none	SunOS	SCSI	27	1 MB	500	35	5 MB	6	call
NETstor Subsystem Model 3030-060	HP	57.2 GB	5 ¼	M	200	D	none	SunOS	SCSI	27	1 MB	500	35	5 MB	6	call
NETstor Subsystem Model 3030-090	HP	93,600 GB	5 ¼	M	200	D	none	SunOS	SCSI	27	1 MB	500	35	5 MB	6	call
ZZYZX Workstation Peripherals, 5893 Oberlin Drive, San Diego, CA 92121. **Circle 264**																
ZW/REO 130S	Sony	128 MB	3 ½	E	79	S	adapter kit	SunOS	SCSI, Qbus, Unibus	30	532	512	—	5.8 MB	12	$2,195
ZW/REO 650	Sony	650 MB	5 ¼	E	199	D	adapter kit	SunOS/DEC IBM	SCSI, Qbus, Unibus	65	680	620	—	5.8 MB	12	$3,995
ZW/REO 1300	Sony	1.3 GB	5 ¼	E	199	D	adapter kit	SunOS/DEC IBM	SCSI, Qbus, Unibus	65	680	620	—	5.8 MB	12	$7,495
ZW/REO 6500	Sony	6.5 GB	5 ¼	E	199	D	adapter kit	SunOS/DEC IBM	SCSI, Qbus, Unibus	65	680	620	—	7.4 MB	12	$9,995
ZW/36000	Sony	36 GB	5 ¼	E	199	D	adapter kit	SunOS/DEC IBM	SCSI, Qbus, Unibus	65	—	—	—	7.4 MB	12	$49,950

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See First Technology Inc., 18809 Cox Ave., Ste. 100, Saratoga, CA 95070. **Circle 251**																
Gigavault 650	Ricoh	280 MB	3 ½	E	170	D	none	DOS	SCSI	50	450	150	66	522 KB	12	$2,750
Gigavault 650	Ricoh	650 MB	5 ¼	E	170	D	none	DOS	SCSI	50	450	150	66	522 KB	12	$2,750
Solid Computer, 1450 Oakbrook Drive, Norcross, GA 30093. **Circle 252**																
WM0650ST	Ricoh	650 MB	5 ¼	E	260	D	Solid adapter	SunOS or Solaris/SPARC	SCSI	4	300	100	66.7	693 KB	36	$3,695
WM0650ST-H	Ricoh	650 MB	5 ¼	E	325	D	Solid adapter	SunOS or Solaris/SPARC	SCSI	28	950	475	37	1 MB	36	$5,395
Sony Corp., Computer Peripheral Products Company, 655 River Oaks Pkwy., San Jose, CA 95134. **Circle 253**																
SMO-P301	Sony	128 MB	3 ½	E	64	S	—	—	SCSI-2	40	625	312	—	7.25 MB	15	call
RMO-S350	Sony	128 MB	3 ½	E	64	S	none	IBM PC, Mac	SCSI-2	40	625	312	—	7.25 MB	15	$2,995
SMO-E501	Sony	650 MB	5 ¼	E	230	D	—	—	SCSI	70	680	340	—	7.4 MB	15	$4,650
SMO-E511	Sony	650 MB	5 ¼	M	230	D	—	—	SCSI	70	680	340	—	7.4 MB	15	$4,895
WDD-600	Sony	6.55 GB	12	W	—	D	—	—	SCSI	34.5	200	200	400	600 KB	3	call
Specialized Systems Technology, P.O. Box 420489, Houston, TX 77242-0489. **Circle 254**																
SSO650	Ricoh	652 MB	5 ¼	E	200	D	—	SunOS	SCSI	28	1 MB	500	37	1 MB	12	$3,550
SSD1000	Maxoptix	1 GB	5 ¼	E	335	D	none	SunOS	SCSI	35	300	900	48	300 KB	12	$4,350
Symmetrical Technologies Inc., 301 Gallaher View Road, Ste. 231, Knoxville, TN 37919. **Circle 255**																
M Series	HP	650 MB-93 GB	5 ¼	M	200	D	none	any NFS OS	Ethernet	95	680	340	95	680 KB	12	$7,995+
W Series	Sony, ATG Cygnet	6 GB-1.2 TB	12	W	500+	D	none	any NFS OS	Ethernet	90	1 MB	90	1	1.5 MB	—	$30,000+
Tass Optical World Inc., 6730 Mesa Ridge Road, Bldg. B, San Diego, CA 92121. **Circle 256**																
PA128	Panasonic	128 MB	3 ½	E	69	S	Tass Commander	Sun, Mac, IBM, NeXT	SCSI	32	—	—	—	7.25 MB	12	$1,399
M21000	Maxoptix	1 GB	5 ¼	E	285	D	Tass Commander	Sun, Mac, IBM, NeXT	SCSI	35	—	—	—	6.8 MB	12	$3,895
DJK/10,000	Maxoptix	10 GB	—	E	285	D	Tass JBK II, Sun	Sun, Mac, IBM, NeXT	SCSI	—	—	—	—	—	12	$12,995
Ten X Technology Inc., 4807 Spicewood Springs Road, Bldg. 3, Ste. 3200, Austin, TX 78759. **Circle 257**																
Opti-MO	Sony	650 MB	5 ¼	E	230	D	none	all SCSI based	SCSI	70	—	—	82.5	5 MB	12	$4,440
Opti-Win 650	Pioneer	650 MB	5 ¼	W	145	D	none	all SCSI based	SCSI	60	—	—	76.7	5 MB	12	$4,495
Opti-Win 940	Panasonic	940 MB	5 ¼	W	149	D	none	all SCSI based	SCSI	90	—	—	115	5 MB	12	$4,495
OptiXchange MO	Sony	650 MB	5 ¼	M	230	D	none	all SCSI based	SCSI	70	—	—	82.5	5 MB	12	$4,995
OptiXchange 650	Pioneer	650 MB	5 ¼	M	W-145 E-250	D	none	all SCSI based	SCSI	60	—	—	76.6	5 MB	12	$5,495
OptiXchange 940	Panasonic	940 MB-1 GB	5 ¼	M	W-149 E-245	D	none	all SCSI based	SCSI	90	—	—	106.7	5 MB	12	$5,495
Opti-Win 5600	LMSI	5.6 GB	12	W	760	D	none	all SCSI based	SCSI	80	—	—	130	5 MB	12	$28,000
Opti-Win 6400	Sony	6.55 GB	12	W	599	D	none	all SCSI based	SCSI	400	—	—	—	5 MB	12	$29,500
OptiChanger 28	LMSI	28 GB	12	W	760	D	none	all SCSI based	SCSI	80	—	—	130	5 MB	12	$39,950
Tracer Technologies Inc., 19584 Club House Road, Gaithersburg, MD 20879. **Circle 258**																
DE-2-I	TEAC	1.44 MB	3 ½	E		S	none	SunOS	SCSI	79	63	63	194	63 KB	12	$549
DE-2-S	TEAC	1.44 MB	3 ½	E		S	none	SunOS	SCSI	79	63	63	194	63 KB	12	$695
DE-21-I	Insight	20.8 MB	3 ½	E	20	S	none	SunOS	SCSI	80	200	200	122	200	12	$695
DE-21-S	Insight	20.8 MB	3 ½	E	20	S	none	SunOS	SCSI	80	200	200	122	200	12	$995
DE-128-I	MOST	128 MB	5 ¼	E	70	S	none	SunOS	SCSI	35.2	512	256	47.7	512 KB	12	$2,649
DE-256-I	MOST	256 MB	5 ¼	E	90	S	none	SunOS	SCSI	35.2	820	410	47.7	820 KB	12	$2,975

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QStar Technologies Inc. (continued)																
Subsystem								Ultrix, etc.								
M650 Multi-function Subsystem	Sony	650 MB	5 ¼	M	250	D	QStar OFS, MOFS	SunOS, AIX, DEC Ultrix, etc.	SCSI	95	680	340	95	680 KB	3	$7,495
R10G Rewritable Jukebox	HP	10 GB	5 ¼	E	250	D	QStar Viewstore	SunOS, AIX, DEC Ultrix, etc.	SCSI	95	680	340	95	680 KB	3	$24,995
M10G Multi-function Jukebox	HP	10 GB	5 ¼	M	250	D	QStar Viewstore	SunOS, AIX, DEC Ultrix, etc.	SCSI	95	680	340	95	680 KB	3	$29,995
W6G Worm Subsystem	Sony	6.55 GB	12	W	360	D	QStar OFS	SunOS, AIX, DEC Ultrix, etc.	SCSI	40	600	300	40	600 KB	3	$32,500
R20G Rewritable Jukebox	HP	20 GB	5 ¼	E	250	D	QStar Viewstore	SunOS, AIX, DEC Ultrix, etc.	SCSI	95	680	340	95	680 KB	3	$44,995
R20G Multi-function Jukebox	HP	20 GB	5 ¼	M	250	D	QStar Viewstore	SunOS, AIX, DEC Ultrix, etc.	SCSI	95	680	340	95	680 KB	3	$49,995
R35G Rewritable Jukebox	Sony	35 GB	5 ¼	E	250	D	QStar Viewstore	SunOS, AIX, DEC Ultrix, etc.	SCSI	95	680	340	95	680 KB	3	$56,495
M35G Multi-function Jukebox	Sony	35 GB	5 ¼	M	250	D	QStar Viewstore	SunOS, AIX, DEC Ultrix, etc.	SCSI	95	680	340	95	680 KB	3	$61,495
R57G Rewritable Jukebox	HP	57 GB	5 ¼	E	250	D	QStar Viewstore	SunOS, AIX, DEC Ultrix, etc.	SCSI	95	680	340	95	680 KB	3	$74,995
M57G Multi-function Jukebox	HP	57 GB	5 ¼	M	250	D	QStar Viewstore	SunOS, AIX, DEC Ultrix, etc.	SCSI	95	680	340	95	680 KB	3	$79,995
R93G Rewritable Jukebox	HP	93 GB	5 ¼	E	250	D	QStar Viewstore	SunOS, AIX, DEC Ultrix, etc.	SCSI	95	680	340	95	680 KB	3	$104,995
M93G Multi-function Jukebox	HP	93 GB	5 ¼	M	250	D	QStar Viewstore	SunOS, AIX, DEC Ultrix, etc.	SCSI	95	680	340	95	680 KB	3	$109,995
W328G WORM Jukebox	Sony	328 GB	12	W	360	D	QStar Viewstore	SunOS, AIX, DEC Ultrix, etc.	SCSI	40	600	300	40	600 KB	3	$179,995
Ricoh, File Products Division, 3001 Orchard Pkwy., San Jose, CA 95134-2088. **Circle 248**																
HyperSpace Shuttle (jukebox)	Ricoh	3.25 GB	5 ¼	E	230	D	none	SunOS, NFS	SCSI	28	1 MB	500	37	4 MB	—	$8,990
R Squared, 11211 E. Arapahoe Road, Ste. 200, Englewood, CO 80112. **Circle 249**																
IFS-650S	Sony	650 MB	5 ¼	E	140	D	Infinity	SunOS	SCSI	95	300	100	85	550 KB	12	$4,208
IFS-1000SA	Maxoptix	1,000 GB	5 ¼	E	140	D	Infinity	SunOS	SCSI	25	1 MB	517	35	1 MB	12	$6,208
IFS-6500S	IDE, Sony	6.5 GB	5 ¼	E	140	D	Infinity	SunOS	SCSI	95	300	300	25	550 KB	12	$22,520
IFS-20KS	HP	20 GB	5 ¼	E	140	D	Infinity	SunOS	SCSI	95	300	300	25	1 MB	12	$85,560
IFS-40KS	Kodak, Sony	34.5 GB	5 ¼	E	140	D	Infinity	SunOS	SCSI	95	300	300	25	1 MB	12	$85,560
IFS-1200	Kodak	1.2 TB	14	W	600	D	Infinity	SunOS	SCSI	450	800	500	100	1 MB	12	$235,000
Relax Technology, 3101 Whipple Road, Union City, CA 94587. **Circle 250**																
Rewritable Sierra 128	Ricoh	128 MB	3 ½	E	49	S	Instar MoSol	UNIX	SCSI	33	—	—	43	640 KB	12	$1,777
Rewritable I Vista	Ricoh	600 MB	5 ¼	E	139	D	Instar MoSol	UNIX	SCSI	50	300	100	66.7	—	12	$2,277
Rewritable II Vista	Ricoh	600 MB	5 ¼	E	139	D	Instar MoSol	UNIX	SCSI	50	450	150	66.7	—	12	$3,077
Rewritable III Vista	Ricoh	600 MB	5 ¼	E	139-189	D	Instar MoSol	UNIX	SCSI	37.5	914	318	65	—	12	$3,377
Rewritable Tahiti-2 Vista	Maxoptix	1 GB	5 ¼	E	269	D	Instar MoSol	UNIX	SCSI	35	—	—	48.6	1.5 MB	12	$4,377

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Panasonic Communications & Systems Co. (continued)																
LF-7010	Panasonic	1 GB	5 ¼	M	—	—	—	—	SCSI-2	—	—	—	—	—	—	$3,995
LF-9000	Panasonic	650 MB	5 ¼	E	—	—	—	—	SCSI-2	—	—	—	—	—	—	$4,650
LF-J5000A	Panasonic	47 GB	5 1/4	W	—	—	—	—	SCSI-2	—	—	—	—	—	—	$35,000
LF-J7000A	Panasonic	50 GB	5 1/4	M	—	—	—	—	SCSI-2	—	—	—	—	—	—	$37,500
Parity Systems, 110 Knowles Drive, Los Gatos, CA 95035. **Circle 242**																
581008	Maxoptix	650 MB-1 GB	5 ¼	E	280	D	Parity	Sun, SGI, IBM	SCSI	35	1 MB	500	48	4 MB	12	$4,995
Perceptics Corp., 725 Pellissippi Pkwy., Knoxville, TN 37932-3350. **Circle 243**																
LS1716	HP	650 MB	5 ¼	M	call	D	Perceptics Laserware	SunOS	SCSI	340	340	—	108	340 KB	3	call
LS520	LMSI	654 MB	5 ¼	M	call	D	Perceptics Laserware	SunOS	SCSI	80	490	—	70	490 KB	3	call
LS4100	LMSI	5.6 GB	12	W	call	D	Perceptics Laserware	SunOS	SCSI	80	700	700	130	700 KB	3	call
LS600	Sony	6.55 GB	12	W	call	D	Perceptics Laserware	SunOS	SCSI	400	600	600	700	600 KB	3	call
LS6800	Kodak	10.2 GB	14	W	call	D	Perceptics Laserware	SunOS	SCSI	53	1 MB	—	700	500 KB	3	call
Pinnacle Micro Inc., 19 Technology, Irvine, CA 92718. **Circle 244**																
REO-130S	Sony	128 MB	3 ½	E	79	S	Pinnacle driver	SunOS	SCSI	38	280	110	48	7.25 MB	12	$1,995
REO-650	Sony	650 MB	5 ¼	E	199	D	Pinnacle driver	SunOS	SCSI	65	240	80	77	7.4 MB	12	$3,995
REO-1300	Sony	1.3 GB	5 ¼	E	199	D	Pinnacle driver	SunOS	SCSI	65	280	110	77	7.4 MB	12	$7,495
REO-6500	Sony	6.5 GB	5 ¼	E	199	D	Pinnacle driver	SunOS	SCSI	65	280	110	77	7.4 MB	12	$9,995
REO-3600	NKK	36 GB	5 ¼	E	199	D	Pinnacle driver	SunOS	SCSI	65	280	110	77	7.4 MB	12	$49,995
Pioneer Communications of America Inc., 3255-1 Scott Blvd., Ste. 103, Santa Clara, CA 95054. **Circle 245**																
DD-S5101	Pioneer	650 MB	5 ¼	W	145	D	Instar, KOM	SunOS	SCSI	60	491	218	76.7	1.5 MB	12	$3,100
DD-S7001	Pioneer	650 MB	5 ¼	M	250	D	Instar, KOM	SunOS	SCSI	53	491	140	69.7	1.5 MB	12	$4,695
Plasmon Data Systems, 1654 Centre Pointe Drive, Milpitas, CA 95035. **Circle 246**																
RF-5010S	Matsushita	940 MB	5 ¼	W	75-179	S, D	—	Sun, DOS, Mac, etc.	SCSI	98	—	—	—	655 KB	12	$3,399
RF-7010	Matsushita	1 GB	5 ¼	M	179-250	D	—	Sun, DOS, Mac, etc.	SCSI	90	—	—	—	4 MB	12	$3,995
RF-7010X	Matsushita	1 GB	5 ¼	M	179-250	D	none	UNIX, Sun, AIX, etc.	SCSI	98	—	—	—	4 MB	12	$5,995
RF-10J (jukebox)	Matsushita	10.3 GB	5 ¼	W	179	D	—	UNIX, DOS, Novell, etc.	SCSI	98	—	—	—	4 MB	12	$12,500
RF-11JM (jukebox)	Matsushita	11 GB	5 ¼	M	179-250	D	—	UNIX, DOS, Novell, etc.	SCSI	90	—	—	—	4 MB	12	$13,200
RF-47J (jukebox)	Matsushita	47 GB	5 ¼	W	179	D	—	DOS, Mac Novell, etc.	SCSI	98	—	—	—	4 MB	12	$35,000
RF-750JM (jukebox)	Matsushita	50 GB	5 ¼	M	179-250	D	—	DOS, Mac Novell, etc.	SCSI	90	—	—	—	4 MB	12	$36,500
RF-1020JM (jukebox)	Matsushita	1,020 GB	5 ¼	M	179-250	D	—	DOS, Novell, etc.	SCSI	90	—	—	—	4 MB	12	$233,000
QStar Technologies Inc., Jefferson Plaza, 600 E. Jefferson St., 5th Floor, Rockville, MD 20852. **Circle 247**																
R650M Rewritable	Sony	650 MB	5 ¼	E	250	D	QStar MOFS	SunOS, AIX, DEC	SCSI	95	680	340	95	680 KB	3	$5,495

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Maximum Storage Inc., 5025 Centennial Blvd., Colorado Springs, CO 80926. **Circle 233**																
Duette System 7	Panasonic	1 GB	5 ¼	M	E-225 W-175	D	none	SunOS/SPARC	SCSI	90	500	167	107	1 MB	3	$4,995
Maxoptix Corp., 2520 Junction Ave., San Jose, CA 95134. **Circle 234**																
Tahiti 2	Maxoptix	650 MB-1 GB	5 ¼	E	240	D	—	—	SCSI	35	1 MB	500	48.6	4 MB	12	$3,995
Tahiti 2m	Maxoptix	650 MB-1 GB	5 ¼	M	240	D	—	—	SCSI	35	1 MB	500	48.6	4 MB	12	$4,195
Tahiti SD	Maxoptix	650 MB-1 GB	5 ¼	E	240	D	—	—	SCSI	35	1 MB	500	48.6	4 MB	12	$4,395
TMT 2	Maxoptix	650 MB-1 GB	5 ¼	E	240	D	—	—	SCSI	35	1 MB	500	48.6	4 MB	12	$4,495
Mesa Technology, 8990 Old Annapolis Road, Columbia, MD 21045. **Circle 235**																
6700 SFXX	Sony	657 MB	5 ¼	M	140	D	Sun, RS/6000, IBM AT	DOS, Windows, UNIX	SCSI	95	680	340	—	1.2 MB	60	$4,369
MicroNet Technology Inc., 20 Mason, Irvine, CA 92718. **Circle 236**																
SB-SMO-1S	Sony	586 MB	5 ¼	E	239	D	OSS Wormware	SunOS	SCSI	95	—	—	90	50 MB	12	$5,290
MOST Inc., 11205 Knott Ave., Ste. B, Cypress, CA 90630. **Circle 237**																
RMD-5100-S	MOST	128 MB	3 ½	E	69	S	—	—	SCSI, SCSI-2	35.2	64	64	47.7	512 KB	12	$1,495
RMD-5200-S	MOST	256 MB	3 ½	E	89	S	—	—	SCSI, SCSI-2	35.2	64	64	47.7	512 KB	12	$1,695
Mountain Optech Inc., 4775 Walnut St., Ste. A, Boulder, CO 80301. **Circle 238**																
SI-250-R/W Industrial	—	128 MB	3 ½	E	80-125	S	—	Sun, UNIX, MS-DOS, etc.	SCSI	60	—	—	77	4.35 Mb	3	$2,995
CS-1000-R/W Commercial	Maxoptix	650 MB-1.02 GB	5 ¼	E	295-350	D	—	Sun, UNIX, MS-DOS, etc.	SCSI	35	623	606	48.6	10 Mb	12	$4,495
CS-400 Commercial	Mountain Optech	400 MB	5 ¼	W	185	D	—	Sun, UNIX, MS-DOS, etc.	SCSI	170	110	110	195	2.2 Mb	3	$4,995
SEL-2 Rugged	Mountain Optech	400 MB	5 ¼	W	185	D	—	Sun, UNIX, MS-DOS, etc.	SCSI	170	110	110	195	2.2 Mb	3	$8,195
SE-1000-R/W Rugged	Maxoptix	650 MB-1.02 GB	5 ¼	E	295-350	D	—	Sun, UNIX, MS-DOS, etc.	SCSI	35	623	606	48.6	10 Mb	12	$14,995
SEL-2-SAMS Space Qualified	Mountain Optech	400 MB	5 ¼	W	185	D	—	Sun, UNIX, MS-DOS, etc.	SCSI	170	110	110	195	2.2 Mb	3	$17,995
O.C.E.A.N. Microsystems Inc., 246 E. Hacienda Ave., Campbell, CA 95008. **Circle 239**																
Vista V128 Industrial	MOST	128 MB	3 ½	E	69	S	—	—	SCSI	35	512	256	47.5	512 KB	12	$2,085
Vista V256	MOST	256 MB	3 ½	E	129	S	—	—	SCSI	35	820	256	47.5	820 KB	12	$2,795
Optima Technology Corp., 17526 Von Karman, Irvine, CA 92714. **Circle 240**																
Diskovery 128MO	Sony	130 MB	3 ½	—	95	S	none	UNIX, DOS, Netware, etc.	SCSI	40	—	—	40	12 MB	12	$2,495
Concorde 600MO	Sony	600 MB	5 ¼	—	145	D	none	UNIX, DOS, Netware, etc.	SCSI	70	—	—	70	4.96 MB	12	$3,595
Panasonic Communications & Systems Co., OAG Group, Two Panasonic Way 7F-2, Secaucus, NJ 07094. **Circle 241**																
LF-3004	Panasonic	128 MB	3 ½	E	—	—	—	—	SCSI-2	—	—	—	—	—	—	$1,995
LF-3000	Panasonic	128 MB	3 ½	E	—	—	—	—	SCSI-2	—	—	—	—	—	—	$2,195
LF-5014	Panasonic	940 MB	5 ¼	W	—	—	—	—	SCSI-2	—	—	—	—	—	—	$2,999
LF-5010E	Panasonic	940 MB	5 ¼	W	—	—	—	—	SCSI-2	—	—	—	—	—	—	$3,299
LF-7014	Panasonic	1 GB	5 ¼	M	—	—	—	—	SCSI-2	—	—	—	—	—	—	$3,695

Company/Manufacturer Model	Manufacturer	Capacity	Form factor (inches)	Erasable (E), WORM (W) or Multifunction (M)	If removable media, price per one ($U.S.)	Media single or double sided	Drivers required	Operating systems/hardware	Interface type	Average seek time (ms)	Read speed (KB/s)	Write speed (KB/s)	Average access time (ms)	Data transfer rate (B/s)	Warranty (months)	Price
FWB Inc., 2040 Polk St., Ste. 215, San Francisco, CA 94109. **Circle 225**																
HD600-2	Sony	600 MB	5 ¼	E	160	D	Sun Optical SW	Sun, NeXT, Mac, etc.	SCSI	95	680	340	107.5	680 KB	12	$4,339
General Microsystems Inc., 3220 118th Ave S.E., Ste. 100, Bellevue, WA 98005. **Circle 226**																
MO/D 220	Maxoptix	1 GB	5 ¼	E	375	D	none	UNIX/Sun, Concurrent	SCSI	35	700	200	48.6	4 MB	12	$5,950
OL/D 440	LMSI	5.6 GB	12	W	699	D	none	UNIX/Sun, Concurrent	SCSI	80	700	700	115	1 MB	12	$27,950
Herstal Automation Ltd., 3171 W. Twelve Mile Road, Berkley, MI 48072-1339. **Circle 227**																
50652A	Ricoh	652 MB	5 ¼	E	195	D	7010, 7014	HP UX	SCSI	50	300	100	—	—	12	$4,100
Hewlett-Packard Co., 3000 Hanover St., Palo Alto, CA 94304. **Circle 228**																
Model C1716C	HP	650 MB	5 ¼	M	185	D	—	—	SCSI-2	27	1 MB	500	—	—	3	$3,900
Model 650	HP, Sony	650 MB	5 ¼	M	185	D	—	Sun, DEC, IBM, HP, Mac, etc.	SCSI	27-95	680-1 MB	340-500	—	—	3	$5,220
10LC (Opitcal Library)	HP	10.4 GB	5 ¼	M	185	D	—	Sun, DEC, IBM, HP, Mac, etc.	SCSI	27	1 MB	500	—	—	3	$9,495
Model 10 (Opitcal Library)	HP, Sony	10.4 GB	5 ¼	M	185	D	—	Sun, DEC, IBM, HP, Mac, etc.	SCSI	27-95	680-1 MB	340-500	—	—	3	$14,900
Model 20 (Opitcal Library)	HP, Sony	20.8 GB	5 ¼	M	185	D	—	Sun, DEC, IBM, HP, Mac, etc.	SCSI	27-95	680-1 MB	340-500	—	—	3	$27,000
Model 60 (Opitcal Library)	HP, Sony	57.2 GB	5 ¼	M	185	D	—	Sun, DEC, IBM, HP, Mac, etc.	SCSI	27-95	680-1 MB	340-500	—	—	3	$33,900
Model 100 (Opitcal Library)	HP, Sony	93.6 GB	5 ¼	M	185	D	—	Sun, DEC, IBM, HP, Mac, etc.	SCSI	27-95	680-1 MB	340-500	—	—	3	$48,200
Hitachi America Ltd., 2000 Sierra Point Pkwy., Brisbane, CA 94005-1819. **Circle 229**																
OD 112	Hitachi	644 MB	5 ¼	E	call	D	Hitachi	—	SCSI	62.5	925	670	62.5	925 KB	call	call
Introl Corp., 2817 Anthony Lane South, Minneapolis, MN 55418-3254. **Circle 230**																
EO3-R1-SUN	Ricoh	128 MB	3 ½	E	call	S	Introl SCSI-FLEX	SunOS	SCSI	45	640	—	43	640 KB	12	call
EO-R2-SUN	Ricoh	650 MB	5 ¼	E	160	D	Introl SCSI-FLEX	SunOS	SCSI	50	1	—	66.7	1 MB	12	$2,995
EO-R3-SUN	Ricoh	650 MB	5 ¼	E	160	D	Introl SCSI-FLEX	SunOS	SCSI	29	1	—	37.4	1 MB	12	$3,775
EO-S1-SUN	Sony	650 MB	5 ¼	E	160	D	Introl SCSI-FLEX	SunOS	SCSI	62	0.9	—	74.2	0.9 MB	12	call
EO3-R1-SUN	Ricoh	128 MB	3 ½	E	call	S	Introl SCSI-FLEX	SunOS	SCSI	45	640	—	43	640 KB	12	call
EO-T2-SUN	Maxoptix	1.02 GB	5 ¼	E	250	D	Introl SCSI-FLEX	SunOS	SCSI	35	1.2	—	48.6	1.2 MB	12	$4,496
Laser Magnetic Storage International Co., 4425 Arrows West Drive, Colorado Springs, CO 80907. **Circle 231**																
LD320	LMSI	128 MB	3 ½	M	100	S	—	DOS, OS/2	SCSI-2	45	640	—	55	4 MB	12	$1,900+
LD510	LMSI	654 MB	5 ¼	W	125	D	—	Sun UNIX, Novell, Mac, etc	SCSI	43	590	—	57	4 MB	12	$2,850+
LD520	LMSI	654 MB	5 ¼	M	125-250	D	—	PC/MS-DOS, Sun UNIX, etc.	SCSI	53	490	—	70	1.5 MB	12	$3,000+
Literal Corp., 2180 Executive Circle, Colorado Springs, CO 80906. **Circle 232**																
I-525MF #99-7001-01	Literal	654 MB	5 ¼	M	W-145 E-250	D	—	—	SCSI-2	85	491	218	69.7	1.5 MB	12	$4,495
525 WO #99-1914-01	Literal	1.28GB	5 ¼	W (ISO)	209	S, D	—	—	SCSI-2	90	200	200	115	3 MB	12	$4,499
525GB+ #99-1814-02	Literal	1.28 GB	5 ¼	W (ANSI)	199	D	—	—	SCSI-2	90	200	200	115	3 MB	12	$4,499
S-525MF External #99-7002-01	Literal	654 MB	5 ¼	M	W-145 E-250	D	—	—	SCSI-2	85	491	218	69.7	1.5 MB	12	$4,695
ISi Personal Library	Literal	12.8 GB	5 ¼	W (ISO)	199	D	—	—	SCSI-2	90	200	200	115	3 MB	12	$10,999
ISi Personal Library #99-7100-02	Literal	12.8 GB	5 ¼	W (ANSI)	199	D	—	—	SCSI-2	90	200	200	115	3 MB	12	$10,999

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Datalink Corp., 7423 Washington Ave. South, Minneapolis, MN 55435. **Circle 216**																
SU1-MOMH/ SU1-MOMH	HP	650	5 ¼	M	160	D	AAP driver	SunOS/SPARC	SCSI Ethernet	95	680	340	95	680	12	$4,695
Datastore Systems Inc., 10929 Franklin Ave., Franklin Park, IL 60131. **Circle 217**																
SU1-MFMH	HP	650 MB	5 ¼	M	350	D	—	Sun SPARC	SCSI	—	—	—	—	—	12	$3,995
LaserSafe	Ricoh	296 MB	5 ¼	E	225	D	none	SCO UNIX	SCSI	66.7	—	—	—	—	12	$4,995
RMF-1000	Maxoptix	932 MB	5 ¼	E	300	D	none	CTOS, BTOS	SCSI	35	—	—	35	—	6	$6,995
Data General Corp., 4400 Computer Drive, Westboro, MA 01580. **Circle 218**																
6614M	Sony	650 MB	5 ¼	M	275	D	none	DG/UX	SCSI	22	—	—	—	—	3	$5,695+
6613	Sony	650 MB-6.55 GB	5 ¼, 12	M, W	275-475	D	none	DG/UX	SCSI	400	—	—	—	—	3	$36,000+
Delta Microsystems Inc., 111 Lindbergh Ave., Livermore, CA 94550. **Circle 219**																
SS-562MA	Ricoh	650 MB	5 ¼	E	call	D	custom provided by Delta	All except Sun-3	SCSI	50	450	150	66.7	450 KB	12	call
SS-562M	Sony	650 MB	5 ¼	E	call	D	custom provided by Delta	All except Sun-3	SCSI	80	680	340	92.5	680 KB	12	call
SS-1000M	Maxoptix	1 GB	5 ¼	E	call	D	custom provided by Delta	All except Sun-3	SCSI	35	1 MB	500	48.6	1 MB	12	call
SS-10MJ	various	6.5 GB	5 ¼	E	call	D	custom provided by Delta	All except Sun-3	SCSI	—	—	—	—	—	12	call
SS-56MJ	various	33 GB	5 ¼	E	call	D	custom provided by Delta	All except Sun-3	SCSI	—	—	—	—	—	12	call
Dynatek Automation Systems Inc., 15 Tangiers Road, Toronto, Ontario M3J 2B1, Canada. **Circle 220**																
ROS600	Sony	594 MB	5 ¼	E	298	D	none	—	SCSI	95	—	—	95	620 KB	12	$5,190+
MFD600	Pioneer	652 MB	5 ¼	M	198	D	none	—	SCSI	53	—	—	53	491 KB	12	$6,990+
Eastman Kodak Co., Components Marketing Group, 901 Elmgrove Road, Rochester, NY 14653. **Circle 221**																
System 6800 (Disk Library)	Kodak	10.2 GB	14	W	725	D	—	—	SCSI	—	—	—	—	1 MB	12	call
Model 560 (Disk Library)	various	60 GB	5 ¼	E, W, M	—	—	—	—	SCSI	—	—	—	—	—	12	$35,000+
ECCS Inc., One Sheila Drive., Bldg. 6A, Tinton Falls, NJ 07724. **Circle 222**																
Optical Module 600	Sony	600 MB	5 ¼	E	250	D	none	UNIX/ AT&T, NCR, Sun	SCSI	70	357	200	92.5	7.4 MB	12	$4,890
Optical Module 1000	Maxoptix	1 GB	5 ¼	E	600	D	none	UNIX/ AT&T, NCR, Sun	SCSI	35	383	250	48.6	—	12	$7,170
Falcon Systems Inc., 5816 Roseville Road, Sacramento, CA 95816. **Circle 223**																
FX-650W	Pioneer	654 MB	5 ¼	E, W	call	D	none	SunOS	SCSI	53	—	—	—	1.5 MB	12	call
FX-1713	HP	10 GB	5 ¼	M	call	D	FalconVision	SunOS	SCSI	95	680	340	—	1.2 MB	12	call
FX-1715	HP	20 GB	5 ¼	M	call	D	FalconVision	SunOS	SCSI	95	680	340	—	1.2 MB	12	call
FX-1720	HP	60 GB	5 ¼	M	call	D	FalconVision	SunOS	SCSI	95	680	340	—	1.2 MB	12	call
FX-1725	HP	100 GB	5 ¼	M	call	D	FalconVision	SunOS	SCSI	95	680	340	—	1.2 MB	12	call
FE-PRO Inc., 9700 W. 76th St., Eden Prairie, MN 55344. **Circle 224**																
FE120-SC (subsystem)	Sony, LMSI	120 MB	3 ½	E	60	S	none	SunOS	SCSI	—	—	—	—	—	12	$1,950
FE600-SC	Sony	600 MB	5 ¼	E	175	D	none	SunOS	SCSI	83	—	—	—	7.4 MB	12	$3,350
FE650-PC (subsystem)	Sony, Maxoptix	650 MB-1 GB	5 ¼	E	175	D	none	DOS/Novell	SCSI	83	—	—	—	7.4 MB	12	$3,350
FE1000-SC (subsystem)	Maxoptix	600 MB-1 GB	5 ¼	E	250	D	none	SunOS	SCSI	35	—	—	—	4 MB	12	$4,250
FE940SMF (subsystem)	Panasonic	940 MB	5 ¼	M	175	D	none	SunOS	SCSI	—	—	—	—	—	12	$4,250
FE5.GG-BC (subsystem)	LMSI	5.6 GB	12	W	420	D	none	SunOS	SCSI	80	700	700	130	4.0 MB	12	$23,950

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ATG Gigadisc Inc., 400 W. Cummings Park, Woburn, MA 01801. **Circle 207**																
GD9001	ATG	9 GB	12	W	865	D	—	—	SCSI, SCSI-2	90	1 MB	1 MB	90	1 MB	12	$28,900
Aviv Corp., 4 Fourth Ave., Burlington, MA 01803. **Circle 208**																
SPO-32	Sony	20 GB	5 ¼	E	—	D	Aviv Library Manager	UNIX, VMS	SCSI, DSSI, HSC	35	1 MB	500	8	5 MB	3	62,500
SPO-88	Sony	60 GB	5 ¼	E	—	D	Aviv Library Manager	UNIX, VMS	SCSI, DSSI, HSC	35	1 MB	500	8	5 MB	3	100,000
SPO-144	Sony	100 GB	5 ¼	E	—	D	Aviv Library Manager	UNIX, VMS	SCSI, DSSI, HSC	35	1 MB	500	8	5 MB	3	156,250
Cal-Abco., 6041 Variel Ave., Woodland Hills, CA 91367. **Circle 209**																
RS-9200EX	Ricoh	650 MB	5 ¼	E	230	D	IN-SF-Sun-EO	SunOS/SPARC	SCSI	28	1 MB	—	37	1 MB	12	call
DR628-00	Ricoh	3.25 GB	5 ¼	E	230	D	none	SunOS/SPARC	SCSI	28	1 MB	—	37	1 MB	12	call
IDE7100-003	Ricoh	6.5 GB	5 ¼	E	230	D	IN-SF-Sun-JB10	SunOS/SPARC	SCSI	28	1 MB	—	37	1 MB	12	call
NKK-N556ET	Maxoptix	52 GB	5 ¼	E	375	D	IN-SF-Sun-JB2056	SunOS/SPARC	SCSI	35	—	—	49	690 KB	12	call
Cherokee Data Systems Inc., 1860 Lefthand Circle, Longmont, CO 80501. **Circle 210**																
CM3301P	MOST	128 MB	3 1/2	E	82	S	—	SunOS, DOS, UNIX, VMS	SCSI	35.2	—	—	47.7	3 MB	12	$2,600
CR6120	Cherokee	640 MB	5 ¼	W	180	D	—	SunOS, DOS, UNIX, VMS	SCSI	105	500	200	—	—	12	$6,700
CR6210/ CR6220	Cherokee	1.28 GB	5 ¼	W	180	D	—	SunOS, DOS, UNIX, VMS	SCSI	105	500	200	—	—	12	$6,700/ $9,000
CMS Enhancements Inc., 2722 Michelson Drive, Irvine, CA 92715. **Circle 211**																
SSE-MOD	Ricoh	600 MB	5 ¼	E	200	D	none	SunOS	SCSI	50	300	100	—	—	12	$2,518
Computer Systems Technology, One Technology Drive, Ste. E309, Irvine, CA 92718. **Circle 212**																
CST128MO-SC	Sony	128 MB	3 ½	E	75	S	—	—	SCSI	38	620	650	45	625 KB	12	$2,350
CST594MO-SC	Sony	650 MB	5 ¼	E	195	D	—	SunOS, UNIX, DEC, Sun	SCSI	65	620	650	70	—	12	$3,495
Computer Upgrade Corp., 2910 E. La Palma Ave., Bldg. A, Anaheim, CA 92806. **Circle 213**																
OMNISTOR	Pioneer	654 MB	5 ¼	M	W-85 E-125	D	none	SunOS, DOS, etc.	SCSI	53	470	250	69.7	250 KB	12	$3,995
Consan Inc., 7676 Executive Drive, Eden Prairie, MN 55344. **Circle 214**																
RS-600-SUN	Ricoh	650 MB	5 ¼	E	125	D	SPARC driver	SunOS	SCSI-2	28	8.3	—	37	4 MB	12	$3,365
RS-600-SUN (5-cartridge jukebox) (10-cartridge jukebox)	Ricoh	3.25 GB 6.5 GB	5 ¼	E	125	D	SPARC driver	SunOS	SCSI-2	28	8.3	—	37	4 MB	12	$8,990/ $13,485
Cranel Inc., 510 E. Wilson Bridge Road, Worthington, OH 43085-2373. **Circle 215**																
NOFS Model 10	HP	10 GB	5 ¼	M	195	D	none	SunOS	SCSI, serial, Ethernet	—	680	340	105	—	3	$35,000
NOFS Model 20	HP	20 GB	5 ¼	M	195	D	none	SunOS	SCSI, serial, Ethernet	—	680	340	105	—	3	$54,000
NOFS Model 40	HP	40 GB	5 ¼	M	195	D	none	SunOS	SCSI, serial, Ethernet	—	680	340	105	—	3	$85,000
NOFS Model 60	HP	57.2 GB	5 ¼	M	195	D	none	SunOS	SCSI, serial, Ethernet	—	680	340	105	—	3	$94,000
NOFS Model 100	HP	93.6 GB	5 ¼	M	195	D	none	SunOS	SCSI, serial, Ethernet	—	680	340	105	—	12	$118,000
NOFS Model 160	HP	150.8 GB	5 ¼	M	195	D	none	SunOS	SCSI, serial, Ethernet	105	680	340	105	—	3	$172,000
NOFS Model 200	HP	187.2 GB	5 ¼	M	195	D	none	SunOS	SCSI, serial,	—	680	340	105	—	3	$190,000

A Sampling of

Optical Disk Drives

compiled by MAUREEN MCKEON

Company/Manufacturer Model	Manufacturer	Capacity	Form factor (inches)	Erasable (E), WORM (W) or Multifunction (M)	If removable media, price per one ($U.S.)	Media single or double sided	Drivers required	Operating systems/hardware	Interface type	Average seek time (ms)	Read speed (KB/s)	Write speed (KB/s)	Average access time (ms)	Data transfer rate (B/s)	Warranty (months)	Price
Alphatronix Inc., 2300 Englert Drive, Research Triangle Park, NC 27709. **Circle 200**																
IRS-10M	Sony	600 MB	5 ¼	E	220	D	none	AIX/RS 6000	SCSI	83	350	220	1	900 KB	12	$6,995
ISS10-M	Sony	600 MB	5 ¼	E	220	D	none	SunOS/Sun	SCSI	83	350	220	1	900 KB	12	$6,995
IRS20-X	Sony	1.2 GB	5 ¼	E	220	D	none	AIX/RS 6000	SCSI	83	350	220	1	900 KB	12	$12,800
ISS20-X	Sony	1.2 GB	5 ¼	E	220	D	none	SunOS/Sun	SCSI	83	350	220	1	900 KB	12	$12,800
American Digital Systems Inc., 490 Boston Post Road, Sudbury, MA 01776. **Circle 201**																
MXO 151-X	Sony	594 MB	5 ¼	E	—	D	—	VAX/VMS, Ultrix, UNIX	SCSI	95	—	—	—	1.2 MB	24	$5,095
MXO 152-X	Maxoptix	932 MB	5 ¼	E	—	D	—	VAX/VMS, Ultrix, UNIX	SCSI	35	—	—	—	4 MB	24	$7,410
Andataco Computer Peripherals, 9550 Waples St., San Diego, CA 92121. **Circle 202**																
ADT/602A	Maxoptix	1 GB	5 ¼	E	295	D	Andataco	Solaris/Sun	SCSI	35	—	—	.099	1.4 MB	12	$3,500
Applied Digital Systems, 30 State St., Fairport, NY 14450. **Circle 203**																
AD650	Sony	650 MB	5 ¼	M	195	D	ADS SunOS	Sun, VMS, Ultrix	SCSI	65	—	—	65	1.2 MB	12	$3,995
Apunix Computer Services, 5575 Ruffin Road, Ste. 110, San Diego, CA 92123. **Circle 204**																
APD-651 M-S	Ricoh	650 MB	5 ¼	E	160	D	none	SunOS, Solaris	SCSI	29	1 MB	500	37	3.4 MB	12	$3,307
Aquidneck Systems International, 650 Ten Rod Road, North Kingstown, RI 02852. **Circle 205**																
OAS 150	Sony, Kodak	650 MB-10.2 GB	5 ¼, 12, 14	E, W	250-700	D	none	Sun, DEC, HP, IBM PC, Prime, Wang VS	SCSI VAXBI, Qbus, Unibus	65-800	800	400	—	1.5 MB	3	$23,000+
Artecon Inc., 2460 Impala Drive, Carlsbad, CA 92008-7236. **Circle 206**																
OD-0120-A	Ricoh	128 MB	3 ½	E	70	S	ArteEOD software	Solaris/SPARC	SCSI, SCSI-2	43	616	207	65	4 MB	12	$2,600
DPU-SP0	Ricoh	128 MB	3 ½	E	70	S	ArteEOD software	Solaris/SPARC	SCSI, SCSI-2	43	616	207	65	4 MB	12	$2,695
DSU0-300P0	Ricoh	128 MB	3 ½	E	70	S	ArteEOD software	Solaris/SPARC	SCSI, SCSI-2	43	616	207	65	4 MB	12	$2,995
OD-600-A	Ricoh	650 MB	5 ¼	E	170	D	ArteEOD software	Solaris/SPARC	SCSI, SCSI-2	37	1.42 MB	710	37	4 MB	12	$4,700
DSU1-300P1	Ricoh	650 MB	5 ¼	E	170	D	ArteEOD software	Solaris/SPARC	SCSI, SCSI-2	37	1.42 MB	710	37	4 MB	12	$4,995
OD-1000 A	Maxoptix	1 GB	5 ¼	E	250	D	ArteEOD software	Solaris/SPARC	SCSI, SCSI-2	35	900	300	35	4 MB	12	$5,700
DSU1-300P2	Maxoptix	1 GB	5 ¼	E	250	D	ArteEOD software	Solaris/SPARC	SCSI, SCSI-2	35	900	300	35	4 MB	12	$5,995
DSU1-300J1 (jukebox)	Ricoh	6.5 GB	5 ¼	E	170	D	ArteEOJ software	Solaris/SPARC	SCSI, SCSI-2	—	—	—	—	—	12	$12,995
DSU1-300J2 (jukebox)	Maxoptix	10 GB	5 ¼	E	250	D	ArteEOJ software	Solaris/SPARC	SCSI, SCSI-2	—	—	—	—	—	12	$15,995
DSU1-300J5 (jukebox)	Ricoh	36 GB	5 ¼	E	170	D	ArteEOJ software	Solaris/SPARC	SCSI, SCSI-2	—	—	—	—	—	12	$42,995
DSU1-300J6 (jukebox)	Maxoptix	56 GB	5 ¼	E	250	D	ArteEOJ software	Solaris/SPARC	SCSI, SCSI-2	—	—	—	—	—	12	$45,995

"You know, I would actually say that the Epoch model, if you throw in Renaissance [software to extend Epoch's data storage model to local disk], is one of the ultimates." In fact, the company's only real problem with the optical jukebox is overuse. "One of the problems with an infinite resource is that people start treating it as such. The guy who administers it calls it Audrey, after the plant [in *Little Shop of Horrors*]. It keeps calling 'feed me! feed me!' optical disks."

The guy in question is Joseph M. Powers, Commonwealth's system analyst. "We're finding that it [the jukebox] is a great tool...if it is used properly," he says. "It's that last statement that causes some heartburn."

Specifically, he has problems with users taking up more of the magnetic disk space than was originally planned. "People will expand their application to fill up as much space as they can," he says. "If that space seems infinite, then they'll expand infinitely."

He says that there are two groups of users on the system: CAD users and "Mel's group," in R&D. Of the two, the CAD people are fairly predictable in their use of the system. The R&D group, though, will be doing different things from day to day, and their storage needs will vary wildly. "If you have everything set up properly, and you have predictable usage, then the system [the jukebox] can take care of itself...and it did for some months. ... The problem now is that the size of the files that was created for R&D on the magnetic isn't large enough to meet their current needs."

This wasn't the result of any lack of planning. Rather, the users themselves didn't realize how much space they would eagerly gobble up. "Before, we were using paper for everything," says Powers. "We went around and asked people how much disk space they thought they would need when we purchased the system. But, of course, since they were using paper before, they had no idea how much they'd really need."

Indeed, he says to others in his position, "expanding the system afterwards has been a little more difficult than configuring it for larger files in the first place."

No Common Ground?

Is there, then, any common theme to all these different users and all their different applications? Is there some neat and easy way to sum up how optical disks are being used by the industry as a whole?

Clearly, the answer is no. There a few common characteristics–optical-disk applications have data sets that are large, and yet which also must be accessed randomly–but otherwise there's not much to label a typical optical disk user.

And perhaps that's a good thing. It means that optical disks are now so much a part of general-purpose computing that no one can accuse them of being niche solutions. Optical disks are now no more remarkable than Winchesters, less focused in terms of mission than tape drives, and in the long run, probably far more important for the workstation market than the mini-floppy drives that now come standard on Sun IPCs.

Maybe, then, the importance and the role of optical-disk technology is best summed up by Commonwealth's Gehrs, who describes his company's Epoch with, "Everybody puts stuff on it. It is the classic Fibber McGee's closet." ⊸

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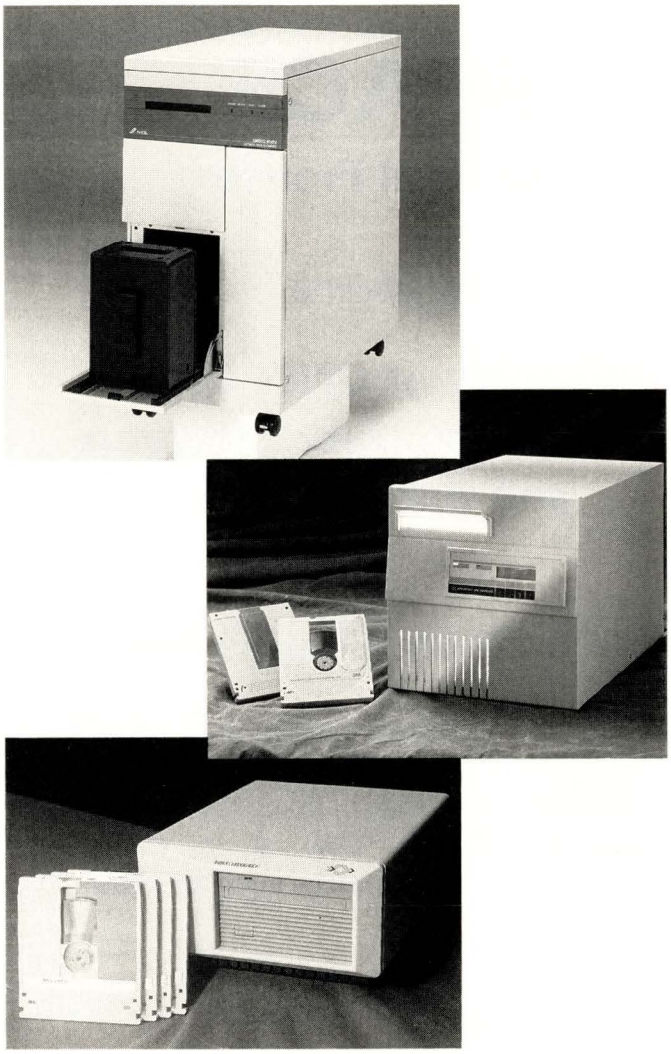

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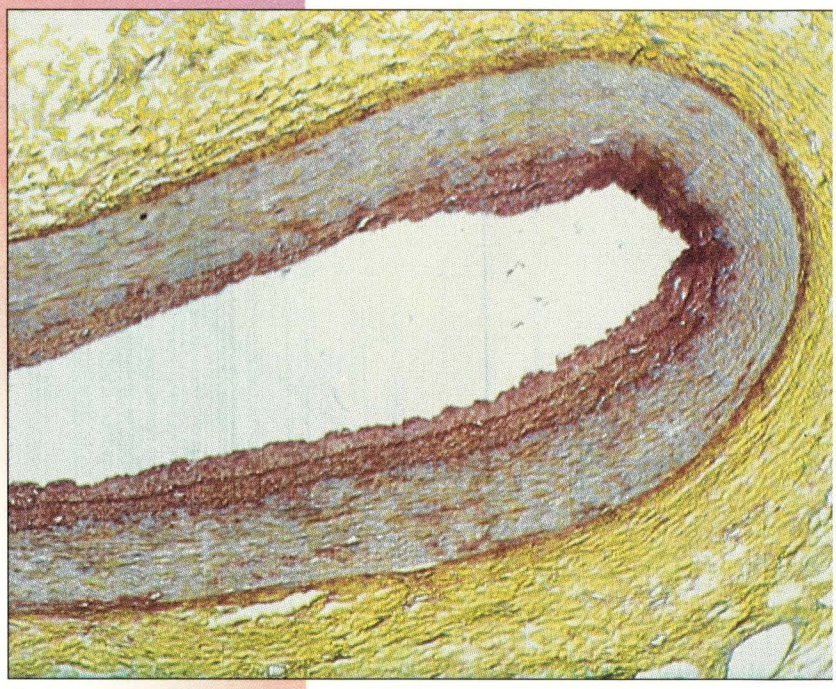
libraries of engineering drawings and plans, many of which are in hard copy or on micrographic media. An early adopter of CADD, Beloit also has an enormous number of CADD documents in electronic form. All of these are slowly migrating to optical disk.

"Basically, we've got a SPARCstation 2 as a network server, and it has one Introl Corp. jukebox on it," explains Rotheroe. The plan is make all the company's engineering documents available eventually in digital form.

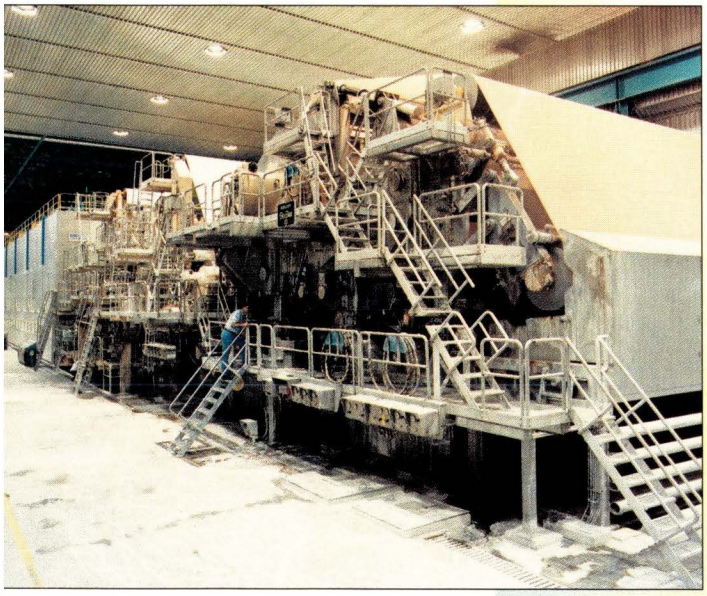
His company needed, however, a vendor that would leave it alone, when necessary. "We didn't want a turnkey system," though that was what a number of vendors wanted to sell them. "When looking at some of the turnkey systems, we found there were a lot of snags." What Beloit wanted was a vendor that would supply them with just the amount of support that was wanted at any one time. "We have a fairly powerful programing staff here," says Rotheroe. "Though I recognize that we are not really typical of the market. There are a lot of people out there who want a higher level of integration."

Ultimately, it settled on an Introl jukebox. In fact, Beloit plans to have multiple jukeboxes at multiple sites–a major consideration in the choice of product. "It [the jukebox] is small and relatively easy to transport. You can literally put it into a box and ship it via Federal Express."



A view of an arterial wall is one of the images on optical disk the Cleveland Clinic Foundation uses as part of a biomedical image-processing project.

A paper-making machine the length of a football field is a product of Beloit Corp. Beloit stores CAD data for these huge devices on optical disk.



Feed Me

Another complex application is resident at Commonwealth Edison Co. of Chicago. "We're an electric utility. In the process of making electricity, you get into all kinds of projects," says Mel Gehrs, supervisor of technology research for Commonwealth. The "projects" include everything from ECAD to geographic information systems (GIS) to 900-MHz radio-signal strength maps used to help manage the company's mobile radios in trucks and service vehicles.

To support so wide a variety of tasks, the company has "over a 100 Suns, I think...and PCs; the PCs are just growing rapidly." For data storage and archival, the company has a large jukebox from Epoch Systems Inc. that allows files to migrate automatically from magnetic to optical media, depending on how often they're accessed. Material used less often goes to the optical, while more frequently accessed material goes to magnetic.

Gehrs says that this system fulfills most of his requirements and more.

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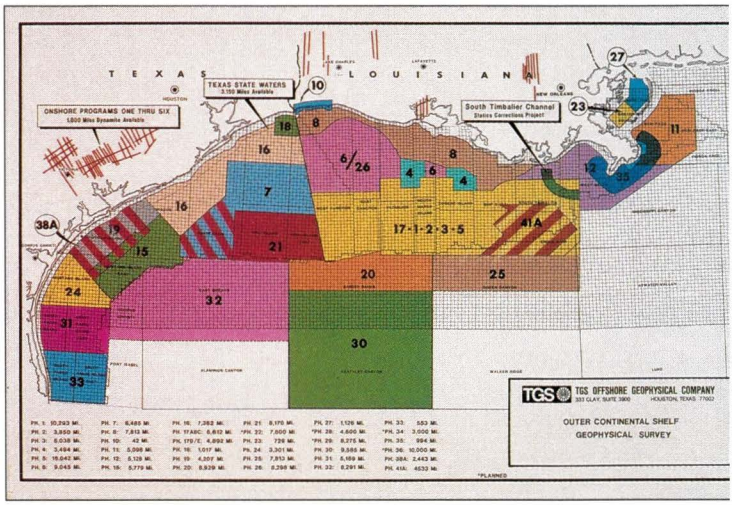
optical-disk jukebox."

The Cleveland Clinic Foundation is an association of several different medical installations. LaPestro is bringing imaging to several of its different parts. "We're doing image processing on images from a variety of sources," he says. "We may be looking at cross sections of a human artery...we may be using it for cell biology...perhaps looking for multiple scleroses lesions."

He says his biggest problem with optical disk came in the buying of it. "It wasn't an easy decision to make," he says. "I knew next to nothing about it at the time." In the end, he went with the machine he did because the jukebox itself was from Hewlett-Packard Co., a company whose hardware he trusted, while the software and support was from Cranel, a company that was accessible to him. "Installation could have been traumatic," he says. "But Cranel came out and basically put it together for us."

Meanwhile, Beloit Corp., of Beloit, WI, wanted the reverse–a distant vendor. "Beloit is one of the world's largest makers of paper-making machines," says Peter Rotheroe, Beloit's manager of CADD/CAM development."

Paper-making machines are complex, to say the least.



This picture of the Gulf of Mexico represents just some of the data stored on optical disk by Woodland Geophysical Group Inc. The company specializes in storing and manipulating seismic data for the oil and gas industry.

"They're as long as a couple of football fields, and two stories tall," says Rotheroe. As a result, Beloit maintains huge

Rock Ridge UNIX Standards on a Roll

by Marilyn R. Kilinski

[Editors note: While MO and WORM tend to grab headlines, CD-ROM is almost certainly the most widely used form of optical disk. One of the reasons for that is the Rock Ridge protocol.]

When it comes to UNIX standards, rivalry and inertia are two characteristics that spring to many Sun users' minds. But when conversation turns to UNIX CD-ROM formatting standards, the Rock Ridge Group's track record is one of cooperation and efficacy.

In less than three years, the Rock Ridge protocol has become the de facto format standard for UNIX CD-ROM publications. Pressed disks premastered in this format can be read by virtually any CD reader attached to any UNIX computer. The Rock Ridge protocol is a transparent, UNIX-specific extension to the ISO 9660 CD-ROM format, extending ISO 9660's MS-DOS orientation to handle UNIX's more complex file system. SunSoft supports Rock Ridge in SunOS 4.1.2 and has pledged to continue to do so in all forthcoming CD-ROM products. NeXT Computer Inc. and many other UNIX vendors also support Rock Ridge in their CD-ROM products.

The Rock Ridge Group was formed in 1989 with a charter to further, in a vendor-neutral fashion, a previous UNIX CD-ROM format standards effort known as "the POSIX extensions," spearheaded by Sun. In addition to Sun, its 16 charter members included Hewlett-Packard Co., Apple Computer Inc. (A/UX), SPARC International and Young Minds Inc. (YMI), a Redlands, CA-based firm specializing in CD-ROM software solutions.

The Rock Ridge Group is not a consortium, stresses Bill Petro, CD-ROM product manager at SunSoft. "The Rock Ridge Group addresses a common need felt among a number of major UNIX players; it's a group of vendors addressing an issue in a cooperative, noncompetitive way."

Rather than have development efforts driven by one of the major workstation vendor members, Rock Ridge's core technology was developed by YMI. Andrew Young, president of YMI and principal author of the Rock Ridge protocol, believes that it has become a de facto standard in the UNIX community for two reasons: the Rock Ridge extensions are completely compatible with an extremely widely accepted international standard, (ISO 9660), and because the Group and its work are vendor-neutral. No single vendor stands to benefit from its acceptance, including YMI; the specifications are published and are made available to all interested parties.

In addition to being an apparent de facto standard, the Rock Ridge extensions are being reviewed by national and international standards organizations, including NIST and IEEE. Young, who chairs the IEEE subcommittee for CD-ROM formatting, hopes the Rock Ridge standard will go to ballot this summer.

And, for the curious, Young provides the ultimate secret to the Rock Ridge Group's success is its name, which is shared by the fictitious town in the Mel Brooks classic, "Blazing Saddles."

Marilyn R. Kilinski is a technology-communications consultant and author, with UNIX software her specialty. She is based in Hoboken, NJ, and may be reached at pookie@world.std.com.

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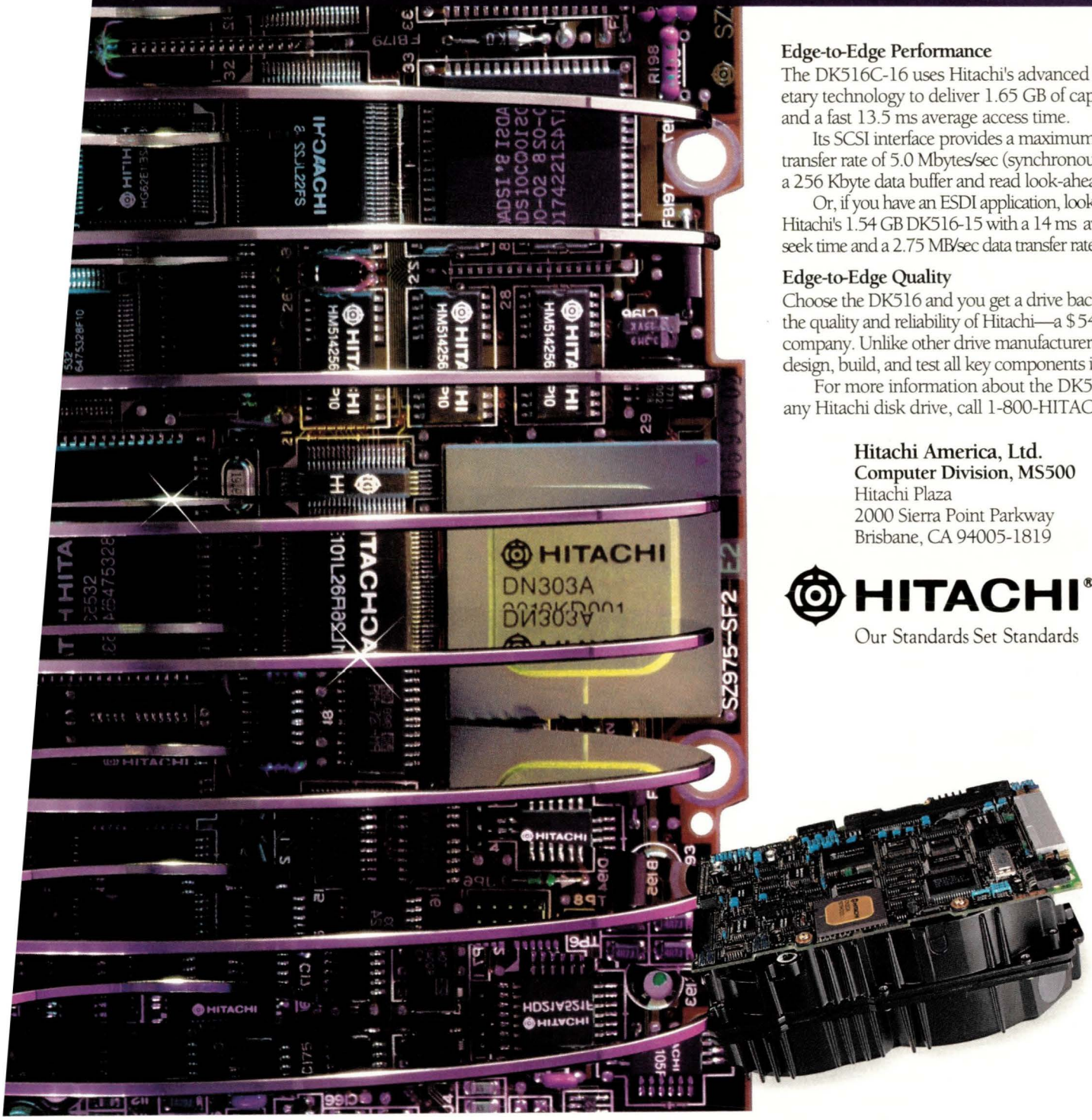

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New Toys, New Tools

Software re-use is one of the long-standing dreams of computer programming. But the problems of rewriting, linking, documenting and otherwise managing reams of code have long frustrated software developers' attempts to build new applications out of old.

Here too, though, optical disk seems to be lending a hand. "The real reason I have an optical disk is that I like playing with new toys," jokes James Purtilo, associate professor at the University of Maryland. "But since we have to have some facade of utility, my excuse is that I'm interested in large code repositories."

Purtilo is working on a project to make code reuse far more possible. Funded by private and government sources under the name of Prototech, the project is establishing large libraries of code on an optical disk from Tracer Technologies Inc. attached to a SPARCstation 2. The code ranges from standalone applications to libraries of subroutines and may have very different targets. "What our technology does," says Purtilo, "is analyze the sources and the target platforms, and figure out how to put the glue between them."

Ideally, users will be able to sit down at a console, type out a purpose for which they need software and the system would automatically find the necessary code and assemble it. You could even make it a distributed application, with parts of the code executing on one machine and other parts on others, since the system itself takes note of the target system for which any piece of code is written in the first place.

Code repositories have not, however, been particularly successful in the past. But Purtilo thinks his project's approach will be more a winner partly because it automates the cut-and-paste process that before had been forced on human programmers, and partly because "we think that one of the reasons repositories haven't been successful in the past was that people have been saving code. And code is a notoriously poor carrier of ideas."

To this end, his repositories carry almost as much information about software as software itself. "Users need to be presented with more than code," he says. "They need information about it. Not just who used it in the past, but why."

drives but his OS. "I found out that it would happen if you did it between two hard drives as well," he says. "I think the problem may have been in 4.1.1 of SunOS...because once I began running 4.1.2, it didn't happen again."

The company also uses optical disk in its own products–specifically, as a mass-storage device in its spectrometers. Here, it is used simply as primary mass storage, not backup. Hu notes that the choice was made to go with optical rather than magnetic because of the size of the data sets being analyzed.

Since the data is just being stored, the company could have gone with a WORM rather than with MO. In fact, Chemagnetics is looking at doing so now, chiefly because "the media [of WORM] is half the cost of MO," he says. "However, the drive costs are about the same." In fact, he doesn't expect the company to move to MO. "I expect to see no advantage to having a WORM drive."

Similar words come from Scripps Institute of Oceanography Center for Coastal Studies in La Jolla, CA. "We have one MO system [from Apunix Computer Services], and it's on one SPARCstation," says Jerome Wanetick, a programmer/analyst at Scripps. "What we're looking at is oceanographic data sets. They're quite large–in the hundreds of megabytes."

Specifically, Wanetick is part of a project that is studying "microseisms" in waves. These are "very small phenomena, on the order of centimeters, that are imposed on ocean waves...by seismic activity. Possibly earth tremors, but more probably, ocean waves impacting on the beach."

While small, they can be quite powerful. "They'll have very long wave lengths," he says. "And they'll have a lot of energy." They also seem to be responsible for a good deal of ocean noise, which is why the Wanetick's particular project is being funded by the Office of Naval Research. "The navy is very interested in background noise, because of its effects on sonar."

To study microseisms, the Scripps team went to North Carolina and placed a number of pressure sensors in the water offshore. "It was a diamond-shaped array," says Wanetick, "a kilometer on a side." From the sensors in the field, "just swags of data" then flowed to a Sun workstation, which was also in the field.

That, in fact, was one of the reasons that Scripps went with an optical drive. "If disk space became a problem, we could still operate directly off the optical disk," Wanetick notes. In other words, from Scripps the optical disk fulfills a hybrid mission, partly like archival media and partly like online mass storage.

He cautions, however, that his situation was somewhat unique because of the sheer size of his data. He isn't certain that users with smaller applications would really benefit from optical disk. "This project began two years ago. Since then, Winchesters have really dropped in price. Unless they have really huge data sets, people might be better off going with magnetic media."

Larger Than Football Fields

Indeed, if there is a theme to how optical disks are being used, it is that they are the type of mass storage that falls between tape backup and magnetic disk. It is the choice for applications where data is too large for standard Winchesters, but too often (and too randomly) accessed for inexpensive tape backup.

"It's a medium-level archival technology," says Eric LaPresto, an image-processing engineer at the Cleveland Clinic Foundation in Cleveland, OH. "It falls between disk and tape." LaPresto uses a 16-slot optical jukebox from Cranel Inc. attached to a Sun workstation for medical-imaging applications. His data is also voluminous. "Instead of going out and buying a huge disk farm, I wound up getting an

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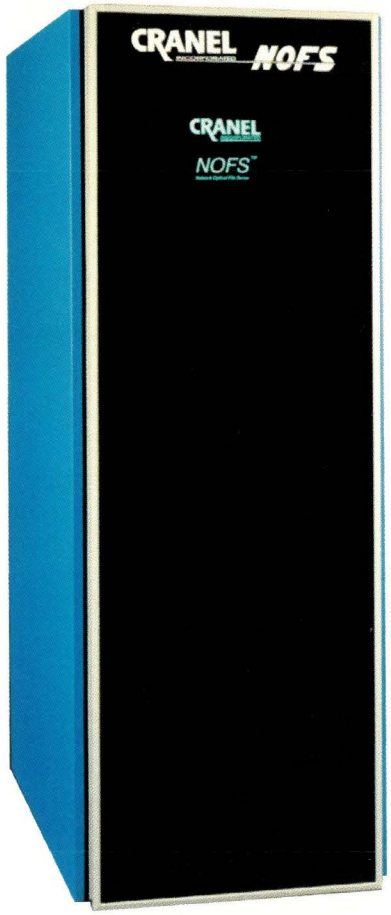

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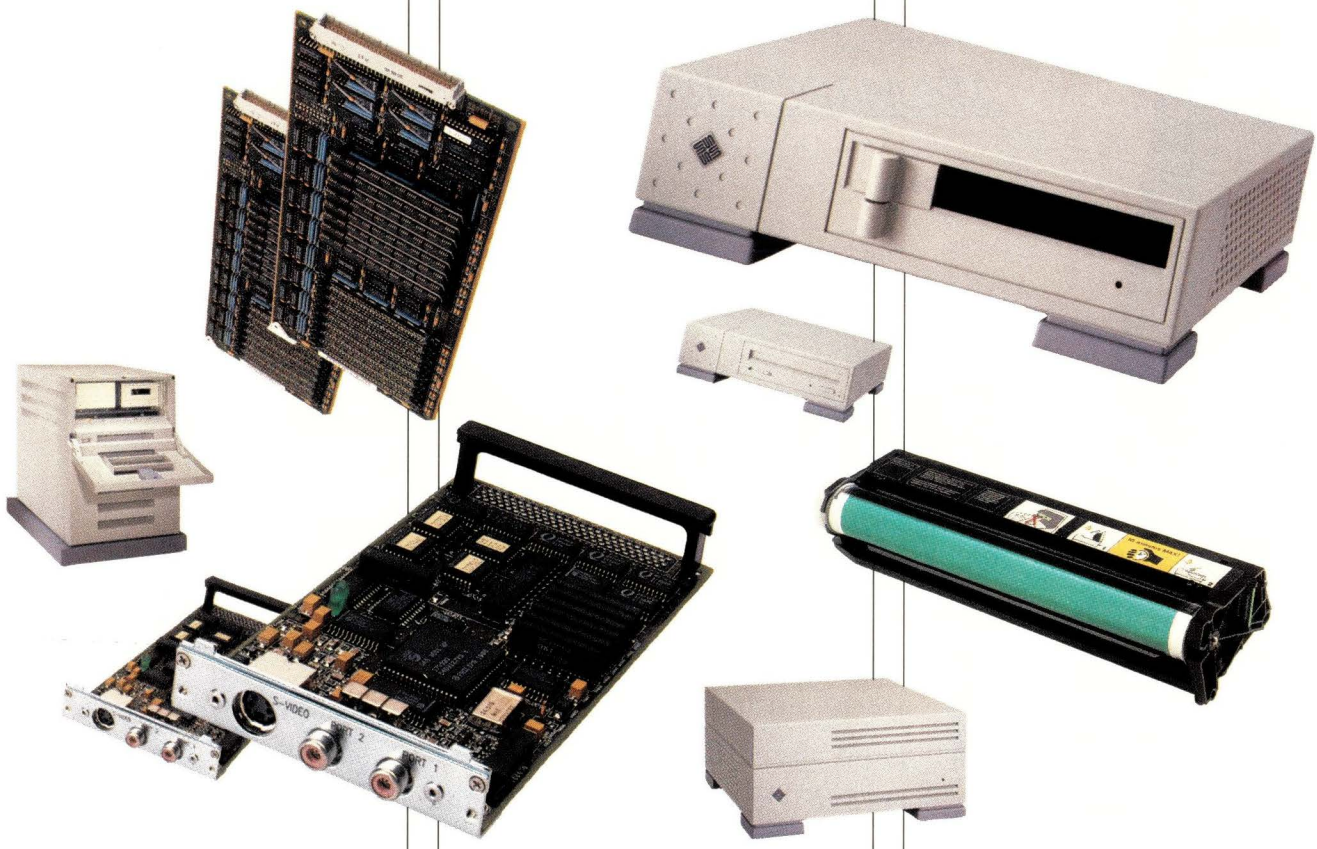

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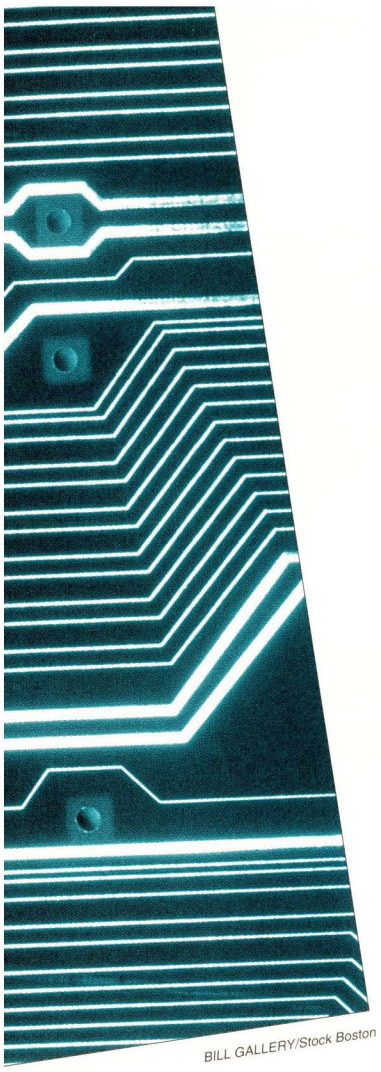

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Parallel Universes

by BARRY SHEIN,
Technical Editor

UNIX hacker's guide to parallel processing fundamentals

There is nothing new about parallel processing: the use of multiple CPUs to accomplish one task. I could argue that the first example of parallel processing occurred when the second computer was built, if we allow a broad enough definition of "task." The late, great Richard Feynman outlines an amusing human parallel processing computer he organized at Los Alamos during World War II while awaiting arrival of his calculating machines (*Surely You're Joking Mr. Feynman,* W.W. Norton, NY). Obviously something specific ties together the mere existence of more than one computer when we use a term like "parallel processing."

One of the earlier experiments in parallel processing was the Iliac project at University of Illinois in the early '60s. As many as 64 mainframe computers were tied together in an eight-by-eight array, all trying to calculate tomorrow's weather before tomorrow became yesterday. It was at least a partial success. Simple multiprocessor systems have been around for years, and specific forms of parallel processing have long been the hallmark of scientific supercomputers.

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Table GRAIN SIZE

	Description	Synchronization Interval
FINE	Parallelism down to instruction level	< microsecond
MEDIUM	Parallel processing within a single application	micro to millisecond
COARSE	Multiprogramming, distributed processing on a network	> millisecond

Large mainframes, notably from IBM Corp., have been using multiple processors for several years. The IBM 3090 (also known as Enterprise System/9000) was first offered around 1984 in two- and four-processor configurations and, more recently, in six- and eight-processor configurations. Digital Equipment Corp. sold multiprocessor configurations based on the PDP-10 architecture as early as the late 1970s. These were generally considered a great success for a wide range of applications. For some reason DEC's later multiprocessor VAX products were, to be kind, less well received.

Two companies, Encore Computer Corp. and Sequent Computer Systems Inc., have been offering very practical and sophisticated parallel processing minicomputers since the mid-1980s, both UNIX-based. Special-purpose systems such as Tandem Computers Inc.'s fault-tolerant systems and Auspex Systems Inc.'s file servers have always used multiprocessors. Silicon Graphics Inc. is a more recent entry into this field, focusing primarily on serving graphical workstation clusters.

Our interest lies in the announcement by Sun Microsystems Computer Corp. of the new 600MP processor. The 600MPs are being offered as new systems and upgrades in two- and four-processor server configurations. Now that Sun says there may be a multiprocessor system in your future, any customer might reasonably ask: "What are they? What are they good for?" and, most importantly, "What do they eat?"

Taxonomies

There are several taxonomies used to describe various parallel processing approaches. One common terminology used is MIMD, an acronym for multiple instruction, multiple data; SIMD, single instruction, multiple data; and the other two possibilities, MISD and SISD. SISD would be the description used for ordinary, nonparallel systems.

Most systems touted as parallel computers are either MIMD or SIMD systems. MIMD machines have multiple CPUs, each of which can access its own data area, often in a shared memory pool. The new Sun offerings are MIMD systems.

The most well-known SIMD machine is Thinking Machines Inc.'s (TMI) Connection Machine. The CPUs are ganged together, clocking out the same instructions but on different data. In the Connection Machine the data is contained locally to each processor. TMI recently announced claims that its system broke the teraflop barrier–that's 1,000 billion floating point operations per second. The Connection Machine uses anywhere from about 16,000 to one million CPUs and has never been accused of being a workstation.

You can further break down MIMD systems into two major categories: symmetrical and asymmetrical multiprocessing systems. In symmetrical multiprocessing systems, each CPU is roughly equivalent (there are always minor issues, such as position on the bus). When a process merits CPU resources, any CPU will do and is usually chosen using some straightforward scheduling algorithm: Find the CPU that is least busy and hand it the work.

For asymmetrical systems, one CPU is the "master" and any others are considered "slave" processors. The

usual distinction is that only the master CPU will perform I/O (or other resource scheduling); the other CPUs are consigned to only instruction processing. Various shades of gray occur in between. Asymmetrical systems exist mostly because it is much easier to get their operating system software working than it is with symmetrical systems. The locking systems within symmetrical systems' operating systems can be very subtle. A bad implementation will run slower than an equivalent single-CPU system due to contention for locks on critical resources in the kernel.

Another important taxonomy distinguishes the sort of parallel computation being done. This is broken down into coarse-grained, medium-grained and fine-grained multiprocessing (variations in between can also be used). Note: for a discussion of these classifications, see "Shared Memory Multiprocessors–The Right Approach to Parallel Processing," by Woodbury, P., Wilson, A., Shein, B., Gertner, I., Chen, P.Y., Barttlet, J., Aral, Z., IEEE Compcon 1989, pp. 72-80. The fineness of "grain" indicates the time required for parallel processes to synchronize with one another–for example, to tell another part of the computation that the key they were all frantically searching for has been found and they can now quit this one and go on to the next key (or finish entirely, but that's rarely a very interesting event from the point of view of the program).

A coarse-grained multiprocessing system typically has a granularity larger than a millisecond. This sort of system is typified by a bunch of workstations on a network, perhaps using a package like Sun's RPC to communicate changes in the computational state. Coarse-grained parallelism has been successful in applications where computation proceeds for a relatively long time on the independent processors and occasionally some small piece of information is passed between them.

A practical example of coarse-grained parallelism is encryption breaking, where each CPU might grind away for a while on a particular guess or set of guesses and then, when rejected, come back for the next guesses to try. Factoring of very large integers (hundreds of digits) has also used this approach. With minimal effort (other than obtaining administrative permission) one can employ vast resources if the problem fits this approach.

Medium-grained parallelism requires communications channels that operate below a millisecond, but not quite down to the instruction-speed level (microseconds). These computations (dozens to thousands of instructions) proceed for some time and then synchronize or otherwise communicate. An example would be searching a large array of data in memory, where each CPU might take a thousand items, check if the desired item is in that set and, if not found, grab the next available thousand items, and so on. An index to the next item available and a lock (so it is not updated by two CPUs simultaneously) would be the typical point of synchronization for such a computation.

Finally, fine-grained computation approaches the machine's instruction cycle time. Typically this involves specialized hardware such as Cray Research Inc.'s array-processing unit.

Sun's 600MP system is designed as an MIMD, medium-grained parallel system. Although the current operating system release is asymmetrical, the goal is symmetrical multiprocessing, which should be fully supported in the next release of the OS.

Multiprocessing: What's It Good For?

Something that multiprocessors in general cannot do (at least not yet) is provide you with processing throughput equivalent to the sum of the speeds of their CPUs. For example, Sun's 600MP uses up to four SPARC chips, each running at about 30 MIPS. You will not see 120-MIPS performance for most programs (though you may come quite close on certain common applications).

However, there are many problems for which you will experience significantly better performance on two CPUs than on one, and three better than two, and so on. Obtaining these

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performance improvements often requires redesign of the algorithms, but not always.

Serendipitous Parallelism

When a programming problem can take advantage of a parallel system without any recoding (of the application) I call it "serendipitous parallelism." The example of this that is easiest to understand occurs when using a UNIX pipe, as in:

```
% tbl some.file | troff
```

Threads are just a rude way to clean up some botches in current UNIX `fork()` implementations.

Assuming that the document is complicated enough to stress the processor at all (and is not significantly I/O-bound), a pipe like the one above will run at about twice the speed on a two-CPU system as it will on a single-CPU system. The only contention between the two processes is across the pipe itself. As long as the `tbl` command keeps feeding data to the second `troff` step, both processes will proceed in parallel. On a single-CPU system, regardless of appearances, one process computes for a while, then stops and lets the other process compute for a while.

Use of pipes such as in this last example are ubiquitous on UNIX, so serendipitous parallel speedup should be experienced immediately upon installing an MP system.

As a more trivial example (though very important to certain applications), time-sharing is sped up serendipitously in MP systems.

This is why MP systems have been popular in transaction processing and database applications. Each screen is generally running one or more processes, taking input and queries while the database itself may be running one or more processes satisfying these activities. With a well-tuned parallel system, this sort of environment can experience dramatic processing improvements (reduced latency, less time to dispose of a transaction), usually without any major recoding of the database system itself.

This is not to say that recoding with parallelism in mind will not help such applications. It can help a lot, but the mere existence of multiple CPUs able to respond to scheduling demands on a busy transaction system is generally significant if the system has previously been broken down into several processes–which many are–even if parallel systems is not the motivation. Parallel OLTP systems have been the performance leaders in industrywide benchmarks for years.

Another performance gain I have experienced, which takes almost no recoding, comes from using a parallel `make`, which rebuilds software systems. (`make` itself will need recoding, although these already exist, such as The GNU Project's `make`.) The rebuild dependency tree is analyzed and, where possible (no interdependencies), multiple compiles are forked off simultaneously. Certain steps must be serialized, such as waiting for `yacc` to produce its output before compiling with the C compiler, but many steps can usually be run simultaneously.

One system I used parallel `make` on (an Encore MIMD machine) would let you set an environment variable, before starting `make`, which limited the number of parallel compilations (or other processes) running at once. I remember commenting that the system compiled at about 9,600 baud: On a high-speed screen the compilation record, which `make` would display as it issued commands, seemed to come out about as fast as my terminal could display it. (I suspected that `make` was bottlenecking on the terminal output!) This was true even for compiles involving several hundred files.

Less Serendipitous Parallelism

In order to take advantage of parallel processing, some algorithms need to be recoded. This is a black art, to some extent, and no tools or programming languages exist that provide a magic solution to this problem. There exist languages, such as Linda, that claim to help you think about how to maximize and control parallelism as you code. Some FORTRAN compilers exist that can detect certain types of parallelism automatically. But, often, you just have to sit down and do it for yourself. O brave new world.

One easy recode involves finding single- and double-nested loops in programs and splitting the computation across multiple CPUs by flattening out the loop. I used this to speed up a Mandelbrot generator and achieved near linear speedups over several CPUs.

Speedups like this depend upon system primitives that allow you to start a new thread of processing in the same address space, or allow you to divide the computation with very little cross talk, or equivalent. The UNIX you are already accustomed to provides primitives that are often adequate. For example, a section of memory to be worked on can be put into a shared memory area (in fact, within limits, it is not hard to put your entire data space into shared memory, if desired), then `fork()` is used to start up each parallel thread of execution.

New primitives are often added to the operating system on parallel systems to provide explicit "threads," a term commonly used with the Mach operating system for these constructs. They provide multiple processor contexts within one address space. I assume that Sun's lightweight processing library (`-lwp`) is intended to provide this same function.

Although it would take an entire article of this length to explain why, I am skeptical of this extension to UNIX and believe that most of the same effect can be achieved without such drastic modification to UNIX's processing semantics. I have worked on parallel kernels where we made minor modifications to process creation (`fork()`) mostly transparent to the user, and came so close to comparable thread performance that we concluded threads are just a rude way to clean up some botches in current UNIX `fork()` implementations. Suffice to say that you rarely actually want to share all process context (e.g., signal state, stack, memory, etc.); you only put up with that if you think you have no choice.

One common gotcha is that standard UNIX library routines are not reentrant. `Stdio` is notorious for having this problem (unless Sun has recently fixed this). Static areas are used during the processing of routines like `printf()`. If the area becomes shared and two threads of execution find themselves in `printf()` at the same time, havoc can result. Although this is a common problem (usually discovered quickly as people often try to use `stdio` routines to help debug their program), it is not very hard to avoid. All I/O can be done via a single process for most algorithms (even simple message printing to follow progress can be placed in a shared area and a flag turned on or a semaphore used to indicate that it should be printed by the process assigned to do I/O).

Another much more serious problem is that debuggers such as `dbx` are almost completely useless with parallel programs. Some debuggers and programming systems have been developed with parallelism in mind (e.g. ParaSight from Encore, `cdb` from Third Eye Software), though most are not products at this time. I will guess that Sun's entry into the MP market will spur some developers to add this ability to their debuggers, but don't expect miracles because the problem is not understood very well. Any attempt to trace or step a parallel program often hides the subtle problem you are having with the code.

Beyond parallelizing loops or other straightforward partitions of a problem lies almost uncharted territory. There is little doubt that parallel algorithms exist that are radically different from their serial counterparts, not just a matter of splitting up a loop or similar. A colleague once remarked that someone should go through Donald Knuth's "The Art of Computer Pro-

gramming" and rework every algorithm investigated to the same level of detail with parallelism in mind (as a first cut at the problem). I tend to agree. Parallelism is very hard to think about in general; as someone else quipped, it's like having bees living inside your head.

One area that has yielded to parallelism very nicely is Finite Element Analysis, essentially a form of modeling of complex systems. These systems tend to run very fast on SIMD machines, but a MIMD machine can always be programmed to behave like a SIMD machine with a little discipline (although you don't often need tens of thousands of processors to make FEA programs really go fast).

What Parallel Systems Can't Do (Yet)

There exist entire, important classes of algorithms that resist any significant parallel speedups, except in special subcases. Perhaps the most important of these is matrix inversion. If we could find a decent parallel algorithm for inverting matrices it would no doubt change our world dramatically, and I mean that quite literally. Matrix inversions are used to solve simultaneous systems of differential (and other) equations in almost every field of science.

Matrix inversion tends toward N^3: The time it takes is proportional to the cube of the total number of elements in the matrix. Hence, inverting a 1,000-by-1,000-element matrix takes about 1 billion operations (1,000 by 1,000 by 1,000), typically all floating point operations. Even on a reasonably fast processor that can take hours. (Supercomputers are much faster at this particular problem, hence one major use of supercomputers is inverting matrices.) A 1,000-by-1,000 inversion is considered a tiny problem these days! Entire realms of critical scientific knowledge lie in matrices that cannot yet be inverted in a reasonable amount of time.

There are many other algorithms that either cannot be sped up with parallel processing or don't speed up enough to make the recoding or hardware worthwhile. Some are important; many are obscure (perhaps important to some few people).

However, just because there are algorithms that resist such improvements does not mean that parallelism is somehow useless!

Considering the rather pedestrian examples of effective speedup I presented earlier, it's hard to claim that parallel systems are less than wonderful, but that doesn't seem to stop people from claiming this. I hear it all the time from people, "But you can't invert matrices any faster on parallel systems!" "How often do you personally do that?" "Never." "Oh."

Even for the scientist who uses algorithms that can't be parallelized, a parallel system can be a boon. For starters, they can run more than one job at a time with little compromising of performance (assuming there is sufficient memory and other resources). OK, why not buy two workstations? That's a valid point, so long as other resources (such as huge memories or disk arrays) don't need to be shared that might be more economical to share on a single MP system. Or other, more mundane chores (reading netnews) can go on without significantly impeding a compute-intensive job.

Summary

Multiprocessor systems can be used to speed up even very common programming problems with little or no reprogramming (other than the vendor's operating-system changes). Simple paradigms such as time-sharing, server-client applications run on one machine, UNIX pipes and background jobs will utilize parallelism implicitly; you don't even have to think about it. Versions of `make` and `grep` exist that will automatically exploit parallelism. There are many common algorithms and applications that can be sped up with minor reprogramming: A simple reworking of the primary loop is all that is needed. There are algorithms that either cannot be sped up, or are very hard to speed up, on parallel machines. Most people can still benefit immensely from parallel systems.

NEW PRODUCTS

The product descriptions are compiled from data supplied by the vendors. To contact them for more detailed information, circle the appropriate reader service number on the card located at the end of the magazine.

Free PEX Software

Shographics has announced that its PEXtk graphics library will be available free from the MIT X Consortium. PEXtk is a graphics library for developers of mechanical computer-aided design, scientific visualization, molecular modeling and other 3D graphics applications. It allows developers to port such applications rapidly to the PEX protocol.

The company says that PEXtk provides efficient access to the PEX protocol without the complexity of the PHIGS programming interface. It features multimode operation, enabling software developers to use both immediate-mode 3D graphics commands and retained structures in the same program. The library has been tested on Sun and DEC systems.

Shographics
1890 N. Shoreline Blvd.
Mountain View, CA 94043
Circle 271

System Expansion from Aurora

Aurora Technologies has announced a variety of SBus products that provide additional I/O ports or otherwise expand the Sun Microsystems Computer Corp. 600MP Series servers, SPARCengine 2, SPARCengine IPX and the Solbourne S4000DX workstation. These include a series of SBus cards: the Multiport Model 10S Single-port Centronics interface; the Multiport Model 210S Single-port Centronics with two RS232 serial ports; Multiport Model 20S+ Dual port, high-performance Centronics interface, the Multiport Model 400S with four serial ports, the Multiport Model 800S with eight high-performance serial ports, and the Multiport Model 1600S, which has 16 high-performance serial ports.

In addition, the company showed two sync/async serial SBus cards, including the multiport Model 400S+ with four intelligent sync/async serial ports and the Multiport Model 800S+ with eight intelligent sync/async serial ports.

Further, the company has recently introduced an SBus expansion chassis, called the SBox, with four or eight SBus slots. Prices range from $395 for the Multiport Model 10S to $2,195 for the SBox.

Aurora Technologies Inc.
176 Second Ave.
Waltham, MA 02154
Circle 272

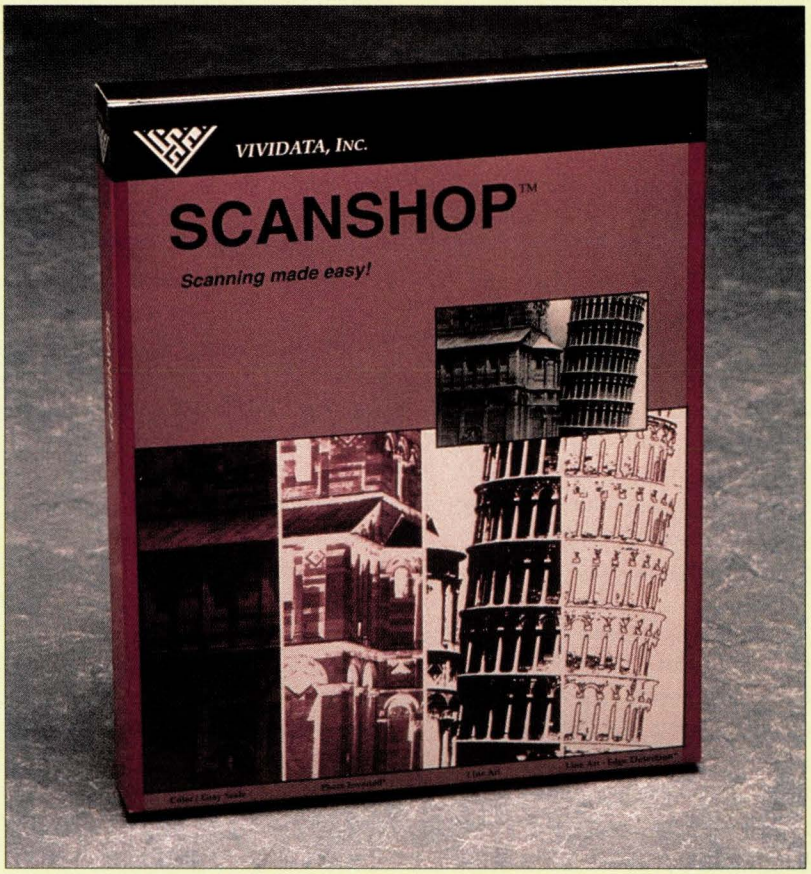


Image Capture for Sun

An image capture program for Sun workstations and compatibles has been announced by Vividata. Called ScanShop, the program supports a variety of scanner devices and provides a comprehensive user interface for scanner functions. The company says that prior to ScanShop, Sun users had to scan with a PC or a Macintosh and transfer files to the SPARC because no SPARC scanning solution was readily available.

ScanShop can be either a stand-alone program or embedded in other applications. It allows the user to control up to seven simultaneously active scanning devices. The company also provides support for black and white, gray-scale and 24-bit image capture. Pricing begins at $695.

Vividata Inc.
2020 Milvia, Suite 414
Berkeley, CA 94704-1176
Circle 270

Commander for Sun

A 3½-inch magneto-optical drive has been introduced for Sun. The Tass Commander, from Tass Optical World, is a 128-MB MO based on the Panasonic engine. It connects to a Sun workstation or compatible via the SCSI interface. The drive uses an embedded SCSI-2 and has an average access time of 30 ms.

The price of the external drive is $2,995. The 3½-inch rewriteable media cartridges are industry standard and are normally priced at $99 each.

Tass Optical World Inc.
6730 Mesa Ridge Road, Bldg. B
San Diego, CA 92121
Circle 273

Rack-Mount SPARCstation 2

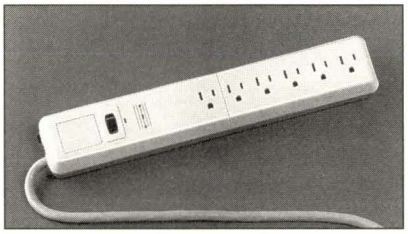
A rack-mount, VME-based version of the SPARCstation 2 has been introduced by Ironics. The Galaxy 32+ is a VMEbus chassis with a 40-MHz, 16-MB SPARCengine 2. The processor connects to the chassis via an internal SBus-to-VME connector. The company says that this internal connector can sustain transfer speeds of up to 8 MB/s.

The Galaxy system enclosure is based on Ironics' Icebox system case. The Icebox is configured for industrial settings with heavy-gauge cooling and power supplies. Pricing on the Galaxy 32+ begins at $16,595.

Ironics Inc.
798 Cascadilla St.
Ithaca, NY 14850
Circle 274

New Surge Strip

A new line of surge strips has been introduced by Intermatic. The EG line of strips monitor incoming power, operating when a surge or some other disruption occurs. The company says that the units will respond to a surge in one billionth of a second by absorbing the overload while allowing normal voltage to pass through. They will also automatically reset to monitoring mode after a surge. Moreover, an audible alarm sounds during a surge.



There are seven models in the line, ranging from six-outlet Model EG614 to the five-outlet EG56AC, and the Model 556EC, which comes with built-in coax cable for safeguarding TVs, VCRs and other video hardware. All models are rated for use at 25 VAC and 15 amps and meet the UL Standard 1449 and IEEE Specification 587, Category A and B, for transient voltage surge suppression. Pricing begins at $9.95.

Intermatic Inc.
Intermatic Plaza
Spring Grove, IL 60081
Circle 275

Linear Programming on Suns

A program that allows users to perform linear programming on Sun

workstations and SPARCalikes has been introduced by CPLEX Optimization. Linear programming attempts to solve problems in which a number of variables (in a "line") must be maximized or minimized subject to a variety of constraints. Typical applications of linear programming include commercial or financial situations in which the amount of some product must be maximized, or its cost minimized, given a set number of ingredients subject to a variety of cost and availability constraints.

The company says its product, CPLEX 2.0, may be the first linear programming environment available on the Sun. CPLEX 2.0 is a suite of tools composed of a linear optimizer, a integer optimizer and two libraries. It is available as an end-user product, or as a set of callable routines that can be embedded in other applications. Pricing ranges from $4,500 to $9,900.

CPLEX Optimization Inc.
Suite 279
930 Tahoe Blvd., Bldg. 802
Incline Village, NV 89451-9436
Circle 276

Video Multiplexer/ Demultiplexer

RGB Spectrum has introduced hardware that allows a Sun workstation or compatible to display, record and transmit signals from multiple video sources. Called OmniView, the product combines a multiplexer/demultiplexer with a reconfigurable multiwin-

dow display on a high-resolution monitor. The system can monitor multiple camera signals while recording on a single videotape recorder or transmitting on a single channel.

OmniView accepts NTSC or PAL video signals. Video sources can be asynchronous. The system displays up to 15 video sources in monochrome windows on a high-resolution monitor. Each window can be independently positioned and scaled from 1/64 to full screen.

RGB Spectrum
950 Marina Village Pkwy.
Alameda, CA 94501
Circle 277

New Alpha Displays

Two Alpha Window terminals have been introduced by Link Technologies. The Alpha Windows protocol is a standard for windowing character terminals that is being promoted by the Display Industry Association as a low-cost alternative to the X Window System. The Link products are the WT80 and WT6. Both terminals can run up to six simultaneous sessions on a host system equipped with an Alpha Windows-compliant Windowing Manager.

The WT6 has a monochrome screen that is available in amber, green or white. Its price is $699. The WT80 is has a 14-inch color screen with 16 foreground and 16 background colors. The WT80 is priced at $999. In addition, the company offers reduced-static-emission models of the two terminals. The low-emission versions are the WT6LE at $749 and the WT80LE at $1,049.

Link Technologies Inc.
47339 Warm Springs Blvd.
Fremont, CA 94539
Circle 278

Tape Backup for SPARC

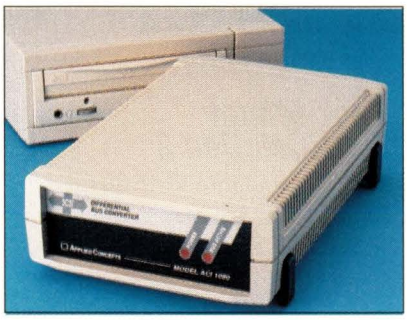
Tape backup system vendors Wangtek and WangDAT have jointly entered the Sun market with five different products. Wangtek, which shares ownership and some management with WangDAT, is coming into the market with three different ¼-inch cartridge tape drive models. These are the Model 5150 SSe, which has a 150/250-MB capacity at $1,695; the Model 5525 with 525 MB at $2,395; and the Model 51000 SSe with 1 GB at $2,995.

WangDAT, meanwhile, introduced two DAT drives. These are the Model DAT 2000 SSe, which has 2 GB at a price of $3,495, and the Model DAT 4000 SSe, with 4 GB, at $4,895. The WangDAT and Wangtek products come with the Legato Networker tape backup software.

Wangtek/WangDAT
Rexon Tape Peripherals
41 Moreland Road
Simi Valley, CA 93065
Circle 279

SCSI Extender from Applied

A bus converter that allows SCSI peripherals to attach to a host system up to 75 feet away has been introduced. The ACI 1080 SCSI Differen-



tial, from Applied Concepts, translates a single-ended SCSI bus into a differential SCSI bus, and vice versa. Where a single-ended SCSI can operate effectively only up to 19 feet, a differential interface allows disk drives, CD-ROMs, tape backups, laser printers and other SCSI-based peripherals to be located much further away.

The Model ACI 1080 supports a maximum data rate of 10 MB/s in asynchronous and synchronous mode. It requires no additional software, nor does it require a SCSI device address, and it is compatible with all standard SCSI systems. Pricing begins at $795.

Applied Concepts Inc.
5350-H Eastgate Mall
San Diego, CA 92121
Circle 280

Swartz Course on Video

Berkeley Decisions/Systems has announced that it is now shipping two video training courses, *UNIX Shell Programming* and *Creating Applications with UNIX Tools*. Both courses are taught by Ray Swartz, author of several books on UNIX and the C programming language. The courses are meant to show users how to create

applications using UNIX's own internal development tools.

The courses are $295 apiece. Both courses come with a student workbook and a course text book named *UNIX Applications Programming*, which is also by Swartz.

Berkeley Decision/Systems
803 Pine St.
Santa Cruz, CA 95062
Circle 281

Pascal-2 for SPARCs

An advanced Pascal development environment, Oregon Pascal-2, has been recently released for SPARC-based systems. The Oregon Pascal-2 development environment is a means of designing, testing, maintaining and improving software written in Pascal. It is an ISO (level 1) and ANSI Standard Pascal-compliant implementation that features true separate compilation, a dynamic string library, flexible file handling and an intelligent highly optimizing compiler.

The product comes with a full-functioned source-level debugger called the Oregon Debugger (ODB). Additional utilities in the package include a profiler used to spot program bottlenecks, cross-reference generators for procedure and variable references, an automatic source code formatter and a macro package to simplify the calling of assembly language routines from Pascal. Pricing begins at $1,800; the first year of technical support is an additional $450.

TauMetric Corp.
8765 Fletcher Pkwy.
La Mesa, CA 91942
Circle 282

Variable Resolution Graphics

An SBus card that allows a Sun workstation to select among different resolutions has been introduced by Tech-Source. The GXTRA/1 is a single-slot card that allows users to dial from screen resolutions of 1,152 by 900 down to 640 by 480. This allows SPARCstations to support low-cost,

low-resolution PC displays.

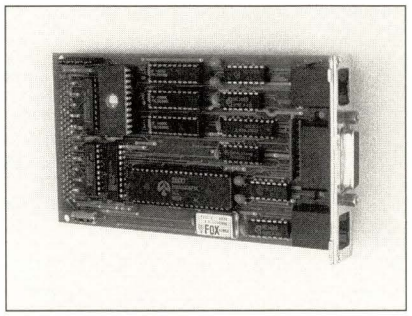
Each XTRA/1 graphics accelerator comes with a Sun/OS CG3-compatible device-driver, an optimized OpenWindows X11/NeWS server, a Weitek W8720 integrated controller, a 1-MB, 8-bit color-frame buffer, a hardware cursor, and a Sun-4 style keyboard/mouse as well as the dial-in resolution feature. Pricing begins at $1,750.

Tech-Source Inc.
442 S. North Lake Blvd.
Suite 1008
Altamonte Springs, FL 32701
Circle 283

SBus Port Expander

An SBus board that provides additional ports to a SPARCstation has been introduced by Agile Systems Corp. The 2100SP provides two additional RS-232C serial ports and one Centronics port to any SBus system. The product comes with auto-loading STREAMS-compatible device drivers.

Based on the same serial I/O chip that Sun uses in the SPARCstation, the 2100SP comes configured for

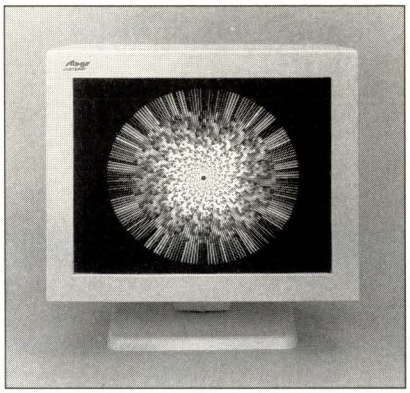


standard 7 signal and ground asynchronous RS-232C. Each serial port is capable of operating up to 76.8 Kb/s asynchronous and 800 Kb/s synchronous. The parallel port is Centronics compatible, and the company says that for users writing their own device drivers, the port can output at up to 88 Kb/s. Pricing begins at $395.

Agile Systems Corp.
2505 Valley Forge Drive
Madison, WI 53719
Circle 284

Monitor Shows Video

A gray-scale monitor that can operate in true video mode has been introduced for Sun workstations and SPARCalikes. The 21-inch M21LV-65MAX and the 24-inch M24LV-65 from Image Systems Corp. operate in both interlaced and noninterlaced modes from 15 kHz to 65 kHz. They sweep in vertical speeds of 55 to 90 Hz. This allows them to operate both as high-resolution 1,280-by-1,024 monitors, and as video screens operating at 15.75 kHz.



The company says the two monitors are meant for applications that combine traditional video with traditional computer graphics. Such appli-

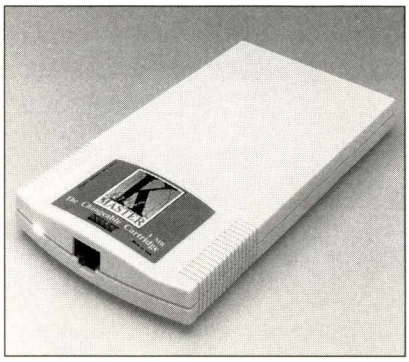
cations include medical, industrial and scientific imaging where video images must be enhanced to higher pixel counts for improved analysis and display. Pricing on the monitors begins at $2,195; OEM discounts are available.

Image Systems Corp.
11543 K-Tel Drive
Hopkins, MN 55343
Circle 285

Font Cartridge For HP

A programmable font cartridge for the HP LaserJet Printer has been announced by Kelly Computer Systems. The FontMaster cartridge can be programmed by the user with bitmapped fonts, scalable fonts, forms or macros. Kelly says it provides a way for forms and fonts to be stored permanently in the cartridge, or it can be quickly reprogrammed with a variety of utilities that come with the product. In addition, the cartridge comes with drivers for several major word processors, including WordPerfect.

The cartridge comes with Kelly's font library of more than 100 fonts. In addition, it supports any soft fonts compatible with the HP LaserJet. The FontMaster comes in 1- and 2-MB models, with retail prices of $449 and $599.



Kelly Computer Systems
274 Ferguson Drive
Mountain View, CA 94043
Circle 286

Optical from R Squared

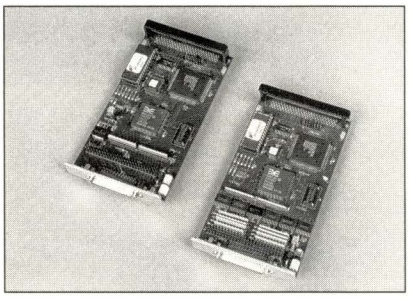
A new optical disk drive that supports both the IS/ANSI standard at 650 MB and the ZCAV-standard at 1 GB has been introduced by R Squared. Based on the Maxoptix Tahiti II drive and integrated by R Squared, the IFS-1050M is a 5¼-inch rewriteable MO disk that has a data transfer rate ranging from 6.8 to 13.2 Mb/s. It has an average seek time of 35 ms and a MTBF of 30,000 hours.

The disk supports synchronous SCSI. R Squared has developed drivers for Sun and Silicon Graphics and says that HP and IBM drivers are coming. It comes in desktop models, and a jukebox version will be available in the near future. Pricing ranges from $4,208 to $6,250.

R Squared
1121 E. Arapahoe Road
Suite 200
Englewood, CO 30112
Circle 287

SBus-SCSI-2 Adapter

Performance Technologies Inc. has announced a Narrow/Fast SCSI-2 add-in SBus card for SPARCstations and SPARCalikes. The Model PT-SBs430 provides add-in SCSI-2 capability for the workstations and supports SCSI-2 transfers of up to 10



MB/s. The PT-SBS430 is available with either single-ended or differential SCSI connection.

The module comes with driver support that is compliant with the Sun Common SCSI Architecture. The software driver supplied by the company also includes Performance's own Adaptive Synchronous Negotiation feature that tunes the SCSI-2 host's operating environment for optimum performance. Pricing begins at $695.

Performance Technologies Inc.
Computer Products Division
315 Science Pkwy.
Rochester, NY 14620
Circle 288

Software AG Ports to Sun

Software AG has ported its core products to Sun workstations. These include Natural, Adabas and Net-Work. The Natural product is a software development tool combining 4GL-style programing with platform independence–that is, Natural applications can run on any hardware on which the underlying Natural software is present. Pricing ranges from $1,500 to $97,100.

Net-Work is a communications package providing transparent links between processing environments. It is priced from $5,000 to $30,000. Adabas is a relational database that supports high transaction volumes and large data sets. Pricing is between $17,000 and $113,700.

Software AG of
North America Inc.
11190 Sunrise Valley Drive
Reston, VA 22091
Circle 289

SBus-based X Terminal

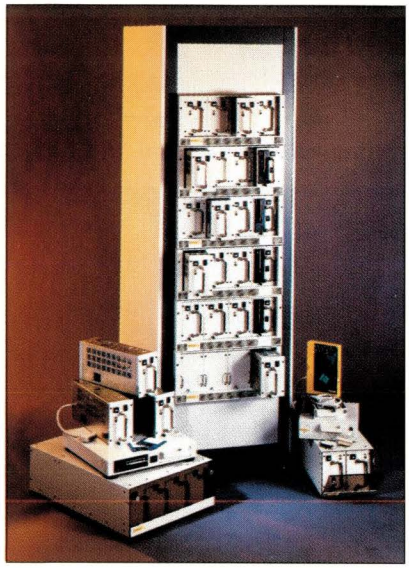
An X terminal with its own SBus, operating system and 32-bit processor has been introduced by Visual, the former Visual Technology Inc. The Visual TX800C is described as a high-performance color network terminal. Based on the Motorola 68040, the product has its own SBus slot and can support SBus cards–such as a JPEG image-decompression card, an ISDN connection, a scanner interface and so on. Drivers for the SBus cards are supported locally, on the terminal itself, since it has an operating system, specifically the microkernel of Chorus Systems, which can support SBus drivers. The company says that users who want more than one SBus device on their terminals can link it to any of the many SBus expansion chassis now on the market.

Visual insists that the product is still a terminal and not a networked workstation–stressing that major processing still takes place at a host. But whatever it is, the TX800C is said to operate at 10,4000 Xstones. In addition to the 68040, the product contains two custom graphics ASICS designed by Visual's European branch. It comes with 4 MB of memory, expandable to 16 MB. Pricing had not been established as of press time, but it is expected to be roughly $6,000.

Visual
120 Flanders Road
Westboro, MA 01581
Circle 290

Hot Plug Data Vault

A device that provides high-availability mass storage has been announced by Artecon. The Online Data Vault, combined with the Online DiskSuite disk-mirroring software from Sun, is a series of products ranging from desktop units to a rack-mount version. The Vaults can support a variety of mass-storage devices, including



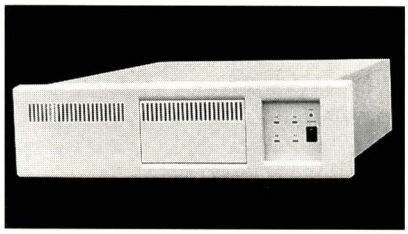
tape and disk. In case of failure, a disk or tape can be pulled and replaced without shutting down the system.

The product line ranges from very small two-slot systems designed for use with the IPC to systems meant for Sun servers. Disk mirroring and backup can be done between disks in the same vault, or even in different Vaults located at different places within a network. Pricing ranges from $2,000 to $100,000, depending on configuration.

Artecon Inc.
2460 Impala Drive
Carlsbad, CA 92008-7236
Circle 291

OEM Enclosure

A four-drive peripheral enclosure for OEM buyers has been introduced. The PE119 from Dyna Five is an chassis that can contain up to four full-height 5¼-inch or eight half-height 5¼-inch peripherals, or a combination of 3½- and 5¼-inch devices. The PE119 is expandable and allows individual drives and 50W power supplies (one per drive) to be added as needed.



The PE119 can contain peripherals for the Sun market, or other systems (VME, DEC, ISA) as required. It can support hard disks, floppies, optical disks, ¼-inch tape, 4mm DAT, and 8mm Exabyte. It also support 50W power supplies. Rear-panel connectors accommodate such interfaces as ST506, ESDI and SCSI.

Dyna Five Corp.
173 Freedom Ave.
Anaheim, CA 92801
Circle 292

8mm with Status Panel

An 8mm tape backup with a low-cost display has been introduced by Dynamic Computer Products. The DP series of tape products comes with a two-line LCD panel that shows read/write activity, remaining tape capacity, average transfer rates, tape-error percentage, Search, Rewind and total data written. Moreover, the LCD Display is available as a separate prod-

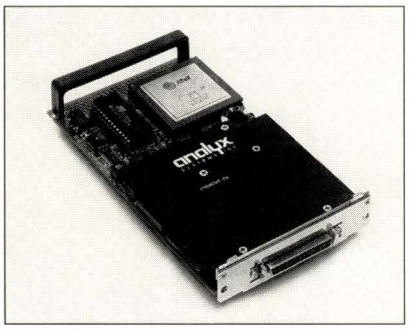
uct for users who already own 8mm tape products.

There are two versions of the DP series of tape drives. The Model 5T23G/DP is a tape subsystem with 2.3 GB and sells for $2,445. The Model 5T50G/DP has 5 GB and is priced at $3,695. The LCD panel alone, the 5T23GU/DP, is $475.

Dynamic Computer Products
63 Commercial Ave.
Garden City, NY 11530
Circle 293

High-Speed Data Acquisition

A high-speed data acquisition subsystem for SBus workstations has been announced by Analyx Systems. The ADDA-1218 SBus board is a 166-kHz data acquisition subsystem with 16-channel 12-bit A/D conversion, plus four-channel 18-bit D/A conversion. Both the A/D and D/A converters operate automatically and simultaneously, giving a combined aggregate



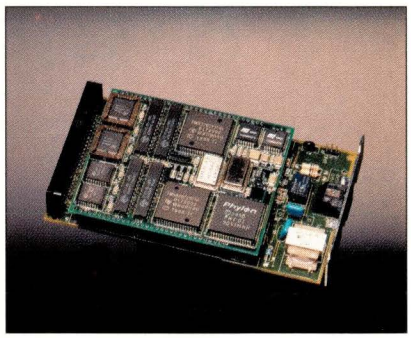
throughput of 2 by 166,666 conversions per second into an on-board 128-KB dual-ported RAM.

Designed for real-time operation, the ADDA-1218 can continuously acquire and output streams of high-speed analog data without real-time CPU intervention. The sampling rate is programmable from 6 microseconds to 1.536 ms per sample. Pricing for a full-featured board is $2,495.

Analyx Systems Inc.
P.O. Box 14644
Fremont, CA 94539
Circle 294

Correction

The "New Products" section of the April issue of *SunExpert* incorrectly reported the price of the Helios

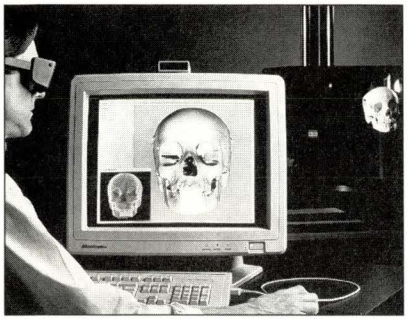


Com+Modem as $850. In fact, this is the price of the modem alone. The actual price of the product, with the fax option, is $1,850. *SunExpert* regrets the error.

Helios Systems
1996 Lundy Ave.
San Jose, CA 95131
Circle 295

Cyberware in 3D

Cyberware has announced that images captured by its 3D color scanners can now be viewed in 3D via StereoGraphics LCD goggles. Cyberware scanners capture the shape and color of complex objects in less than



30 seconds. The image of the object is then available as a 3D color model on graphics workstations. Currently, the Cyberware products are best known on SGI platforms, but they are also available on other UNIX systems.

The stereoscopic viewing technology, which was developed by the San Rafael, CA-based StereoGraphics Corp., allows Cyberware users to see their captured images in 3D. The user looks at the workstation through glasses consisting of LCD shutters that are electronically synchronized with the screen to show left-eye and right-eye views of the image. Pricing for the necessary hardware begins at $1,950.

Cyberware
8 Harris Court
Monterey, CA 93940
Circle 296

Office Setting VME Chassis

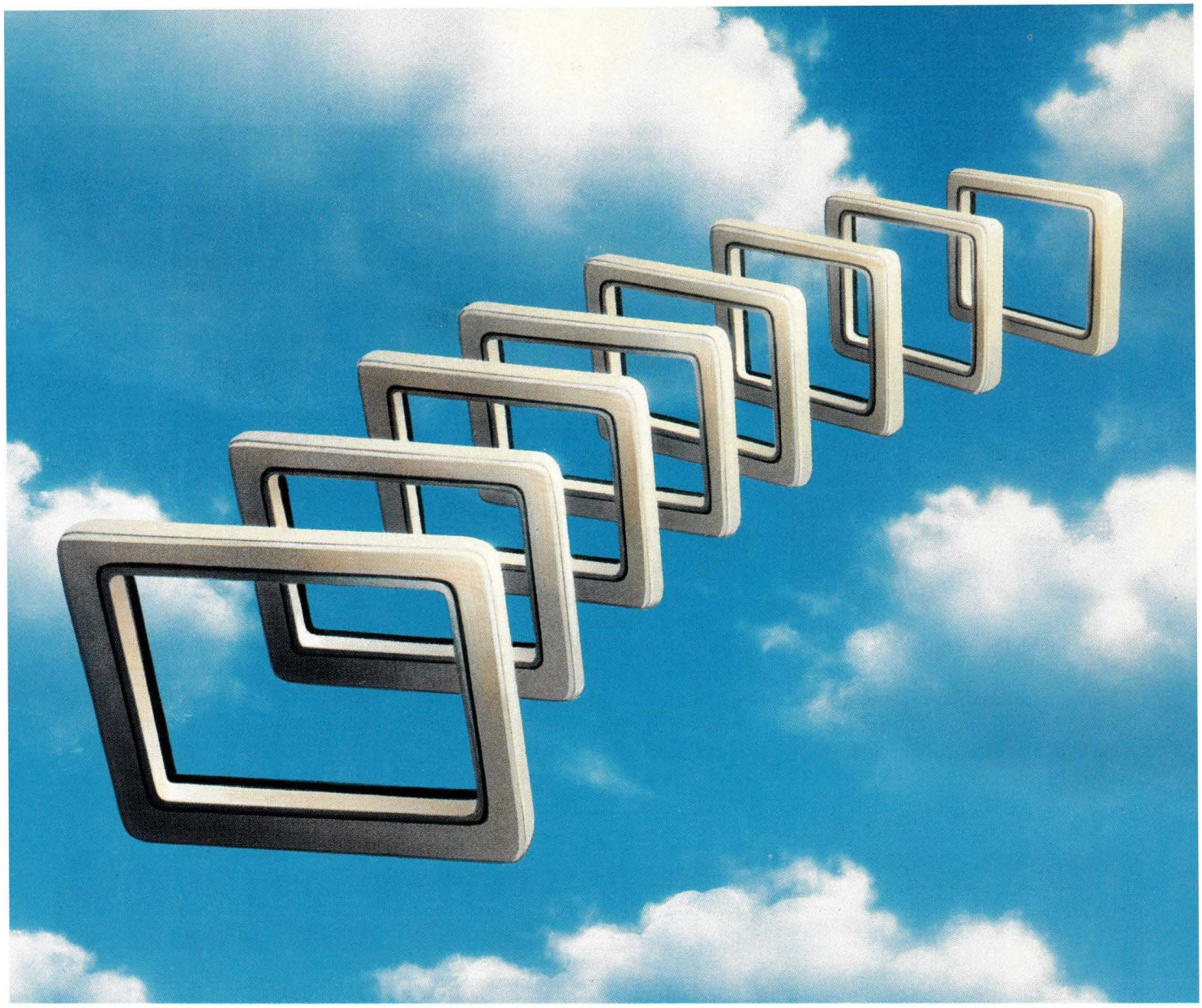
A VME chassis meant for office or lab settings has been introduced by Force Computers. The VME Chassis-7 supports up to seven 6U VME boards and a variety of peripheral devices in the 3½- and 5¼-inch form factors, including floppy and hard disks, tape and CD-ROM drives. It provides front access to all drive bays, and side panels can be removed.

The chassis is 210mm wide and 550mm high by 600mm deep. It has aluminum exterior panels and an integral steel cage. It meets FCC Class A environments and comes with two 49-dB low-noise fans as well as temperature sensors and a warning light to signal overheating. Pricing begins at $3,995.

Force Computers Inc.
3165 Winchester Blvd.
Campbell, CA 95008-6557
Circle 297

An Invitation

Mr. Protocol, gourmand of the late night snack buffet, requests the pleasure of addressing your network and communications questions. He can be reached at amp@expert.com day or night, rain or shine.



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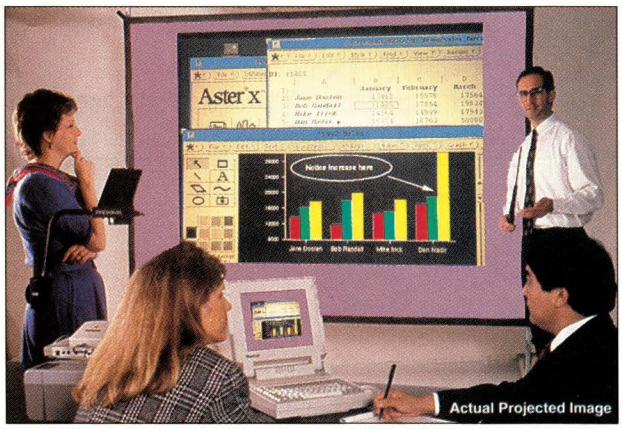

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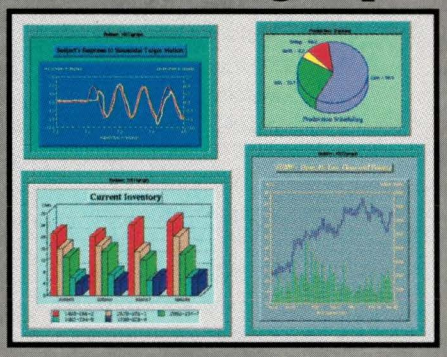

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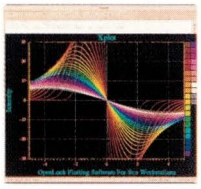

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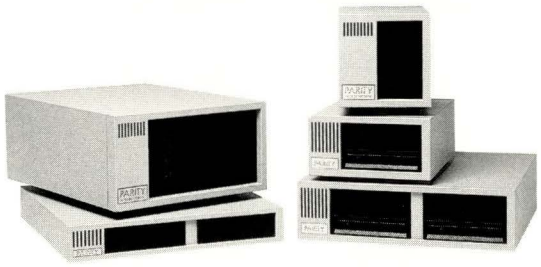

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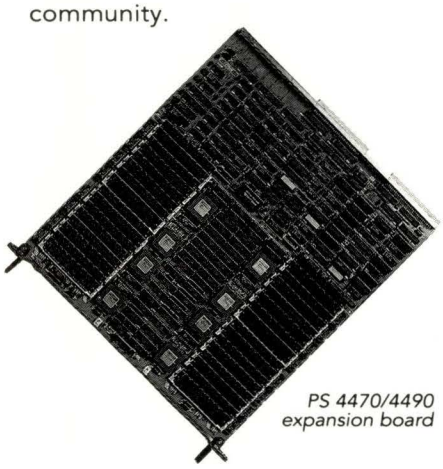

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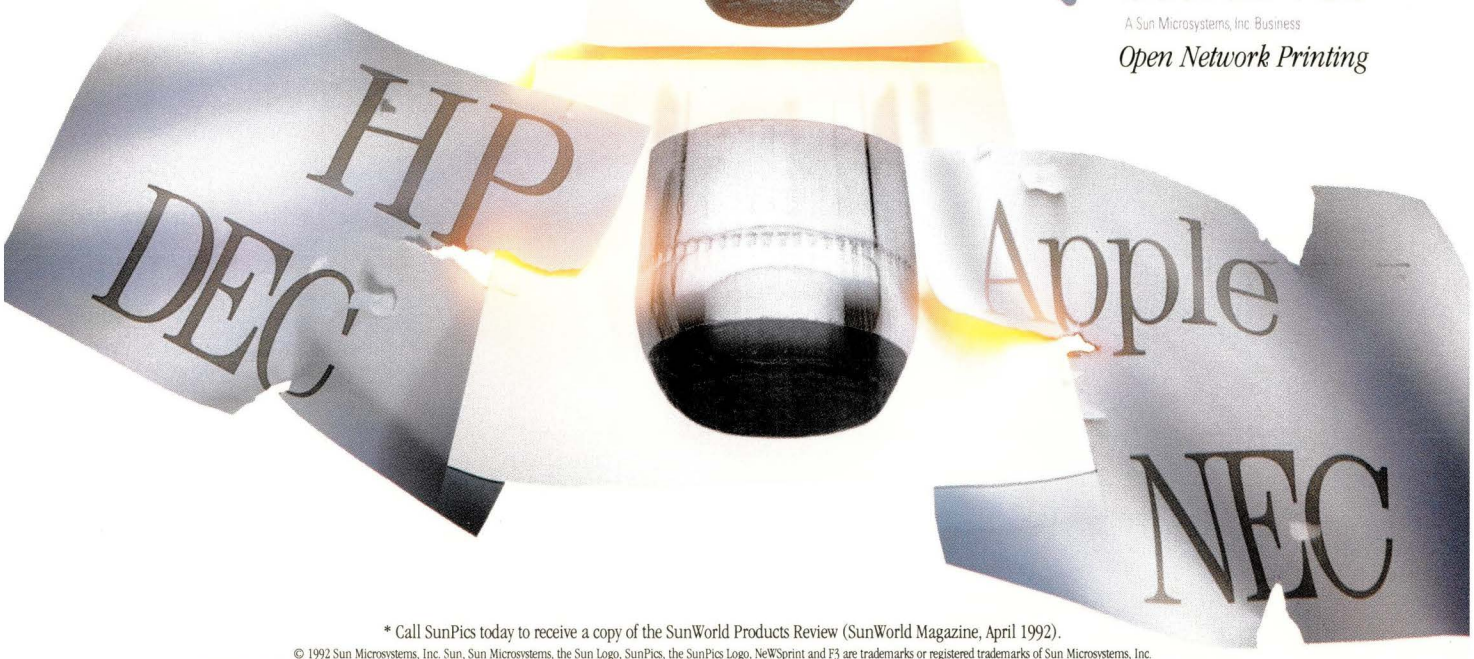

* Call SunPics today to receive a copy of the SunWorld Products Review (SunWorld Magazine, April 1992).