

# Mini-Micro Systems<sup>®</sup>

AUGUST 1987

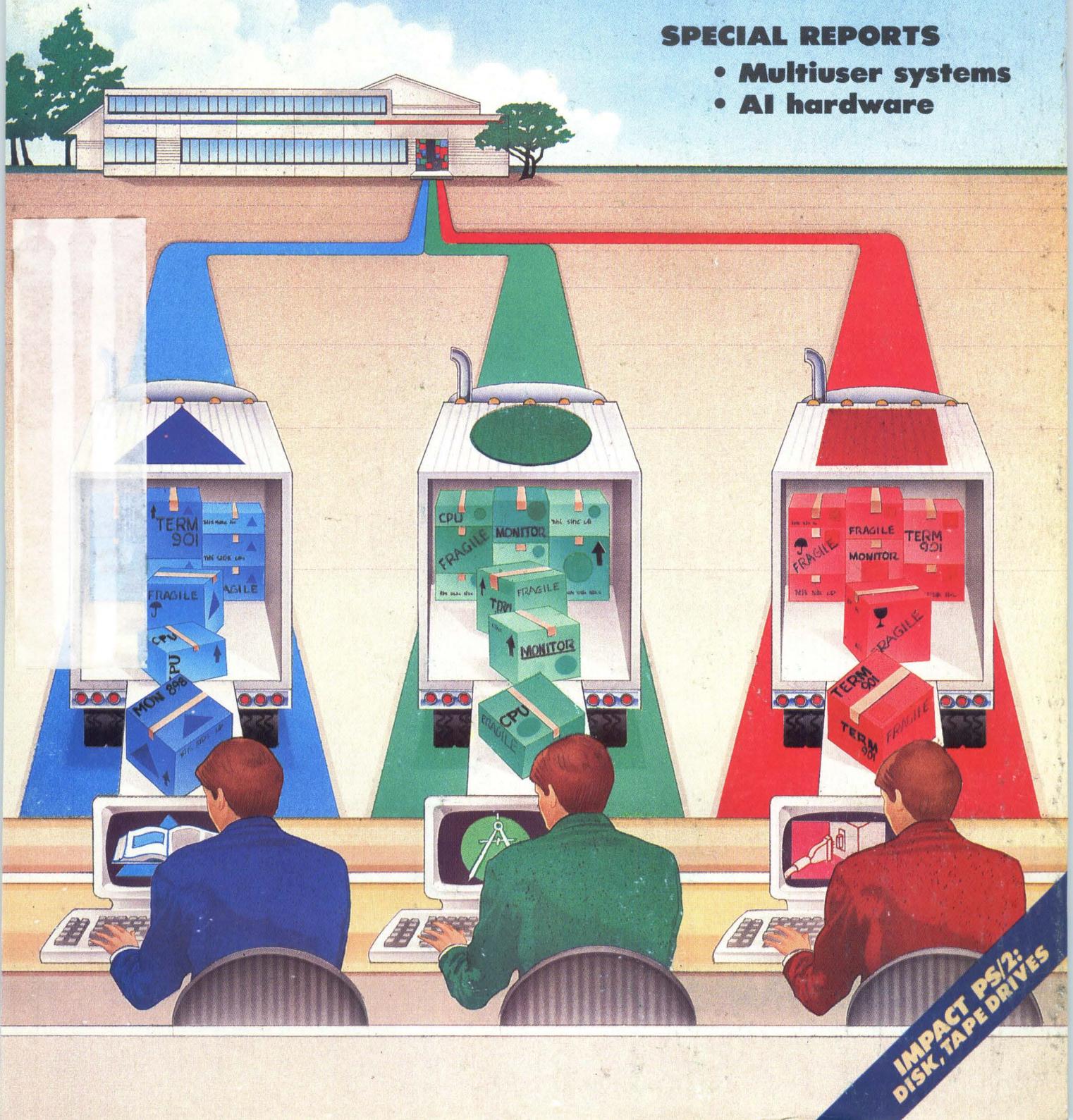
THE MAGAZINE FOR SYSTEMS INTEGRATION

A CAHNERS PUBLICATION

## Forward integration: dock-to-dock solutions

### SPECIAL REPORTS

- Multiuser systems
- AI hardware



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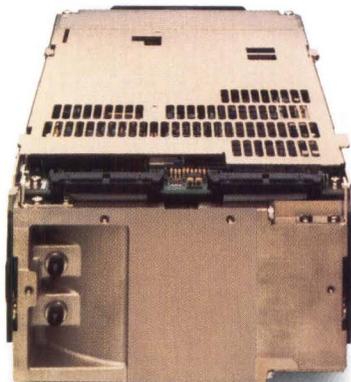
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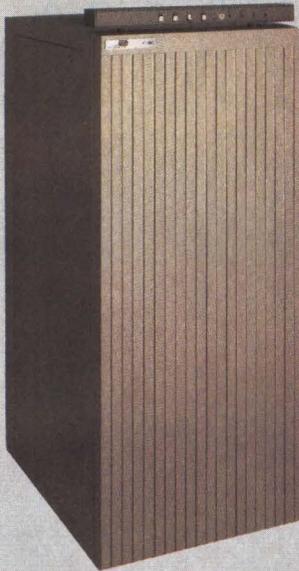
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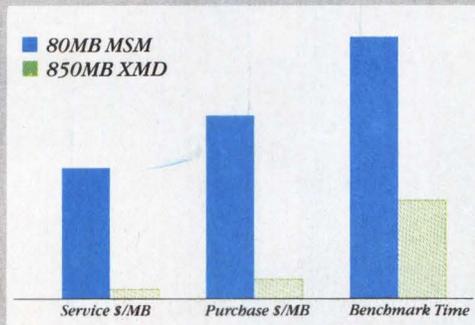
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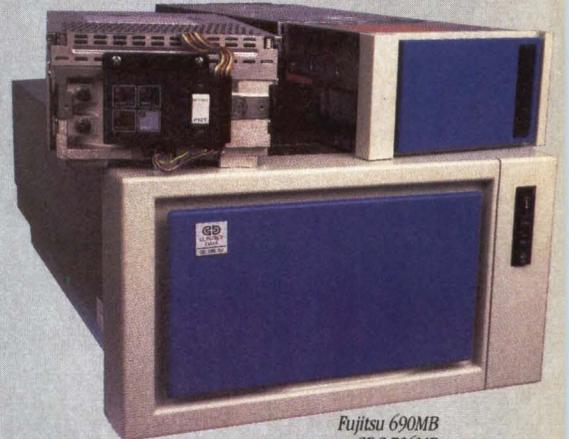


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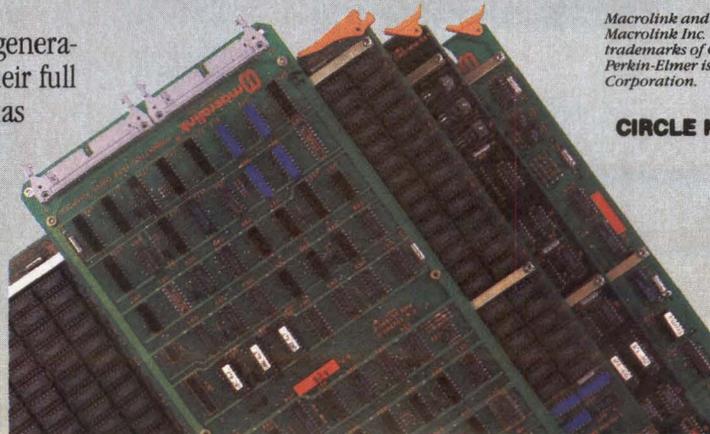
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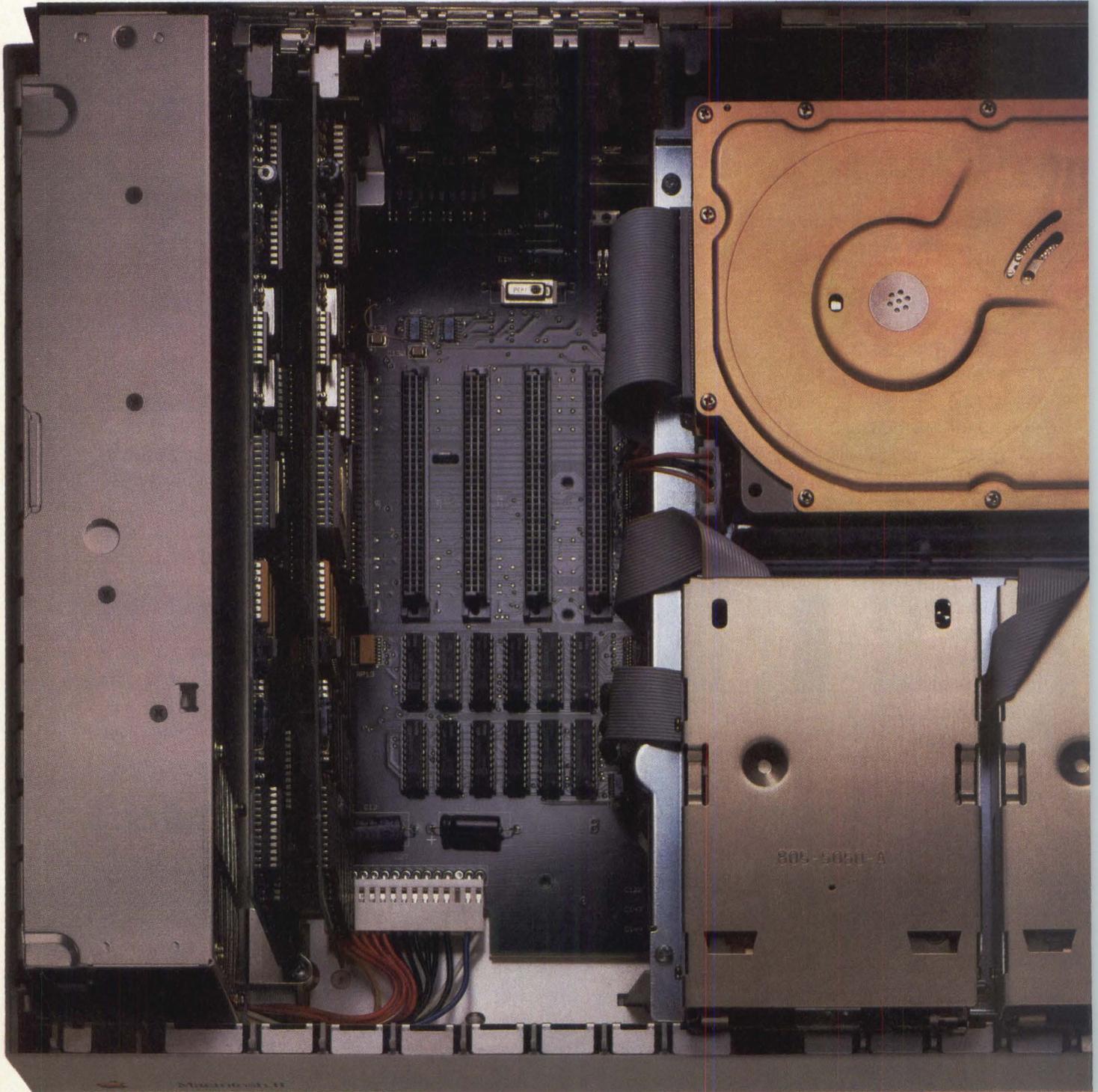
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**CIRCLE NO. 2 ON INQUIRY CARD**



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They're designed to let you put together systems that offer more speed and graphics power. And are actually more affordable and easier to use.

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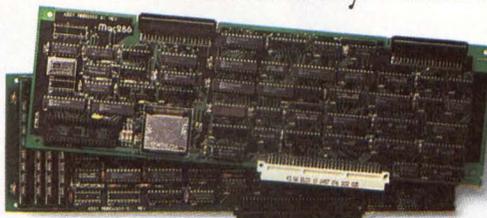
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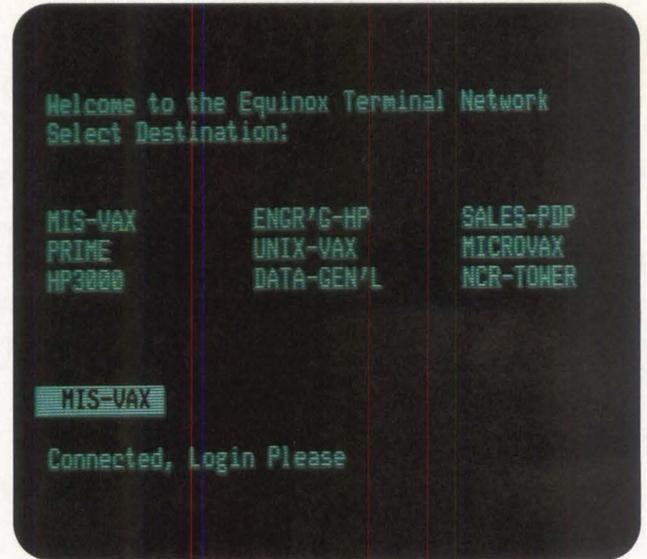


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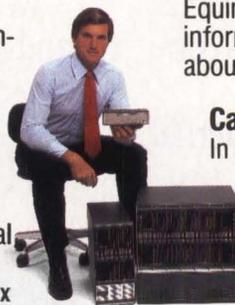
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# Mini-Micro Systems®

A CAHNERS PUBLICATION

VOL. XX NO. 8  
AUGUST 1987

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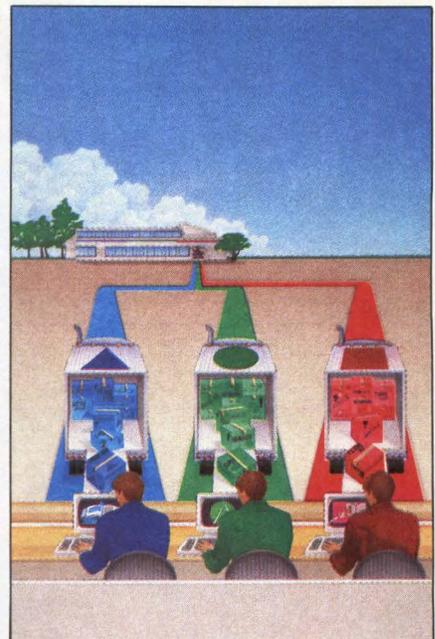
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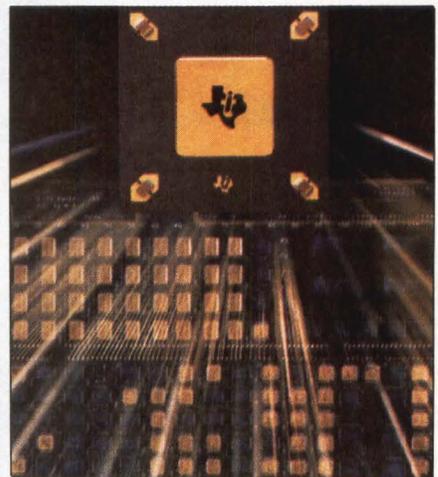
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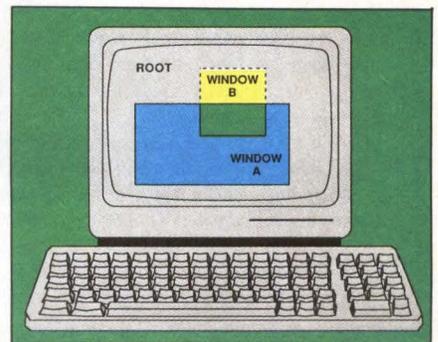
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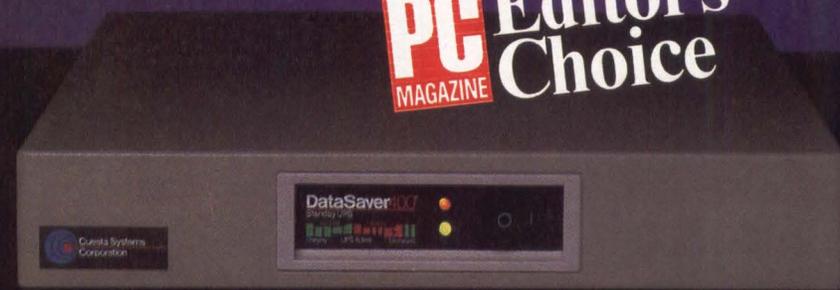


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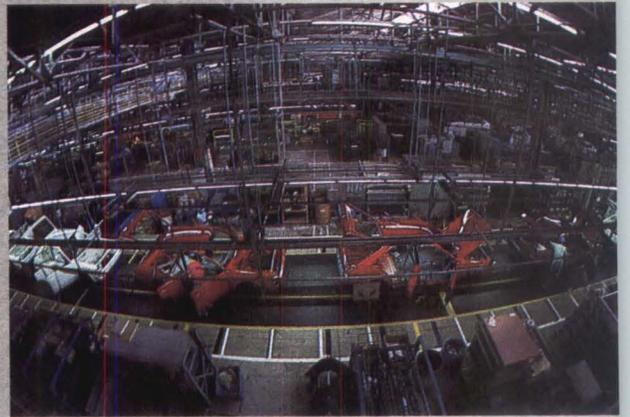


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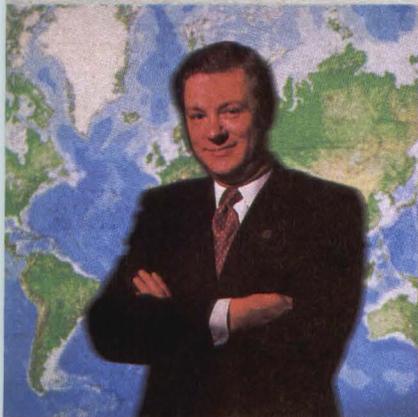


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**"Computing systems so cost-effective, Cincom uses them to develop its software products – even those for the IBM market."**

of developing each line of code had soared. As a conservative estimate, now we have cut our costs in half." Mr. Sewall is equally impressed with the time savings and productivity gains Cincom has made. "With Digital systems, our software development cycle is four times faster than before. As a result, we're beating our competitors to market with our products. And that's the kind of edge everyone can appreciate."

To find out how your company can gain a competitive advantage now, write to: Digital Equipment Corporation, 200 Baker Avenue, West Concord, Massachusetts 01742. Or call your local sales office.

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# BREAKPOINTS

## **IBM SUPPORTS LOCUS SCHEME FOR RUNNING DOS UNDER UNIX**

When it comes to combining DOS under UNIX, IBM Corp. apparently likes the method developed by Locus Computing Corp. The Santa Monica, Calif., company recently announced its "long-standing" agreement to jointly produce a version of IBM's UNIX-like Advanced Interactive Executive (AIX) operating system for the PS/2 Model 80. That software presumably will include Locus' Merge 386, a program that allows multiple DOS applications to run as tasks under UNIX. Pricing and availability of AIX products for the Model 80 are expected from IBM during the fourth quarter. Locus just recently began shipping Merge 386, bundled with MS-DOS, for 80386 computers running AT&T Co.'s UNIX System V/386 Version 3.—*Mike Seither*

## **CULLINET READIES STRATEGIC ALLIANCES IN CAD**

Cullinet Software Inc., Westwood, Mass., says it will announce several alliances with CAD vendors in September during its Users Week in Anaheim, Calif. The alliance will combine Cullinet's shop floor and inventory-management software with a range of CAD software aimed variously at IBM Corp. mainframes, IBM and Digital Equipment Corp. minicomputers and IBM PCs and compatibles. This will be the second leg in Cullinet's three-leg effort to use strategic alliances to build products for factory automation. The first, in March, linked Cullinet with Epic Data, Elmhurst, Ill., a vendor of data-collection software. Still to come: alliances with vendors of automatic materials-handling software.—*Jim Donohue*

## **SOFTWARE DEVELOPERS NOT EXTENDING THEMSELVES FOR OS/2 EXTENDED**

With the complete version of Microsoft Corp.'s OS/2 tool kit available this month (including the delayed Presentation Manager), Lotus Development Corp., Cambridge, Mass., will soon unveil a version of its 1-2-3 package for both the protected and real modes of DOS and OS/2. Oracle Corp., Belmont, Calif., will also unveil an IBM Corp. OS/2-compatible version of its minicomputer-based Sequel relational database management software. Least on developers minds: creating new products for IBM's OS/2 Extended, a hybrid version of the Microsoft operating environment that most developers say will attract only a limited audience.—*Tim Scannell*

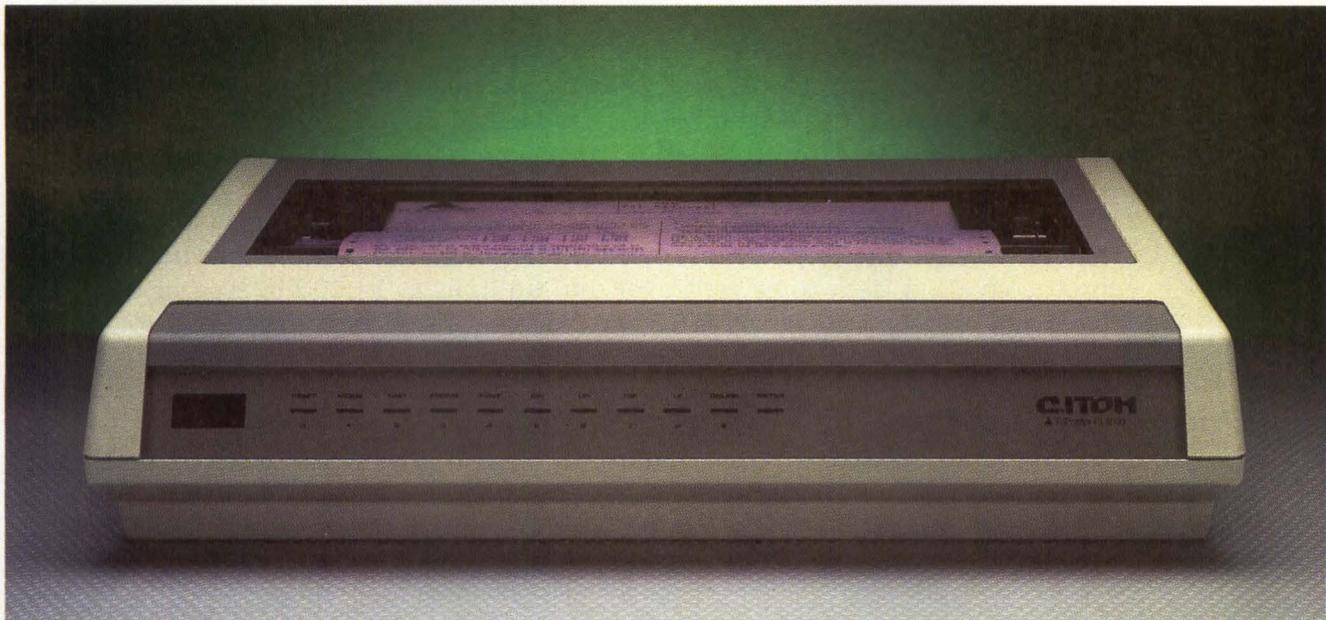
## **NETWORK MANAGEMENT SYSTEM HANDLES 16,000 USERS**

Bridge Communications Inc., Mountain View, Calif., is taking orders for its most powerful network management system yet—a \$35,000 workstation built by Sun Microsystems Inc. that can monitor LAN traffic generated by up to 16,000 users. The NCS/2 network control server, packaged with a 140M-byte SCSI disk drive, audits all activity on Ethernet and Bridge broadband LANs. Programs can be downloaded in about three seconds to other servers. An alarm system notifies the administrator when errors exceed predetermined limits. NCS/2 software (\$10,000) runs as a program under Sun's UNIX operating system and graphically displays network traffic and problems on a monochrome screen with a resolution of 1,152 by 900 pixels.—*Mike Seither*

## **CONTROL DATA UNVEILS CAPACIOUS 8-INCH WINCHESTER**

Control Data Corp. of Minneapolis used the SIGGRAPH show in July to

# Quick Zipper.



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**CIRCLE NO. 7 ON INQUIRY CARD**

unveil its highest capacity 8-inch drive yet, one with an unformatted capacity of 750M bytes and an average access time of 16 msec. The newest member of CDC's Sabre line is available now with a choice of three interfaces—SMD, SCSI or IPI. OEM pricing is \$4,260.—*Mike Seither*

### **HIGH-SPEED MODEMS NOW HAVE BUILT-IN PROTOCOLS**

Communication protocols are typically packaged with modem software. Now Telebit Corp., Cupertino, Calif., has built four popular protocols—Kermit, XMODEM, YMODEM and the UNIX UUCP communications utility—directly into its TrailBlazer modems with programmable ROM. The PROM feature is standard on both board (\$1,195) and standalone (\$1,345) models. Current models can be upgraded by swapping PROM chips. Telebit claims that the protocols allow data to be sent over dial-up lines at 14,000 bits per second. The company also has made the MNP error-correction protocol standard for transmissions of 300, 1,200 and 2,400 bps.—*Mike Seither*

### **INTEL UNVEILS REAL-TIME SOFTWARE FOR 80386**

Intel Corp., Hillsboro, Ore., has begun shipping what it claims is the fastest 32-bit, real-time, multitasking kernel on the market. The iRMK kernel, optimized for Intel's 80386, can interrupt a task in 5.4 microseconds, the company claims. It requires as little as 8K bytes, or a maximum of 32K bytes, of programmable ROM, making it ideal for embedded control applications. Development licenses cost \$1,500. Intel also has unveiled release 2.0 of the iRMX 286 real-time operating system, which now features 16-bit support for the 80386 and 80387 math coprocessor, a new command-line editor for application development, improved error messages and an optional debugger. Licensing for iRMX 286 is \$5,500.—*Mike Seither*

### **OAZ PUSHES JAM-PACKED PC FAX**

Throwing its hat into the widening ring of personal computer facsimile board competition, start-up OAZ Communications Inc., Tustin, Calif., has started shipping its XAFAX board and related software. In addition to the 9,600-baud modem available on all add-in fax boards, the company crams in an Intel Corp. 80188 coprocessor with 512K bytes of memory; a multitasking, real-time operating system; a 1,200-baud Hayes Microcomputer Products Inc.-compatible modem; a SCSI interface; and a scanner interface. The board receives and transmits in background mode. The company will sell the \$1,195 XAFAX to distributors and OEMs.—*Dave Simpson*

### **HONEYWELL BULL ITALIA READIES 'STORED-ENERGY' PRINTER**

A dot-matrix printer with a new type of printhead is in prototype at the Caluso, Italy, manufacturing plant of Honeywell Bull Italia S.p.A. The printhead uses "stored-energy" technology: A permanent magnet holds the print needles in place until a solenoid is charged, neutralizing the permanent magnet and releasing the print needle to strike the paper. With regular electromagnetic printheads, an electromagnet is charged, driving the needle onto the paper. Honeywell Bull Italia (a wholly owned subsidiary of Honeywell Bull Inc.) says the stored-energy technique produces printheads that are 40 percent lighter, 50 percent smaller and consume less energy. Honeywell expects to announce the product next year.—*Jim Donohue*

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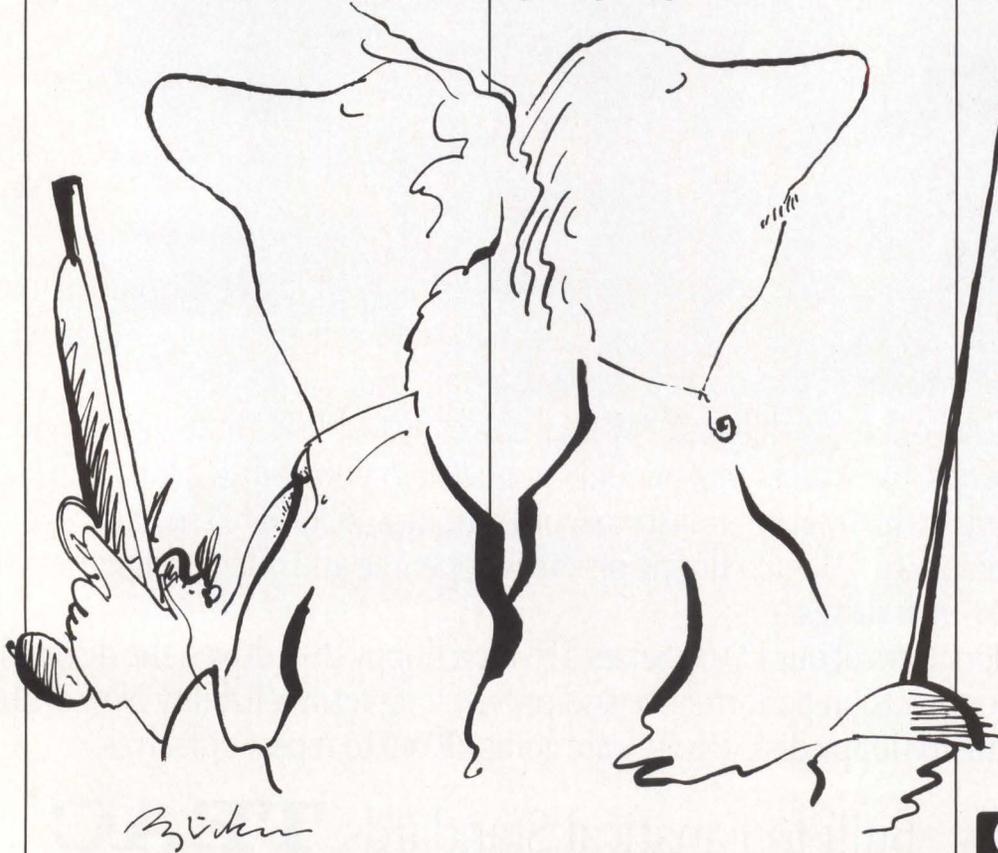
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# MINI-MICRO SYSTEMS PRODUCT SPOTLIGHT

OPERATING SYSTEMS

## AT&T's 80386 UNIX debuts, revamped XENIX on the horizon

Mike Seither, Senior Editor

It has finally happened. After a series of delays, AT&T Co. has authorized vendors to begin shipping Intel Corp.'s port of UNIX for the 80386 processor. In so doing, AT&T took the first step in setting a standard for the much ballyhooed 32-bit processor in the UNIX world.

The stage also has been set to merge the AT&T-sanctioned UNIX and the UNIX lookalikes available from both Microsoft Corp., Bellevue, Wash., and The Santa Cruz Operation, Santa Cruz, Calif., all to establish a common UNIX ground for the 80386 architecture and so avoid the confusion that hounded earlier chip technologies.

What is so special about AT&T giving its corporate blessing to 80386? For one thing, the new operat-

ing system—officially called UNIX System V/386 Release 3.0—brings binary compatibility to multiuser, multitasking computers built with the 80386. That's significant, industry analysts say, because applications written under UNIX System V/386 will reportedly run on any 80386-based system. This could do for 80386 UNIX machines what DOS did for the world of IBM Corp. personal computers and compatibles. That is, software companies can develop standard applications that users, thankfully, will be able to run on any of a variety of vendors' machines.

"UNIX has never had that advantage," says Chuck Hickey, president of Microport Systems Inc., a Scotts Valley, Calif., UNIX vendor. "Moving an application from one UNIX system to another costs thousands of

dollars. Now there is a standard interface that guarantees compatibility."

Furthermore, UNIX System V/386 gives system integrators a way to move 80386 products immediately. The multitasking operating system most people are awaiting for the 80386—either IBM's or Microsoft's OS/2, for the new IBM Personal System/2—won't be available until next year. There are other multitasking alternatives, but they are limited and don't seem to have UNIX's growing support. For instance, there is Theos 386 from Theos Software Corp., and the Pick operating system.

"This [UNIX] is it," says Dimitri Rotow, president of Bell Technologies Inc., Fremont, Calif. "It's 32-bit, it's debugged, it's certified, and the minute Locus [Computing Corp.] and Interactive [Systems Corp.] release, you'll have multitasking DOS." (See

### Who's who and what's what in the UNIX/XENIX arena

*The following is a brief list of companies and their UNIX and UNIX-like products for systems based on Intel Corp.'s 80386 microprocessor.*

- Bell Technologies Inc.: AT&T Co. source code for UNIX System V/386, run time, development system and text editor; \$75 for one to two users, \$195 for unlimited users (quantity 100). Various tape and magnetic drivers available. Five-volume Prentice-Hall Inc. set of UNIX manuals, \$125.

- Interactive Systems Corp.: UNIX Systems V/386 sold as 386/ix; \$400 for one to two users, \$700 for unlimited users. Device drivers for IBM Corp. PC/AT include programmable serial ports; Hercules monochrome and IBM monochrome, color and enhanced graphics adapters; 360M-byte and 1.2M-byte flexible disk drives; up to two Winchester disk drives described in the IBM ROM BIOS configuration table; three parallel printers; real-time

clock; quarter-inch streaming tape drives with QIC-02/36 controller; multiport serial cards; MICOM/Interlan Inc. Ethernet controller.

- Microport Systems Inc.: UNIX System V/386 source code; \$299 for two-user license, \$549 for unlimited users. Device drivers for ST506 rigid disk drives; 320K-byte, 360K-byte and 1.2M-byte flexible disk drives; most standard parallel line printers; various multiport I/O cards; tape cartridge for TeleVideo Systems Inc.'s Telecat 286 and 386; Logimouse mice.

- The Santa Cruz Operation: XENIX System V/386 operating system; \$695 for unlimited-user license; development system, \$695; text processor, \$195. Various device drivers available for multiport serial cards, streaming tape drives, modems, hard disk drives and video graphics adapters. Prices and hardware supported available on request.

"The DOS connection: VP/ix and Merge 386.")

The movement to port UNIX to the Intel 80386 environment has been an industry-wide effort, involving a wide range of software companies and their products. Some of these are: Applix Inc., Westboro, and Gold Hill Computers, Cambridge, Mass.; Excelsan Inc., San Jose, Franz Inc., Berkeley, Oracle Corp., Belmont, and Informix Software Inc. and Lucid Inc., Menlo Park, Calif.; Graphic Software Systems Inc., Beaverton, Ore.; and Lachman Associates, Naperville, Ill. Other major companies are: Ryan McFarland Corp., Rolling Hills Estates, Sun Microsystems Inc., Mountain View, and Teknowledge Inc., and The Wollon-

gong Group, Palo Alto, Calif.; and MICOM/Interlan, Boxborough, Mass.

Microport and Bell Technologies are among the first vendors to begin shipping UNIX V/386. Interactive Systems, Santa Monica, Calif., which contracted with Intel to write most of the 80386 UNIX V/386 port, has also announced the availability of the operating system. These AT&T licenses resell the generic UNIX/386 source code and add value by providing different device drivers, networking and graphics support, plus documentation and applications packages.

Meanwhile, although the AT&T-sanctioned UNIX for the 80386 chip is in the limelight, XENIX—one of

the more popular UNIX derivatives in the IBM PC world—is still very much alive and kicking. Microsoft has its XENIX System V/386 Release 2.2, and, in July, Santa Cruz Operation began volume shipments of its packaged version of XENIX 386 for end users and value-added resellers. It includes device drivers, a development system, a compiler and a text processor. Company marketing director Dave Berstein says that SCO is initially selling the new XENIX for 80386-based systems from Compaq Computer Corp. and for IBM's PS/2 Model 80.

These latest XENIX products are built around the same software base used in XENIX for 16-bit 80286 systems, according to Paul Sribhibhadh,

## The DOS connection: VP/ix and Merge 386

What do you do if you are a system integrator and the tools needed to develop particular products won't be available for months down the road? You start developing anyway, of course, but with tools that let you build now and make an easy transition later.

For example, Microsoft Corp.'s multiuser, multitasking operating system for the IBM Corp. Personal System/2 and compatibles is not due until well into 1988. So system integrators are opting for solutions that enable more than one DOS application to run at a time on machines using those Intel Corp. 80386 operating systems that are now available—XENIX and UNIX. The bulk of such gateway products is presently marketed by two Santa Monica, Calif., vendors: Locus Computing Corp. and Interactive Systems Corp. (Phoenix Technologies Ltd., Norwood, Mass., is a development partner with Interactive.)

Merge 386 from Locus, and VP/ix from Interactive and Phoenix, are so-called "virtual monitors" that trap 8086 DOS operating system calls and translate them into 32-bit UNIX or XENIX operating system calls on the 80386. Users attached to the host 80386 system, whether by a terminal or a PC, can execute a number of DOS, UNIX or XENIX applications simultaneously.

System integrators who have evaluated Merge 386 and VP/ix since their recent availability generally agree that the programs are functionally equivalent. Some OEMs have already made a decision. For instance, Convergent Technologies Inc., Prime Computer Inc. and TeleVideo Systems Inc. have signed up for Merge 386. At press time, Altos Computer Systems was the only major computer vendor to go with VP/ix.

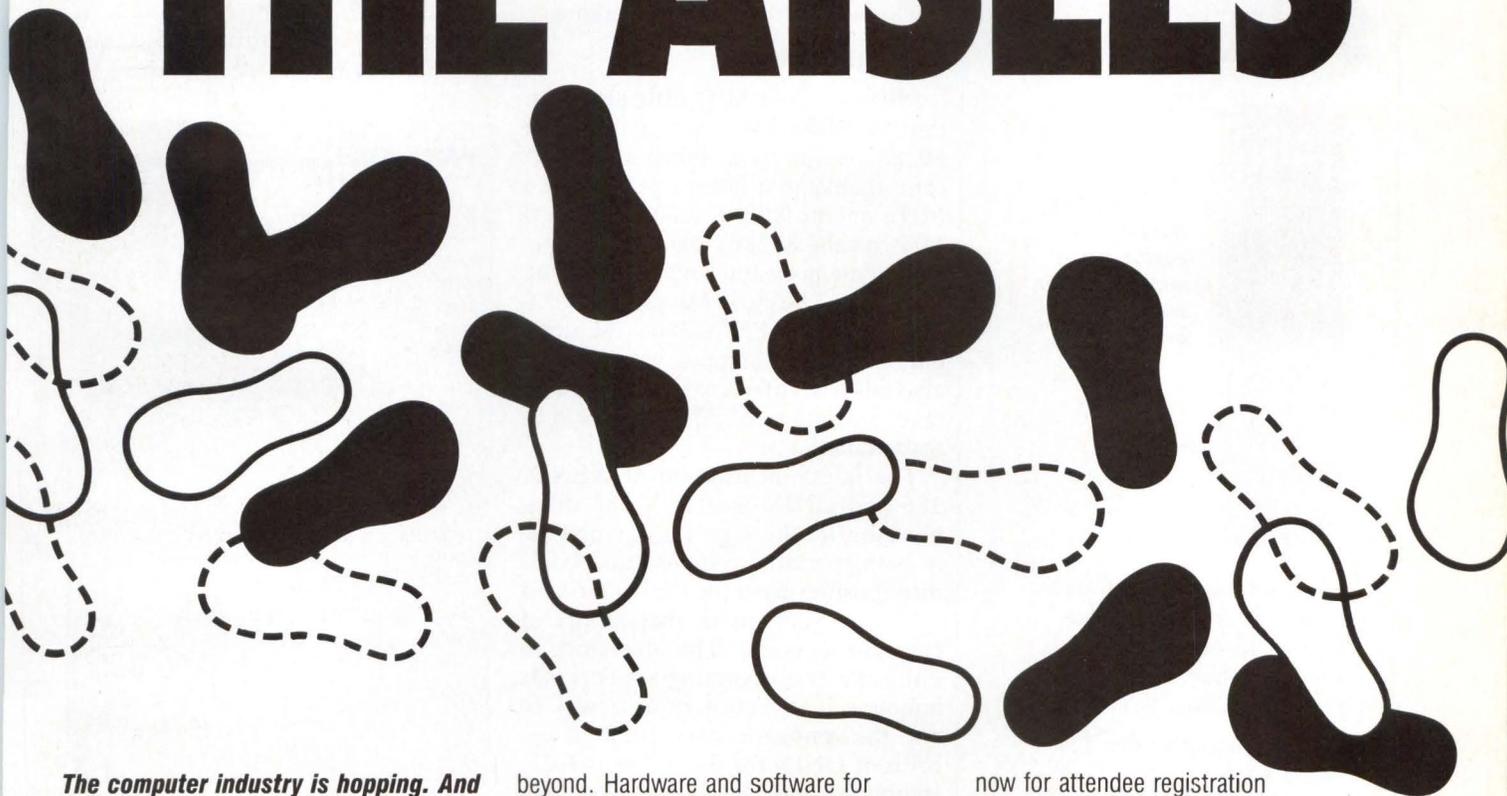
Whether one program becomes dominant may hinge on the outcome of a brewing marketing war. "It will boil down to price and performance and who provides the best incentives and support," says Dimitri Rotow, president of Bell Technologies Inc., a Fremont, Calif., UNIX vendor. "I get the feeling that both [Merge 386 and VP/ix] are better programs than they would have been had Locus or Interactive not had a key competitor along the way. As a result there has been a convergence of what they can do."

To garner more support for their products, developers are stressing their expertise with system software as well as their alliances with other major players. Locus points to a proven track record with its Merge technology, originally developed as a program called Simultask for AT&T Co.'s UNIX-based 6300 PC.

Locus also has had success with a similar PC/AT version of the program called Merge 286 and has experience in joining the DOS and UNIX worlds with its PC Interface—software that lets DOS machines share files, peripherals and CPU time with UNIX systems. Locus recently signed a deal with Microsoft allowing MSDOS to be bundled with Merge 386.

Merge 386 currently works only in conjunction with UNIX System V/386 Release 3.0. On the other hand, Interactive's VP/ix can operate with both the latest version of UNIX or XENIX System V/386 Release 2.2. Microsoft developed specific hooks into the XENIX kernel to accommodate VP/ix, and Phoenix has been allowed to modify MS-DOS to enhance the performance of VP/ix. Interactive's claim to fame is that it was the prime contractor in porting UNIX to the 80386. In addition, Interactive wrote a number of PC/AT device drivers for UNIX System V/386.

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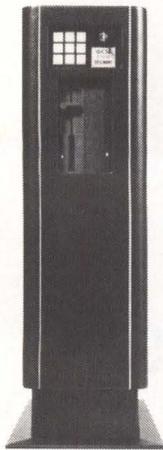
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## MINI-MICRO SYSTEMS

### SPOTLIGHT

#### OPERATING SYSTEMS

Microsoft's UNIX marketing manager. "All XENIX 286 programs are binary-compatible with XENIX 386 and will run without compiling," he says. That is good news for many of the 200,000 current XENIX licensees, three-quarters of whom, Microsoft says, use Intel-based machines.

#### A new UNIX rising

Microsoft and SCO officials claim that XENIX 386 outperforms the 80286 version by as much as 40 percent, thanks to a faster clock rate (16 MHz on the 80386 compared to 8 MHz on the 80286), demand paging, virtual memory and a new optimizing compiler. The new Microsoft C 5.0 Compiler for XENIX 386—the same one that will be shipped with OS/2—also allows software developers to take advantage of 32-bit code, says Sribhibhadh.

The latest incarnation of XENIX 386 and UNIX System V/386 does, however, set the stage for the merging of both operating systems into a common porting base for the 80386 and follow-on versions in that family of Intel processors. The decision to unify the two operating systems was announced in February as a way to end the confusion over different hybrids of UNIX for the 80386. AT&T, Interactive and Microsoft are collaborating on the unification project. The new implementation will be distributed under a single name—the AT&T trademark of UNIX.

What does that mean for system integrators who feel forced to choose between XENIX and UNIX now in order to get their 80386 systems to market? In theory, they shouldn't feel any more boxed in than they do now. That's because the forthcoming common porting base will combine XENIX System V/386 and UNIX System V/386, assuring backward and forward compatibility of respective applications.

"The goal is to achieve binary compatibility over all 386 hardware for XENIX and UNIX users," says Microsoft's Sribhibhadh.

Many observers note that combining the two operating systems will be no easy feat. Microsoft and AT&T officials say that the unified UNIX

will be available in 1988, but they will not give a more specific date. Microsoft's Hickey believes the project "will tie them up for at least a year."

In the interim, system integrators will have to make up their minds whether they want to support XENIX or UNIX on the emerging class of low-cost 80386 multiuser systems, network servers and workstations. □

#### FACT FILE

Merge 386

**Locus Computing Corp.**  
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Santa Monica, Calif. 90405  
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**Circle 473**

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#### FACT FILE

VP/ix

**Interactive System Corp.**  
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Santa Monica, Calif. 90404  
(213) 453-8649  
**Circle 474**

**Phoenix Technologies Ltd.**  
320 Norwood Park S.  
Norwood, Mass. 02062  
(617) 769-7020  
**Circle 475**

\*\* Available for UNIX System V/386 Release 3.0 or XENIX System V/386 Release 2.2.

\*\* DOS applications invoked directly from UNIX/XENIX prompt.

\*\* File integration between DOS and UNIX/XENIX. DOS runs on terminal, PC, console.

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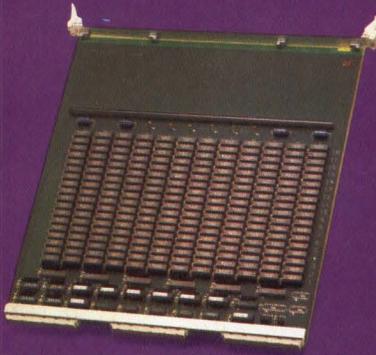
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## MINI-MICRO SYSTEMS SPOTLIGHT

### MULTIUSER SYSTEMS

# Prime pushes 80386 chip, new system targets VARs

Tim Scannell, Senior Editor

In the past few months, more than a handful of computer companies with solid reputations in the mini-computer and superminicomputer areas have extended their businesses downward to encompass systems of a less powerful persuasion.

Companies like Data General Corp., Westboro; Digital Equipment Corp., Maynard; and Wang Laboratories Inc., Lowell, Mass., have all come out with small, desktop workstations that are based on new chip technologies like that of Intel Corp.'s 80386. These systems are for the most part designed to fit into so-called "departmental work groups." They are primarily offered through value-added reseller (VAR) channels, because they are applications-oriented and not general-purpose number crunchers like the systems of yore.

Recently, yet another supermini-computer veteran—Prime Computer Inc., Natick, Mass.—entered this small-systems fray with a computer that is not only based on the 80386 architecture but is the first to simultaneously accommodate both UNIX and IBM Corp. PC software programs running under the same environment. The system, called the EXL 316, employs a DOS-UNIX integrator from Locus Computing Corp., Santa Monica, Calif. However, at its heart is Prime's implementation of AT&T Co.'s UNIX System V.3.

In terms of speed, the EXL 316 can reportedly zip through applications at 3.2 million instructions per second (MIPS), or roughly six times faster than an IBM 9370 minicomputer. It can also juggle 32 users and 58 devices simultaneously.

More important, the EXL 316 marks Prime's first move away from a proprietary chip architecture to something that is more off-the-rack in terms of accessibility. This fact signals the company's increased interest



Based on the Intel 80386 microprocessor, the Prime EXL 316 is the first multiuser system to transparently run commercially available UNIX and MS-DOS programs. A fully configured system offers 8M bytes of memory and more than 1G byte of disk storage.

in the VAR buyer, since the system is being called the consummate VAR machine.

### Riding a new life cycle

Prime officials claim they decided to go with the 80386 microprocessor, rather than with a competing multi-tasking environment like Motorola Inc.'s MC68000 microprocessor, because the former offers more flexibility and growth. With a clock speed of about 25 MHz, the 68000 is "at the top of its life cycle," while the 80386, although presenting a 16-MHz speed, has greater speed potential, claims Brian E. Ritchie, director of sales channels for Prime's Entry Level Systems division. "The chip is so strong, there are a lot of different things you can do."

In fact, Prime may be hitching its wagon to the 80386 because most

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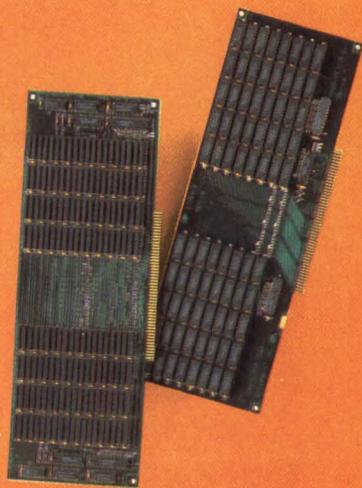
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**CIRCLE NO. 16 ON INQUIRY CARD**

## MINI-MICRO SYSTEMS

### SPOTLIGHT

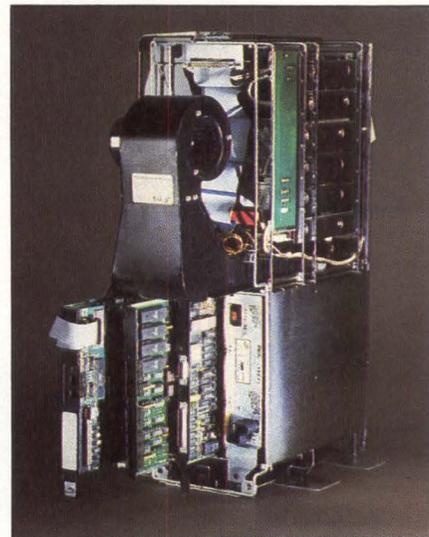
#### MULTIUSER SYSTEMS

software and hardware development over the next year or two will center on this chip, as well as on such multi-tasking operating systems as UNIX and IBM and Microsoft Corp.'s Operating System/2 (OS/2). According to Market Intelligence Research Corp., Palo Alto, Calif., total U.S. sales of 80386 software, hardware and peripherals will rocket from about \$889 million this year to more than \$4 billion in 1991. In addition, roughly 90 percent of all the 80386 systems in the United States will be churning away at office applications, while a scant 10 percent will be devoted to high-end technical work.

The one difficulty may be that Prime is not as strong as it would like to be in the office-automation segment, says Tom Roberts, manager of microcomputer systems research at International Data Corp., Framingham, Mass. And while departmental computing is an idea that should attract large corporations like picnics lure ants, it is smaller businesses that are taking the lead in work-group computing, Roberts claims. This may put a crimp in Prime's stated intention to market the EXL 316 as an extension for users of its 50 Series minicomputers and 6350 superminicomputers, which can handle up to 960 users at the same time.

Also, in the same way the term departmental computing glibly rolls off the tongue, more and more vendors seem to be rolling out systems that target this area. Earlier this year, NCR Corp., Dayton, Ohio—which Prime views as its chief competitor in this market—unveiled the PC916. That also incorporates an 80386 chip and can keep pace with the EXL 316 in terms of MIPS power, but it does not have a dual-operating-systems personality. And DEC has its MicroVAX 2000, which also targets the work group and has a heavy penetration in the VAR and third-party developer markets.

So, why would Prime develop and market a system to compete where it does not have a sizeable foothold, and where the competition is intense? One opinion is that the EXL 316 represents nothing more than techno-



**Housed in a 25-inch-tall cabinet,** the EXL 316 is held together with 20 screws and incorporates the industry-standard Multibus II bus structure.

logical fireworks, ignited by Prime engineers to flaunt the company's technical expertise.

In fact, the system is an exercise in state-of-the-art computer design. Packed into a single, 25-inch-high cabinet, the EXL 316 contains the 80386 CPU, three Multibus II expansion card slots, and space for a tape drive and two disk drives. However, a double-cabinet version is available that sports seven Multibus slots and space for four disk drives. The system supports up to 8M bytes of main memory, 1G byte of disk storage, a SCSI (small computer systems interface) interface and two asynchronous control lines for a modem or printer. It also has 64K bytes of combined instruction/data-cache memory and virtual memory with a paging capability.

In its standard configuration, with a UNIX license, 2M bytes of memory, a 90M-byte formatted disk drive, a 60M-byte streaming tape backup and 10 asynchronous communications lines, the EXL 316 costs \$23,900.

#### A bridge to VARs

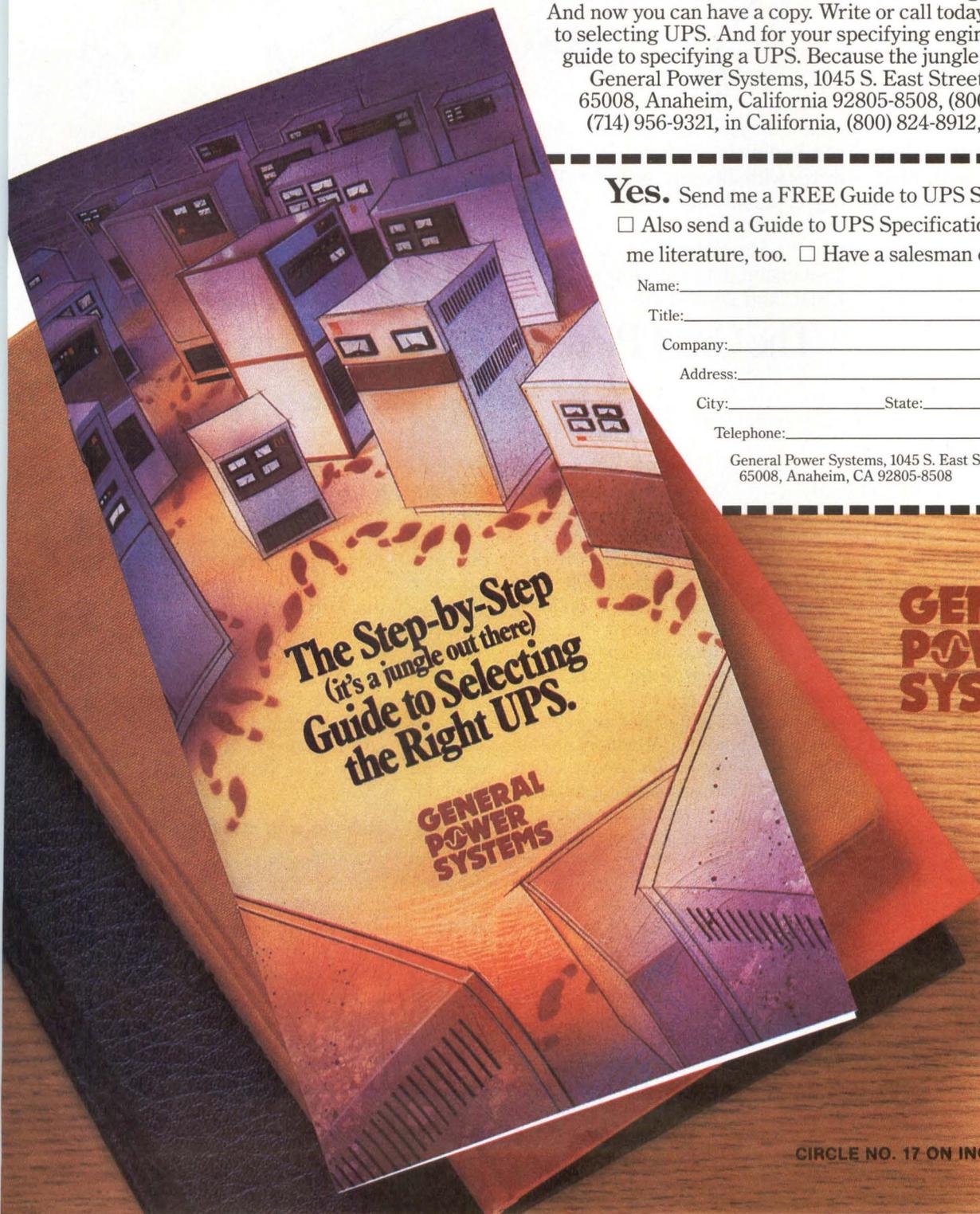
A far more plausible strategy, however, identifies the EXL 316 as the flagship in a Prime assault on the

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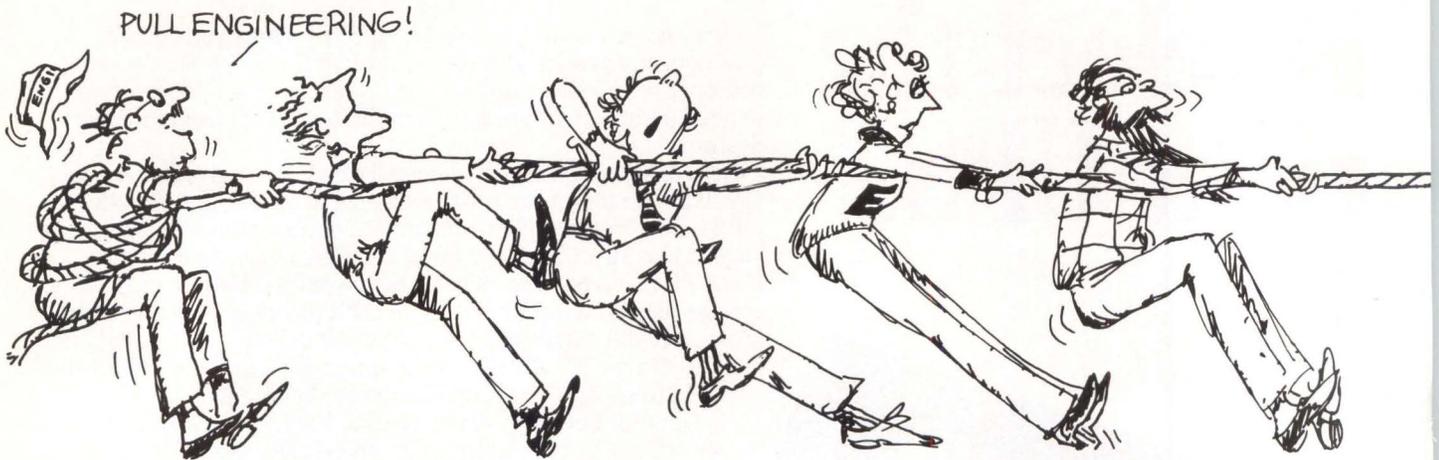
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### MULTIUSER SYSTEMS

VAR marketplace, which presently accounts for about 17 percent of its total revenues and 25 percent of its unit shipments, according to IDC. (Comparatively, NCR reportedly ships 40 percent to 45 percent of its systems to the VAR community.)

For instance, the entire system is held together with about 20 screws, making it attractive to system integrators who want to pull things together and to end users reluctant to pull complicated things apart. It also has an autoconfiguration routine that does away with the need for confusing DIP switches and, at 750 dB, is quieter than an IBM PC/AT, a spokesman for the company claims.

"What the new box does is give [Prime's] existing VARs a way to get into the smaller accounts—the people who don't need the processing power of one of Prime's large systems," states Stephan Bosley, an IDC analyst. "It also gives Prime a way to recruit VARs who might not be large enough to put their resources behind the full product line, but could support a small system."

While Prime has traditionally targeted the end user as a customer, it wants to increase its exposure in the reseller channels. Presently, the company has about 100 VARs who work in nearly every major market segment, including the government. But plans are to expand this base, particularly with the EXL 316, says Prime's Ritchie.

That is not to say that Prime intends to abandon end-user sales, or slowly to slip out of the high-end minicomputer market. On the contrary, Prime introduced two more additions to its popular 50 Series minicomputers last April—the 6350 and dual-processor 6550—which boosted the company's processing power range from about 8 MIPS to more than 23 MIPS. The series is based on Prime's own MCA2500ECL very large scale integration chip. The first of these systems was just delivered to retailer Neiman-Marcus in Dallas to handle its worldwide mail order business. The company also unveiled a number of communications products that connect UNIX-based systems to

talk with 50 Series machines, including products that adhere to Ethernet, TCP/IP (Transmission Control Protocol/Internet Protocol), SNA (Systems Network Architecture) and X.25 standards.

However, the high-end minicomputer market is not growing fast enough to meet the company's goals, and the small-system VAR and reseller channels offer more potential, says Leonard F. Halio, vice president of Prime's Small Systems Products Group.

### Sticking with standards

Working in Prime's favor is the fact that the EXL 316 adheres to a number of industry-accepted standards. As a result, it appeals to a greater number of system integrators and VARs. For example, the Multibus II architecture in the EXL 316 is considered to be the bus of choice in 80386-class machines, rivaled only by VME-type buses. In fact, shipments of Multibus II board-level products are expected to reach \$477 million by 1991 from less than \$50 million this

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year, according to Venture Development Corp., Natick.

The EXL 316 also incorporates an intelligent Ethernet local area network controller, based on the 68000 microprocessor, to connect it to other systems and peripherals.

Rather than sell the EXL 316 on its hardware aspects alone, Prime wants to push its software and language capabilities on three VAR levels: to current UNIX/XENIX resellers and users; to MS-DOS users, as a cluster machine in a LAN; and as a high-end platform to PC/AT and even PS/2 users and resellers who want to migrate to a more powerful technology.

UNIX is particularly attractive to Prime since so much of the multitasking and multiuser computer activity has migrated to this environment. For example, the growth rate of licensed UNIX products approached 70 percent in 1985, and more than two-thirds of all bids submitted to the government in the past year have spotlighted UNIX as the primary operating system, points out Prime's Halio.

Prime is also porting major software packages to the EXL 316 architecture to make it easier to sell the system through VAR channels. For instance, the company ported Oracle Corp.'s Oracle database software to the EXL in less than two days—no small accomplishment considering that, with at least 2,000 modules, Oracle is one of the largest programs written in the C language.

"All the VARs have investments in software, and they're going to port that software down to this machine," says IDC's Bosley. "They will look to Prime to help them do that."

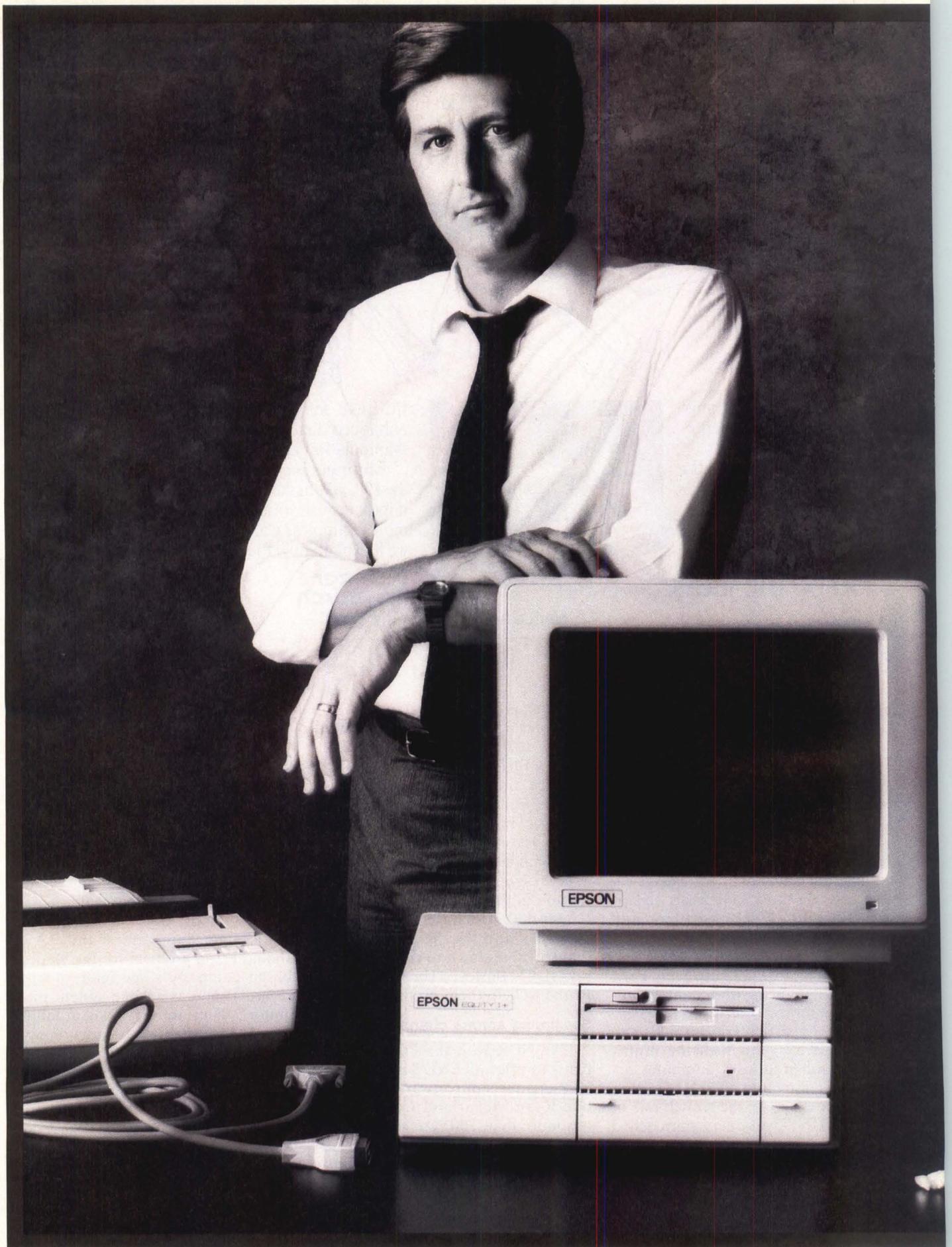
#### Swimming across channels

Like NCR with the PC916, Prime plans to offer its EXL 316 across the VAR channels of software companies like Ryan-McFarland Corp., which has more than 700 resellers, and Science Management Corp., with nearly 800 resellers. The company has also initiated a compensation program to keep VARs and direct-sales people from competing for the same customer.

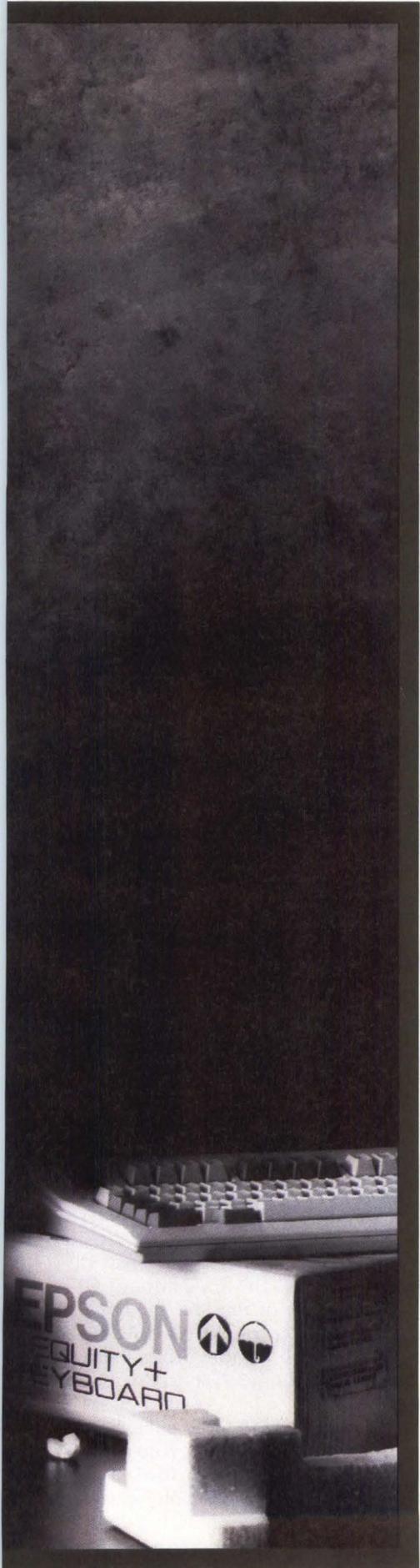
Admittedly, it will take time to train Prime's existing VAR and direct-sales force in selling into the UNIX market—about six to nine months, sales director Ritchie maintains. Although the company wants to expand its VAR base, it is in no hurry to sign up new VARs, because those that come on board will have to be well-versed in multitasking systems and the UNIX environment.

But, finding, training and qualifying system integrators and VARs should be no problem for the Natick-based company since many people regard Prime as a large system integrator. "They are very good at taking a box and making it work," says IDC's Bosley. "It is not Prime's strategy to just sell iron and get out. They're much more concerned with getting longer term relationships with people, and not to just dump a box and run." □

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MASS STORAGE

## Disk, tape OEMs ride in wake of IBM PS/2 entries

Tim Scannell, Senior Editor

Like pebbles thrown into a pond, IBM Corp.'s debut of the Personal System/2 series of computers has caused ripples throughout a number of hardware and software areas, particularly impacting disk and tape drive manufacturers.

Basically, by incorporating such things as 3½-inch flexible and Winchester disk drive formats in its PS/2 Model 50 and announcing 5¼-inch rigid disk capacities of up to 230M bytes in its top-of-the-line Model 80, IBM has created all sorts of opportunities and a few headaches for OEM manufacturers and system integrators.

Disk drive makers can compete against IBM in the high-capacity disk market by offering capacities that equal or exceed the 70M- and 115M-byte disks manufactured by IBM at its Rochester, N.Y., facility. Although IBM announced these products at the April unveiling of the PS/2 series, the 70M-byte disk was not scheduled to be available until July, while the 115M-byte version was not set to ship until sometime in the fourth quarter.

As a result of this delay, which seems more strategic than related to any production problems, a handful of disk drive manufacturers are rushing high-capacity 5¼-inch Winchester disk products into the PS/2 market for both end users and system integrators. These include such disk drive veterans as Maxtor Corp., San Jose; Micropolis Corp., Chatsworth, Calif.; and Control Data Corp., Minneapolis.

Claiming to be the first with alternative disk products is relative newcomer Peripheral Technology Corp., Boca Raton, Fla., which in June began shipping 150M- and 300M-byte internal and external drives. The disks cost \$3,995 and \$5,995, respec-



**James Sedin, chairman and CEO of Mountain Computer Inc., holds one of the company's internal tape drives as vice president of sales Tom Parkinson looks on. A Mountain tape system is installed in an IBM PS/2 Model 60 system beneath the desk.**

tively, and are aimed at replacing or supplementing the disks in the PS/2 models 50, 60 and 80 systems. The company also offers a controller for \$800 that is compatible with the PS/2's Micro Channel architecture, allowing the disks to take full advantage of the computers' increased bus capacities, says Peripheral Technology's president Charles Lambka.

"The PS/2s are clearly designed to be used by multiple users, either in a network environment or as multiuser computers," he observes. As a result, more disk storage will be needed for programs that are shared among groups of users and therefore take up additional disk space, particularly those programs that use IBM's Operating System/2 as a springboard to go beyond the 640K-byte barriers

erected by previous microcomputer operating systems, MS-DOS and PC-DOS. "The people who are used to using 20M- and 30M-byte drives right now will find that their drives will very rapidly fill up on this stuff," Lambka contends.

Another minus for IBM that looks to be a plus for third-party disk vendors is that, while IBM's drives adhere to the higher performance enhanced small device interface (ESDI), they are slower compared with the new wave of disk alternatives. For example, IBM's 70M-byte, 5¼-inch rigid disk drive has an average seek time of 30 msec, weighted, and a full seek time of 60 msec, while Peripheral Technology claims to cut those figures in half with its 150M- and 300M-byte disks.

Furthermore, while IBM states a storage maximum of 230M bytes on its Model 80, Peripheral Technology's Lambka says his products can boost that to 600M bytes and beyond, if necessary. "Most people are quite happy with 40M-byte drives, but there is no technical reason why you couldn't put two or three gigabytes in a [PS/2] Model 80," he says.

Keeping up with the disk storage appetites of networked and heavy-duty PS/2 users will be the least of the worries for most disk manufacturers, however. In fact, most of the activity in the market is occurring at the 3½-inch, 20M- and 40M-byte rigid disk drive levels—the PS/2 Model 50 is the only one of the four models that has a 3½-inch rigid disk drive—and with 3½-inch flexible drives, because all four PS/2 models sport the smaller drives.

According to figures published by Disk/Trend Inc., a Los Altos, Calif., market researcher, worldwide shipments of 3½-inch flexible and rigid disk drives will reach 22.1 million by 1989, from a little more than 10 mil-

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## **Maxtor**

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MASS STORAGE

lion this year. Most of the rigid drives will wind up as internal components to systems based on Intel Corp.'s 80286 and 80386 microprocessor, although significant numbers will surface as external drives.

For example, recently Miniscribe Corp., Longmont, Colo., inked a deal with Apple Computer Inc., Cupertino, Calif., to supply up to \$83 million worth of the rigid disks for the Macintosh SE. Rodime Plc, a Scottish disk drive manufacturer, also relied on Apple for more than 40 percent of its revenue in the second quarter this year.

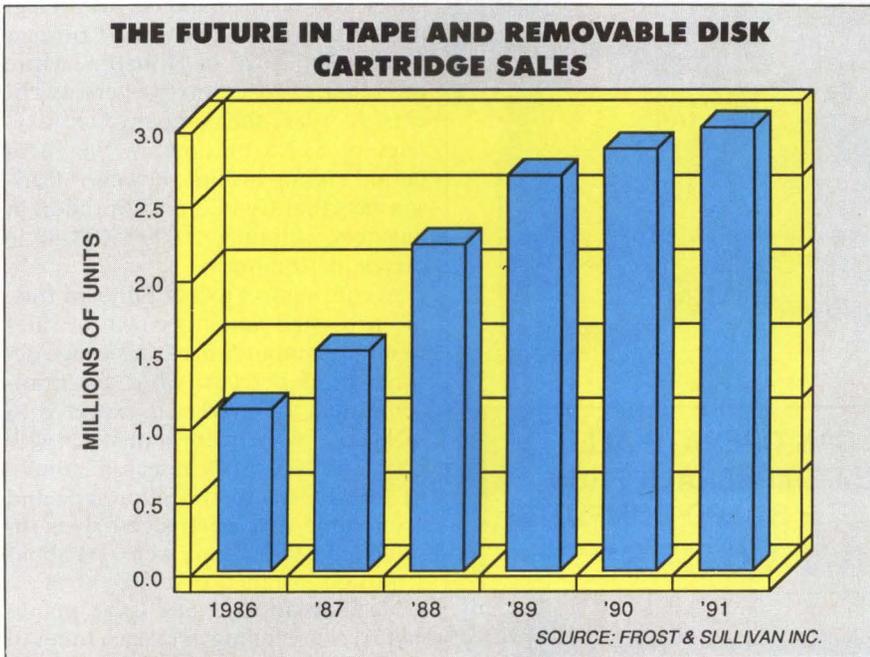
There is a great deal of heat in the battle among OEM vendors for system integration dollars. Earlier this year, Rodime filed suit against both Miniscribe and Conner Peripherals, claiming those companies had violated patents Rodime had established as the initial maker of 3 1/2-inch rigid disk drives. IBM became worried that the Rodime action might stick, and that IBM would be locked into one second source for 3 1/2-inch rigid disks. IBM filed a challenge to Rodime's complaint, which threatened to im-

pact the 3 1/2-inch drives that IBM, itself, manufacturers for the PS/2. At press time, results of these actions were pending.

To add coal to the fire, IBM is also slowly getting into the OEM business by selling its own disk license to computer and peripheral manufacturers. Analysts estimate that IBM can manufacture up to 1 million 3 1/2-inch drives this year at its Japanese plant, an amount that will hardly match the number of PS/2 systems projected to be sold. (A survey conducted recently by Newton-Evans Research Co. of Ellicott City, Md. revealed that, of 174 Fortune 1000 company's asked, nearly 20 percent had already installed one or more PS/2 systems.) As a result, there is expected to be a sizeable stockpile of drives that are suitable for the system integration market.

"We want to be at the high end of what the average corporate user wants to do," says Peripheral Technology's Lambka. "We also want to stay away from the low end where the law suits are."

Disk drive manufacturers are not



Shipments of tape backup drives and removable disk cartridge systems are expected to skyrocket from about 1 million units in 1986 to more than 2 million in 1988 and close to 3 million installed by 1991. Much of this growth will be spurred by the IBM PS/2 market.

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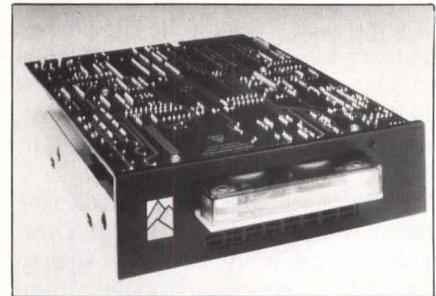


MASS STORAGE

the only ones thrown into a spin by the PS/2 series. As disk capacities soar higher and higher, tape backup has suddenly surged to the forefront—not only as a means to protect against data loss, but also as a way to transfer programs and data among systems that are not connected in a network.

“The applications that the 386 ma-

chines are used to have gotten much more serious,” says Edwin W. Carlson, president of Irwin Magnetics Systems Inc., a tape drive manufacturer in Ann Arbor, Mich. As a result, tape backup has become a necessity rather than an option. “It’s one thing to lose your word processing files or your personal spreadsheet, but quite another to lose the company’s ac-



**Mountain Computer Inc.'s TD4000** 40M-byte drive incorporates such features as adherence to QIC-40 specs, the ability to transfer data at 2M bytes per minute, and an error correction and detection routine that is reportedly 100 times greater than conventional rigid disks.

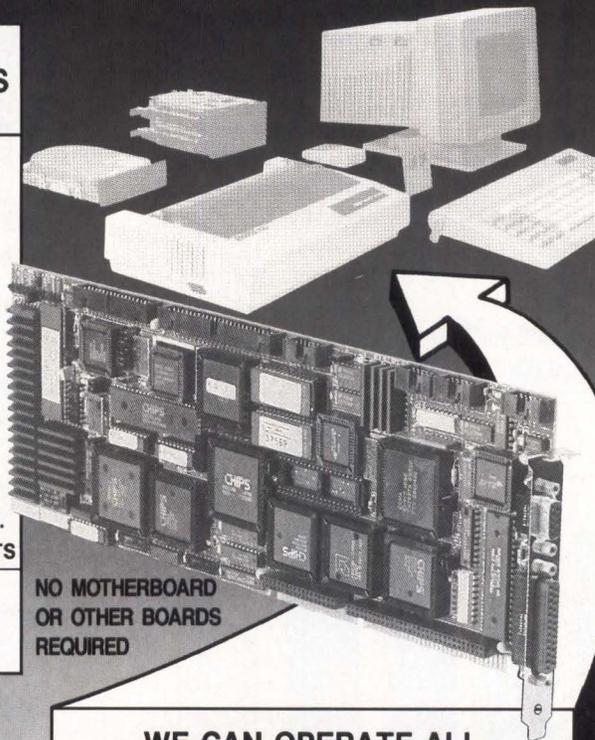
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counts receivables,” Carlson points out.

At present, Irwin Magnetics is considered to be the leader in the tape backup market, with close to 65 percent of the worldwide business and more than 350,000 units installed. About two-thirds of the company’s U.S. business is now split between the OEM and retail markets, with a significant portion going to Compaq Computer Corp. in Houston, while the other third involves overseas clients. In 1986, the company had revenues of \$12.5 million. In the fiscal period ending in June, however, Carlson says that Irwin did \$50 million in business, shipping 50,000 40M-byte drives in 10 months.

According to Frost & Sullivan Inc., the predicted annual growth of sales in microcomputer backup-storage devices is 23 percent, while for mini-computers the market is expected to rack up a 46 percent annual growth rate. The New York research company foresees nearly 3 million tape and removable disk cartridge drives installed by 1991. There were just about 1 million installed in 1986.

Needless to say, tape drive manufacturers are falling over each other to meet the rising demand for their products. Just weeks after the PS/2 announcement, Mountain Computer Inc., Scotts Valley, Calif., unveiled the TD4000 external 40M-byte tape drive for the Model 50 PS/2, which is

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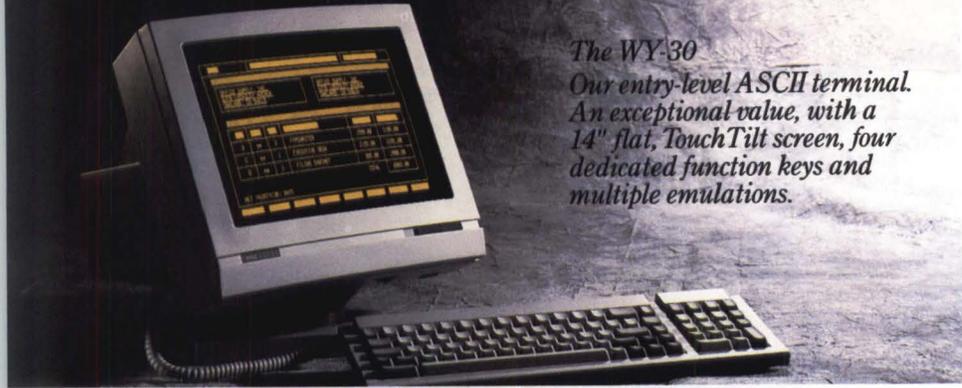
*Our optional arm elevates your point of view.*



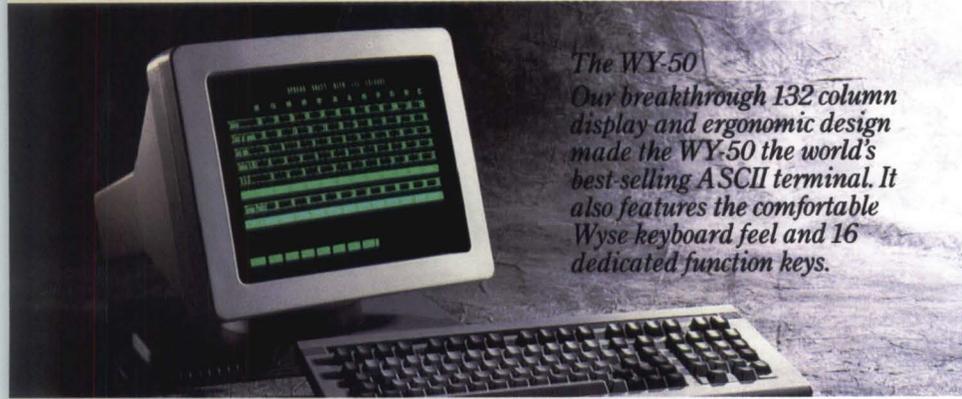
*Key decision: which of five WY-60 layouts to choose?*

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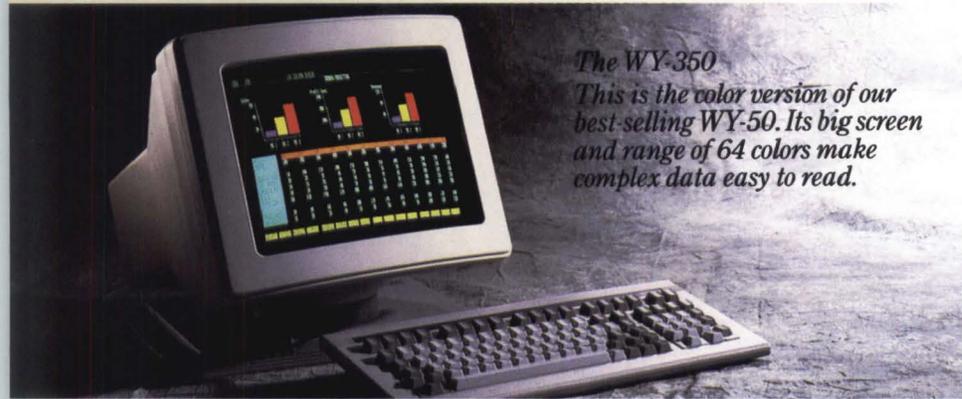
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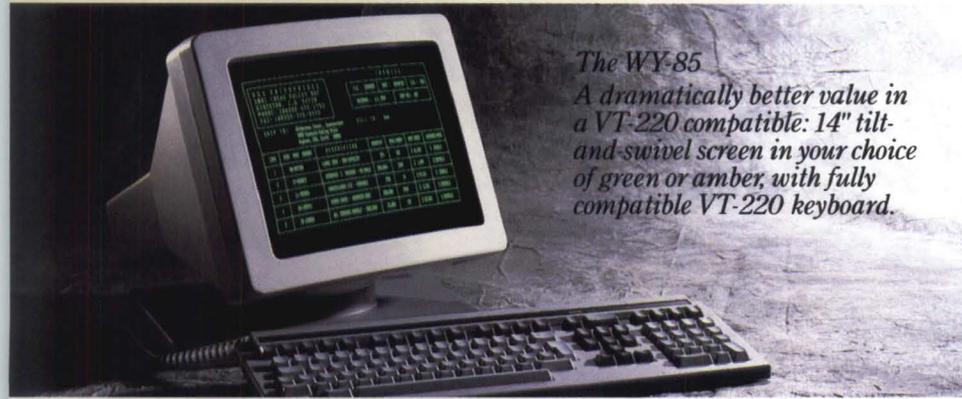
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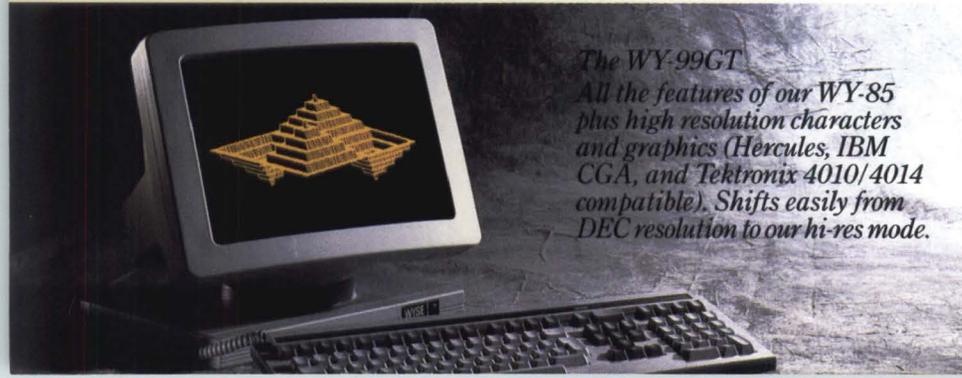
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turning out to be the most popular of all four PS/2 systems, if early demand is any indication. The reason Mountain brought a product so quickly to the market, says director of engineering Eric Swartz, is that the company's automatic test division was hired by IBM to run tests on the PS/2's Micro Channel, and had access to its design long before its specs were made public knowledge.

"It turns out they [IBM] didn't do anything really mind-boggling with the bus anyway," avers Swartz.

Although Mountain is not traditionally an OEM supplier, it did form an OEM marketing group with the announcement of its 40M-byte TD4000. It also expects at least 20 percent of its business to be OEM, selling to such customers as AT&T Co. and Sun Microsystems Inc.

One of the outstanding features of Mountain's tape backup systems is that they adhere to the Quarter-Inch Committee (QIC) 40 specification for 40M-byte cartridge tape systems. With QIC-40, 40M bytes of storage are distributed over 20 tracks, the device is optimized for shifts in the tape and the data-transfer rate is greater than 2M bytes per minute—all of which reportedly results in increased reliability and higher performance. Presently, at least three other companies manufacture QIC-40 devices. They are: Alloy Computer Products Inc., Archive Corp. and Wangtek Inc.

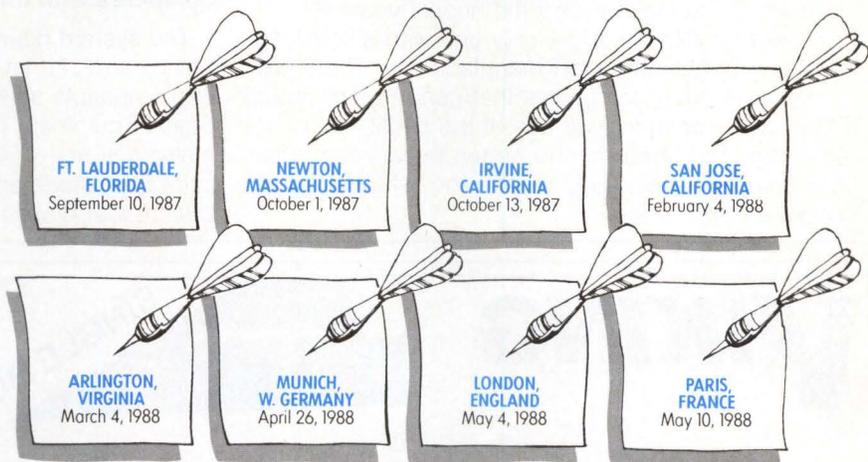
But, although QIC-40 is being touted by some as a standard, there are some major players in the tape drive arena who prefer to acknowledge it as a common format but not something set in stone. One of these is Irwin Magnetics. While Irwin feels that QIC-40 devices have a place in the rush to hang onto the IBM PS/2 coattails, president Carlson maintains it is by no means the only way to boost tape performance.

In fact, Irwin's 40M-byte drives, and a 64M-byte drive introduced at the Spring Comdex show in Atlanta, all feature embedded servos and specialized head-posturing software that position the tape heads in the center

of each track. Other drives use mechanical or electromechanical devices that place heads at the beginning of each track. As storage is increased and tracks are squeezed tighter and tighter, Carlson claims, Irwin's choice of technology will result in higher reliability and performance.

Whoever is right, both factions have submitted their technologies to ANSI in the hopes of capturing the standards' crown. Irwin may have a slight edge since Carlson maintains that more than 3 million tape cartridges are presently in use that adhere to the Irwin design. □

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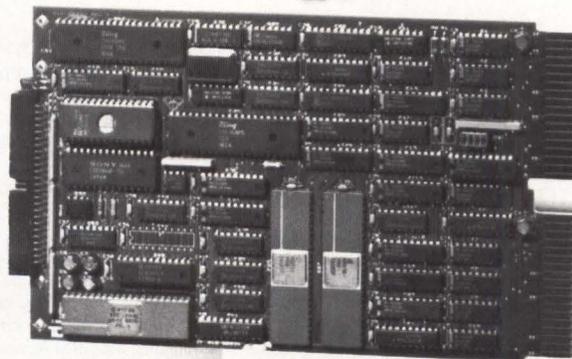
When IBM Corp. rolled out its Personal System/2 series of computers this spring, the company made no effort to hide the fact that these new systems were packed with a myriad of microprocessor miracles. These ranged from 1M-bit chips, to 3½-inch disks to surface-mount manufacturing techniques. However, if you look beyond the hoopla you will discover that IBM is not the only one with a knack for dipping into state-of-the-art manufacturing. There are a number of other companies that can not only match IBM point for point in their use of the latest technology but often go one better, because smaller companies are more likely to take the risks that larger concerns often avoid.

For example, take Datamedia Corp., a 10-year-old company based in Nashua, N.H. About three years ago, it began tinkering with the idea of a desktop workstation for one of its OEM customers, AT&T Co. To keep costs down, Datamedia began using custom gate arrays and application-specific integrated circuits (ASICs) long before they were the buzzwords they are today. In an effort to squeeze more graphics capability out of its system, the company developed its own enhanced graphics adapter (EGA) chip set. As for storage, Datamedia engineers designed into the system 2M bytes of internal battery-backed RAM, along with an ability to use innovative credit-card-size storage devices—called RAMfile and CARDfile—from Epson America Inc. These plug into the system much like the way a bank card slips into an automatic teller and provide up to 128K bytes of storage for MS-DOS programs and data.

**Competes with IBM and DEC**

The system delivered to AT&T, called the Colorscan/2, is not only able to run IBM PC-compatible software but is also compatible with Digital Equipment Corp. VT240 and VT340 terminals. It also delivers a 640-by-480-pixel graphics resolution in its EGA mode and an 800-by-480 resolution in its DEC mode. While the unit complies with a number of

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## IBM clone recipe

desktop standards, it primarily targets the DEC OEM color-graphics-terminal market, says Datamedia president and chairman Guy A. Daniello. However, it can also be a tough competitor for IBM's PS/2, since a PS/2 port was hastily added to the system after Daniello sat in on the PS/2's introduction in Miami last April and learned of Big Blue's networking plans for its new machines.

The Colorscan/2 costs about \$2,000 in single quantities. Shipping started in July, with full production runs planned for this month.

### Getting there without OS/2

Realizing that both IBM and Microsoft Corp. may have problems delivering what they have promised (and that the vaunted Intel 80386 microprocessor may not be available by the barrel full, as most system vendors claim), Terence M. Colligan, president of Rational Systems Inc., Natick, Mass., decided to give users what is available. By taking advantage of the "native mode" of both the 80286 and 80386 chips, Colligan and his programming team came up with a compiler that allows users to go beyond the 640K-byte barrier of DOS, without switching to a new operating system or sacrificing compatibility.

The product, DOS/16M, lets third-party software developers write large programs that access as much

as 16M bytes of memory and can port mainframe-level software down to IBM PC/XT and PC/AT machines. To maintain compatibility, the C-written compiler switches from native to real mode to handle DOS functions and calls. The idea was "to provide an environment that is really more compatible than OS/2, but really doesn't change anything," Colligan stated. He noted that DOS/16M was originally planned as a short-term product but will probably be around for at least a year until OS/2 gets off the ground. At that point, Rational Systems plans to use OS/2 as a platform and offer an added-value product of some kind to software developers.

One thing going in Colligan's favor is the fact that DOS/16M's in C language is the language of choice for many artificial intelligence and UNIX-compatible applications. In fact, Colligan is a member of ANSI committee X3-J11, which is pushing for C language standardization.

While the price—\$29,000 for a one-time license—may seem steep by personal computing standards, a large number of the thousands of present users of Rational Systems' C compilers, as well as companies that require large amounts of memory to run mainframe-level programs, have shown a great interest in DOS/16M, Colligan claims.

—Tim Scannell

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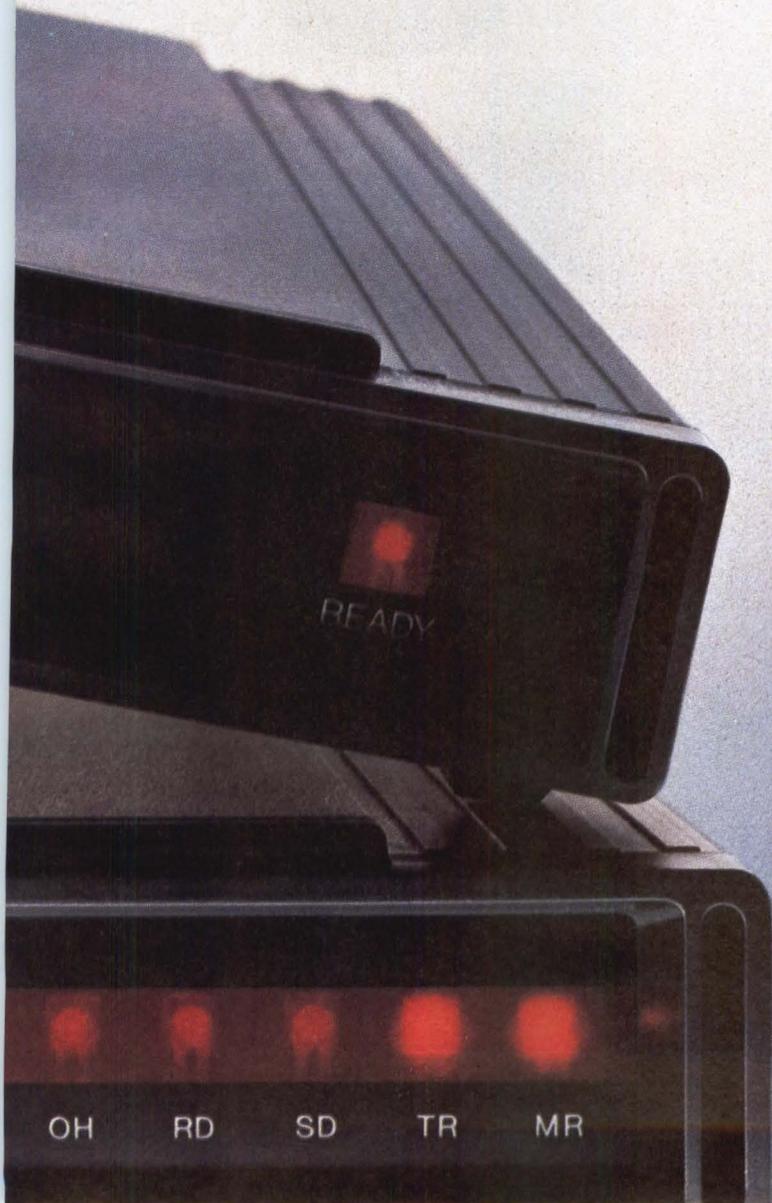
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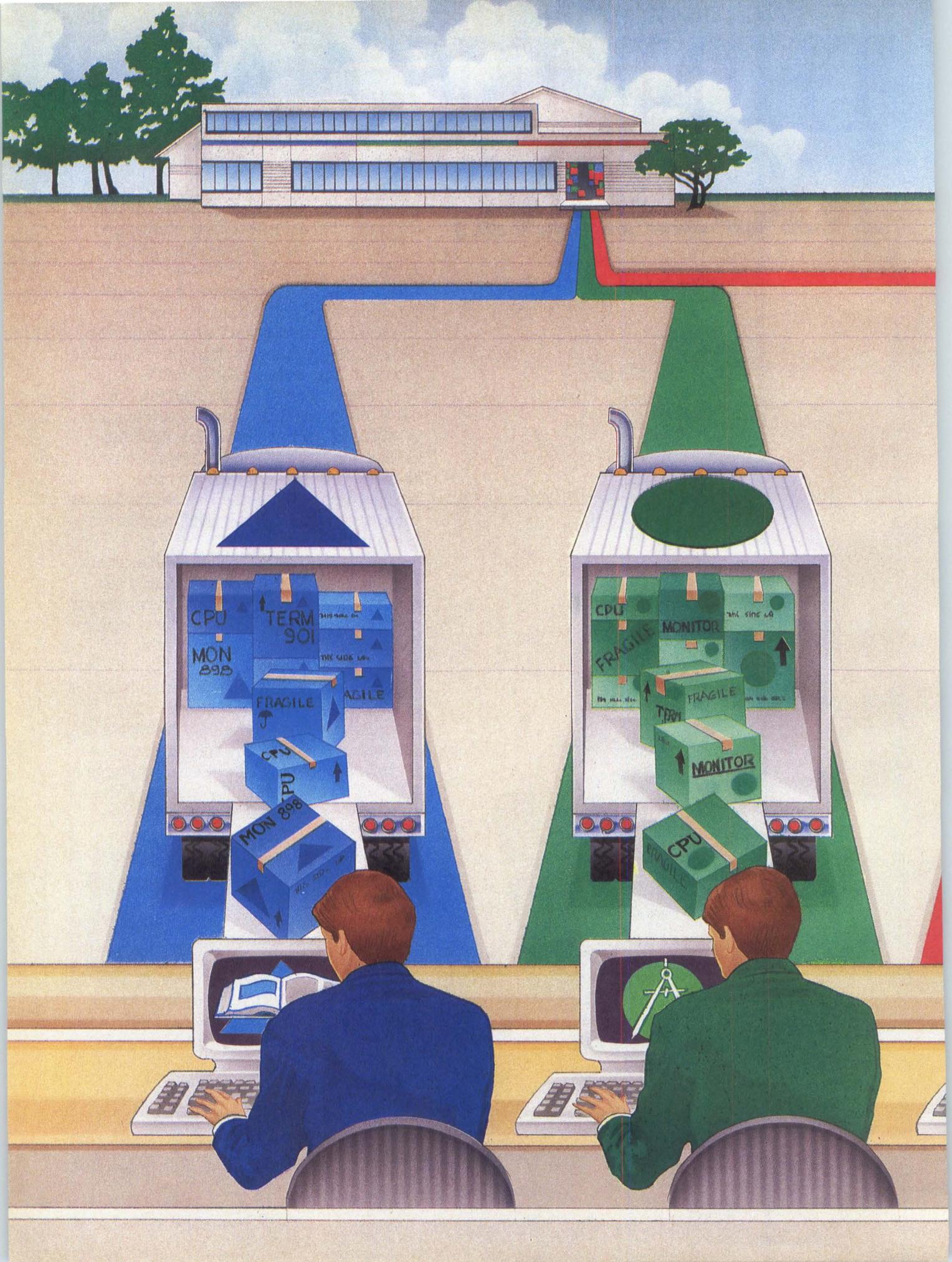
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# FORWARD INTEGRATION IMPACTS VARs

You'll get new markets, opportunities, but vendors will usurp many system integration chores

Andrew Allison, Contributing Editor

In 1986, the personal computer market began to exhibit a telltale sign of maturity—fierce fights for market share. As a result of mounting competitive pressures and price slashing, some suppliers, eager to shore up profits and protect margins, began to “forward-integrate” hardware and software by combining them into application-specific platforms at the manufacturing stage.

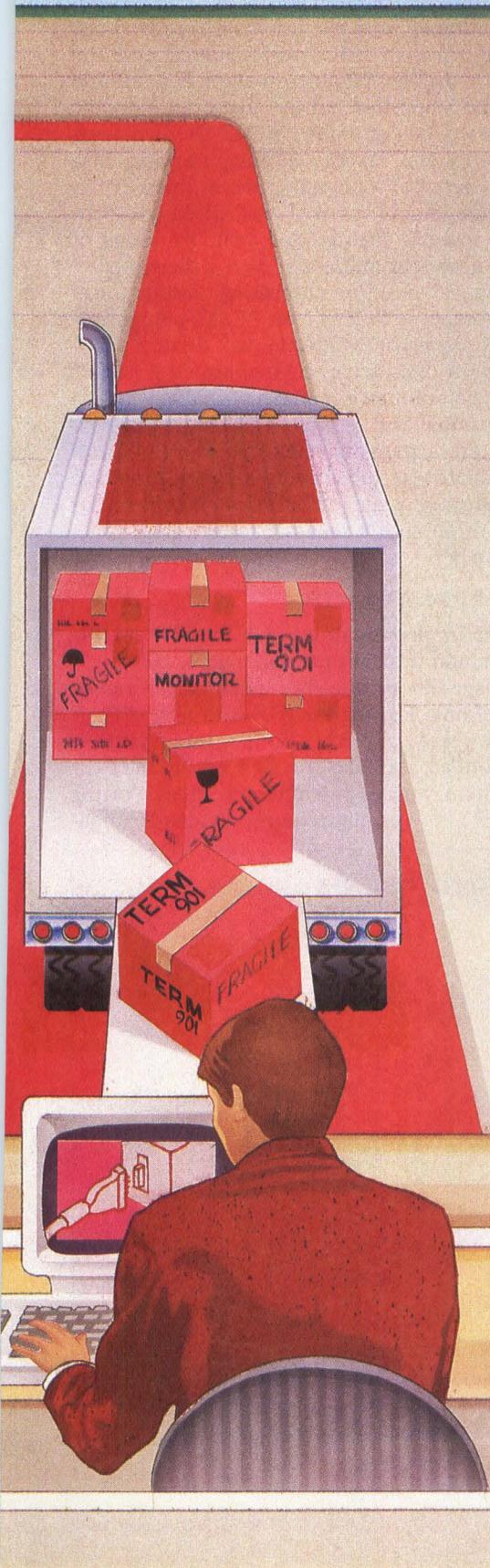
That's both good and bad news for resellers. It will open new markets and provide profitable opportunities, but the system-integration chores will be pre-empted by the personal computer manufacturers. The ramifications of this trend—especially for value-added resellers and system integrators in electronic publishing, CAE, networking and host-connectivity—will ripple through the low-end of the IBM Corp. PC-compatible market. And suppliers will seek new ways of differentiating MS-DOS systems in order to escape the pressure-cooker forces of commodity pricing (MMS, March, Page 55).

Personal computer and workstation suppliers like IBM, Hewlett-Packard Co., Sun Microsystems Inc. and 3Com Corp. have already introduced forward-integrated products, but the real news is the entry of high-volume, low-cost, IBM-compatible PC suppliers. This evolution of clone manufacturers into turnkey system suppliers is a natural outgrowth of the mounting PC-vendor competition. However, it will have a profound impact on resellers as well as

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**The real news in forward integration is the entry of IBM-compatible PC suppliers.**

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on workstation/server manufacturers.

The first PC-based systems offering integrated hardware and software operating environments for desktop publishing, CAE/CAD, network and host-connectivity products began to appear last year. As these proliferate, they will be joined by a likewise widening range of work-group, departmental and network servers; personal workstations; and front- and back-end processors.

**Examples on the desk top**

Although originally made possible by, and developed around, the Apple Computer Inc. Macintosh, desktop publishing has become the most active area of application-specific, forward-integrated PC-based systems (MMS, January, Page 57). Proving attractive in this regard is the combination of PC-based composition languages and low-cost, medium-resolution page printers; i.e., those offering 300 to 600 dots per inch, compared to 1,270 to 2,540 dpi typical of phototypesetters and the 72 dpi of dot-matrix printers.

Among other things, desktop publishing has been largely responsible for the Macintosh's penetration of the business world. In the same way that, 25 years ago, Digital Equipment Corp.'s "programmed data processors" circumvented the need for centralized computers, Macintosh-based "graphics terminals" and "desktop publishing" workstations elude IBM-compatible PC procurement standards.

However, the MS-DOS software base makes IBM-compatible PCs very attractive. This is

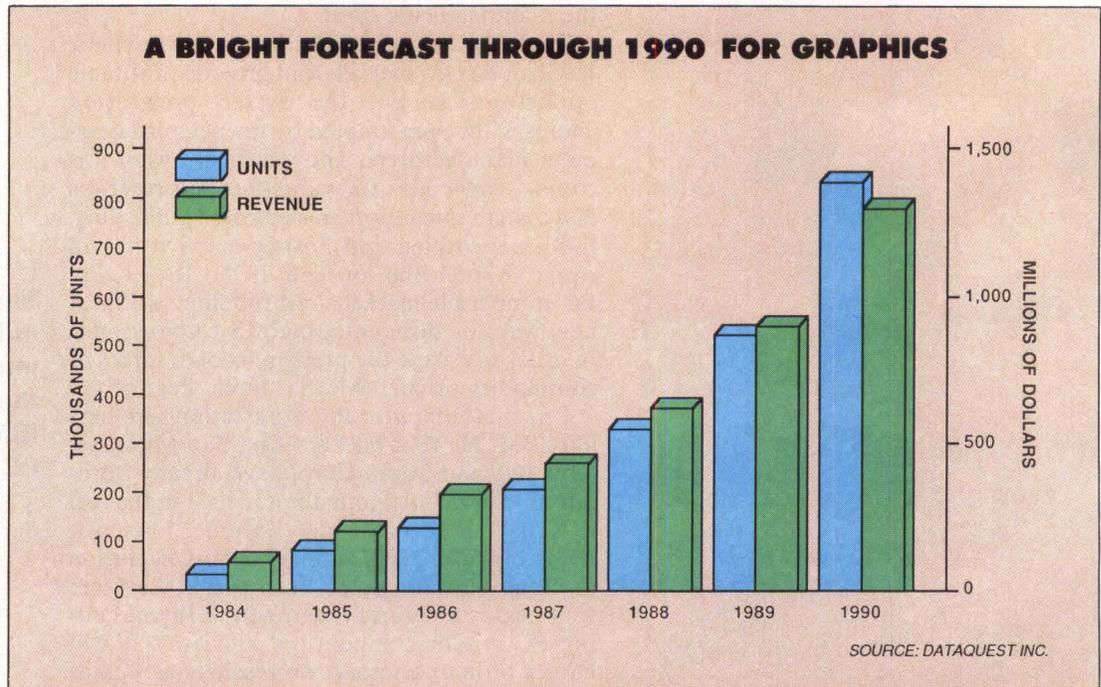
particularly true of PC/AT-compatibles, because of their performance and the ability to migrate to the OS/2 operating system as that operating environment develops. These benefits, combined with the impact of multivendor competition on price/performance and the need for higher resolution than is available from the Macintosh, ensure that eventually the market will be dominated by MS-DOS-compatible products. Dataquest Inc., the San Jose market research company, has estimated that MS-DOS machines will outsell Macintosh-based systems slightly this year, by ratios of 2-to-1 next year and about 3-to-1 thereafter.

A typical desktop publishing system today incorporates a PC/XT- or PC/AT-compatible central processor, a flexible disk drive, a 20M-byte rigid disk drive, a bit-mapped graphics display, a scanner to enter text and artwork, a page printer and a mouse. Software requirements are a page makeup language (PML) to manipulate text and artwork and a raster image generator (a page description language, or PDL) running in a separate raster image processor (RIP).

**Toward true WYSIWYG**

Most implementations put the RIP in the printer, and transmit the 5K- to 20K-byte high-level page description over a standard serial or parallel link. Putting the RIP within the PC, as in the case of IBM Publishing System's SolutionPac, provides it with access to the PC's file system, storage and other resources. Putting the RIP in the printer requires a video-frequen-

**An increasing demand for CAE/CAD capability is seen by market observers as the key element in a projected PC graphics growth rate topping 50 percent annually through the end of the decade.**



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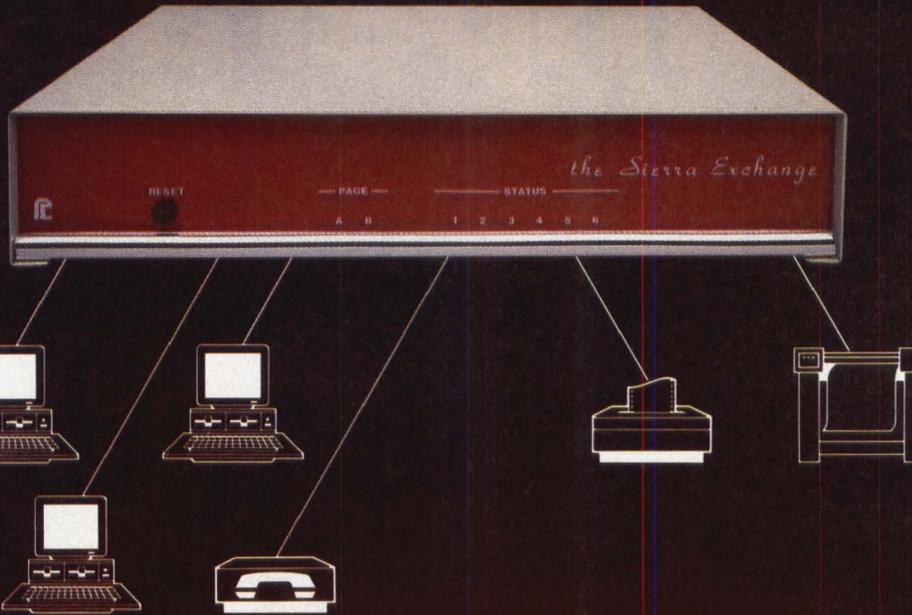


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## Bye, bye XT

Manufacturers of IBM Corp. PC/AT-compatibles stand to benefit enormously from the Personal System/2. That's because, despite its price, the low-end Model 30 is nothing more than a relatively costly PC/XT clone. That fact, coupled with price reductions in AT-compatible PCs as a consequence of the rest of the PS/2 line, is likely to deliver a body blow to the PC/XT market, especially in light of IBM Corp.'s withdrawal of the XT in June. The XT and its compatibles will be left with low-cost products for the home and education markets and with terminal replacement.

Unsurprisingly, suppliers of Intel Corp. 8086-based personal computers disagree. For example, Ennio Panzetto, product planning manager at Olivetti Advanced Technology Center Inc., argues that, "The 8086 (which Olivetti has long used for its XT-compatible products) is OK as an engine for cost-sensitive applications. IBM, after all, has just introduced a PC based on it." However, making XT compatibles into true 16-bit systems narrows the cost

differential between them and the 80286-based ATs still further.

Meanwhile, until OS/2 Enhanced Edition operating system applications become available (unlikely much before the end of 1988), the Models 50, 60 and 80 will remain souped-up ATs. Despite their proprietary (and costly) new technology, they do no more than match the performance of already available clones. The Microsoft Corp. Standard Edition of OS/2 (the long-awaited 286DOS/ADOS/MS-DOS 5.0), makes use of none of the PS/2 family's proprietary hardware features, is readily transportable to ATs, and runs MS-DOS applications more slowly than MS-DOS 3.2.

The PS/2 introduction will aid clone makers in another way as a result of IBM's concomitant restrictions on the distribution of the products. Just as when the company tried in the past to shut down gray-market channels it had, itself, created to dispose of excess inventory without lowering a product's retail price, former IBM dealers will continue to serve the demand—but with clones instead of IBM products.

cy link to the printer and prevents it from being used as a shared resource.

A high-resolution monitor, required to provide true WYSIWYG (what you see is what you get) display of a full page—or better yet two pages—is highly desirable, as is increased printer resolution. (Low-cost printers with 600-dpi resolution are starting to become available.) IBM-compatible PC manufacturers offering turnkey desktop publishing systems include: HP, IBM, AST Research Inc., Canon U.S.A. Inc., Cordata Technologies Inc., Daewoo Telecom Ltd. and Multitech Electronics Inc., which is changing its name to Acer Technologies Inc.

The leading PML, at least in terms of installed base, is Aldus Corp.'s PageMaker, the original PC-based product developed for the Macintosh-based LaserWriter. However, the long delay before the appearance of an IBM-compatible version created a window of opportunity for several others, notably Xerox Corp.'s Ventura Publisher, a fully featured language that is highly rated by the desktop publishing community.

Ventura Publisher's screen drivers are written in Intel Corp. 8088 assembly language to permit the program to run on an XT, whereas PageMaker requires an AT (or a PS/2 Model 30) and runs under Microsoft Windows. On an 80386-based system, Ventura is comparable in performance with Interleaf Inc. software running on a Sun workstation.

Like PageMaker, Adobe Systems Inc.'s Post-

Script is used in Apple's LaserWriter. However, it is also licensed by Allied Linotype and IBM and, with an April announcement of support by HP, appears to be in a commanding position.

HP's PCL page description language, used in the company's LaserJet printers, currently has the largest installed base. However, like Xerox, HP has adopted a policy of supporting any popular PDL, including the only serious competition for PostScript—a PDL from Imagen Corp. called DDL.

Similarly, Imagen has introduced a host-resident RIP, the PC Publisher Kit, that supports both PCL and DDL and can interface existing applications via printer emulation. Adobe is also diversifying, with a line-art production aid called Illustrator that complements Aldus's PageMaker.

### CAE/CAD workstations have a role

The low-cost, high-resolution graphics display of desktop publishing can be applied equally well to other graphics applications. According to Dataquest, the PC-based graphics product market will grow more than 50 percent per year through the end of the decade (see Graph), primarily in the CAE/CAD area. Bob Moore, vice president of marketing at Daisy Systems Corp. of Mountain View, Calif., sees the trend as positive in that, "The low cost and software base provided by AT-compatible products are an asset." However, Moore goes on to suggest, "The importance of the estab-



**3Com claims** its single-board, diskless 3Station, a PC-graphics workstation, delivers the performance of a PC/AT and expansion cards for networking, video, memory and I/O.

lished (proprietary) software, sales channels, support and customer bases of present workstation suppliers should not be underestimated."

Nevertheless, CAE-specific PC-based products will have a considerable impact on workstation manufacturers and their OEMs. As the widely used software packages get tightly integrated with the powerful image-processing and display capability becoming available in the MS-DOS operating environment, pressure will mount on the established suppliers. Most of the leading CAE/CAD system suppliers have already begun to offer PC-compatible products in addition to their Motorola Inc. MC680X0-based or proprietary systems. In a concrete example of the impact, Sun reduced the price of its 3/50 low-end workstation by 37 percent last March.

#### Compatible vendors fight back

Among IBM-compatible PC manufacturers that have already begun to introduce forward-integrated systems are Olivetti Advanced Technology Center Inc. and HP. Olivetti has 8086- and 80286-based Personal Engineering Workstations on the market, and HP has announced it will use PC products in offering across-the-board single-vendor solutions in the design-

## Profile of an IBM-compatible system supplier

Born in 1976, the same year as the personal computer, Multitech Industrial Corp./Acer Technologies Inc. has evolved from a parts and test equipment vendor into a supplier of high-performance IBM Corp.-compatible products to major OEMs and distributors. At its current production rate of just under 20,000 personal computers a month, the company is the largest computer manufacturer in Taiwan.

However, according to Edward Chang, chairman of the company's San Jose subsidiary, Multitech Electronics Inc., the goal is to become, "by 1991, one of the top three personal computer suppliers in Asia, one of the top five in Europe and one of the top 10 in the United States, achieving sales of over half-a-billion dollars."

Multitech has recognized that this objective can be met only by serving the broad value-added resale market. Its strategy for doing so has been, first, to develop technology that enhances the performance of its personal computers, then, to develop peripheral subsystems and drivers and, finally, to bring these elements together as integrated, application-specific platforms.

To implement this strategy more effectively, Multitech has assigned advanced R&D and systems-definition responsibility to its San Jose

operation (also established in 1976), while maintaining high-volume, low-cost manufacturing in Taiwan.

Multitech's U.S. operation currently houses 70 employees, 20 percent of whom are employed in ASIC (application-specific integrated circuit) design and communication R&D and system definition. Technical support, a full-fledged depot repair facility to support VARs, and the nationwide service provided by TRW Inc. account for another 20 percent, with the remainder engaged in marketing, sales and administration.

The personal computer products shipped during the first half of the year included:

- The 710, a 4.77-to-10-MHz PC/XT-compatible in a chassis with the same small footprint as the IBM PS/2 Model 30 but offering four, rather than three, expansion slots. It has up to 768K bytes of memory on the motherboard (vs. 640K bytes), integral serial and parallel ports, a flexible disk controller and graphics and room for two 5¼-inch half-height storage devices and an internal 3½-inch drive.

- The 910, a 6-to-10-MHz PC/AT-compatible with the same footprint as IBM's PS/2 Model 50, up to 1M byte of memory on the motherboard, a 1.2M-byte flexible disk drive and optional 40M-byte and 80M-byte rigid disks. It offers twice as many (six) expansion slots; three half-height, 5¼-inch front panel

automation market.

The trickle of CAE/CAD-specific products from PC manufacturers this year will become a torrent next year. As 80386-based CAE/CAD platforms proliferate, they will reach deep into the market now served by workstation manufacturers like DEC, Sun, Apollo Computer Inc. and Prime Computer Inc. At least one CAE industry analyst has forecast that PC design-automation systems will outnumber engineering workstations by a greater than 2-1 ratio by 1988. As a result, companies that have developed extensive CAE/CAD software will be forced to port it to integrated PC-based platforms, abandoning a good deal of their present hardware.

There is a real question as to how many kinds of non-PC workstations the market will support. DEC's position seems secure, but there is going to be a shakeout among the rest—and a battle royal between Apollo and Sun.

#### Link to networking and connectivity

An early example of a forward-integrated network product is the 3Com 3Station, introduced last April. This diskless, AT-compatible terminal with a built-in Ethernet connection supports Hercules, monochrome, CGA (color

graphic adapter) and EGA (enhanced graphics adapter) graphics with up to 4M bytes of memory. It replaces an AT and three or four expansion cards with a 14-by-14-by-3-inch package that consumes about 25W and, not requiring a fan, is silent.

The high level of integration and large on-board memory permit programs to execute 25 percent to 30 percent faster than on an AT with the same 8-MHz clock and one wait-state. A few PC manufacturers already offer diskless ASCII terminal replacements, and the networking equivalents are not far behind.

The step from standalone application-specific platform to network server is a short one, and integrated servers can be expected from many PC manufacturers. Capabilities beyond those of the familiar file and print servers will be brought to LANs and multiuser systems. For example, as an alternative to replacing terminals, integrators may choose products like Logi-craft Inc.'s 386 WARE. That's an Ethernet-based multiuser DOS server that permits eight VT terminals in a VAX system to run MS-DOS programs. Many other VAX-compatible PC-based workstations/servers are under development.

HP currently offers two PC-based connectiv-

**There is a real question as to how many kinds of non-PC workstations the market will support.**

slots; and one for an internal 3½-inch rigid disk. It boasts a second serial port in addition to integral serial and parallel ports, a flexible disk controller, a clock/calendar and graphics.

- The 1100, a 16-MHz Intel Corp. 80386-based, 3,400-Dhrystone system that provides 1M byte of motherboard memory with 16M bytes of total capacity and eight general-purpose expansion slots. It offers room for two half-height storage devices in addition to the standard 1.2M-byte flexible and 40M-byte (80M-byte and 130M-byte optional) rigid disk drives in a desktop configuration.

On the subsystems front, the company has completed development of 12-inch and 14-inch dual-frequency monochrome monitors and both standalone and add-in 2,400 baud modems with X.25 and Systems Network Architecture support. The modems are Hayes Microcomputer Products Inc.-compatible. Then there is a printer fully compatible with the Hewlett-Packard Co. LaserJet Series II, featuring full-page bit-map and vector capability yielding two to three times faster printing for mixed text and graphics. An Adobe Systems Inc. PostScript-compatible version will be offered before the end of the year.

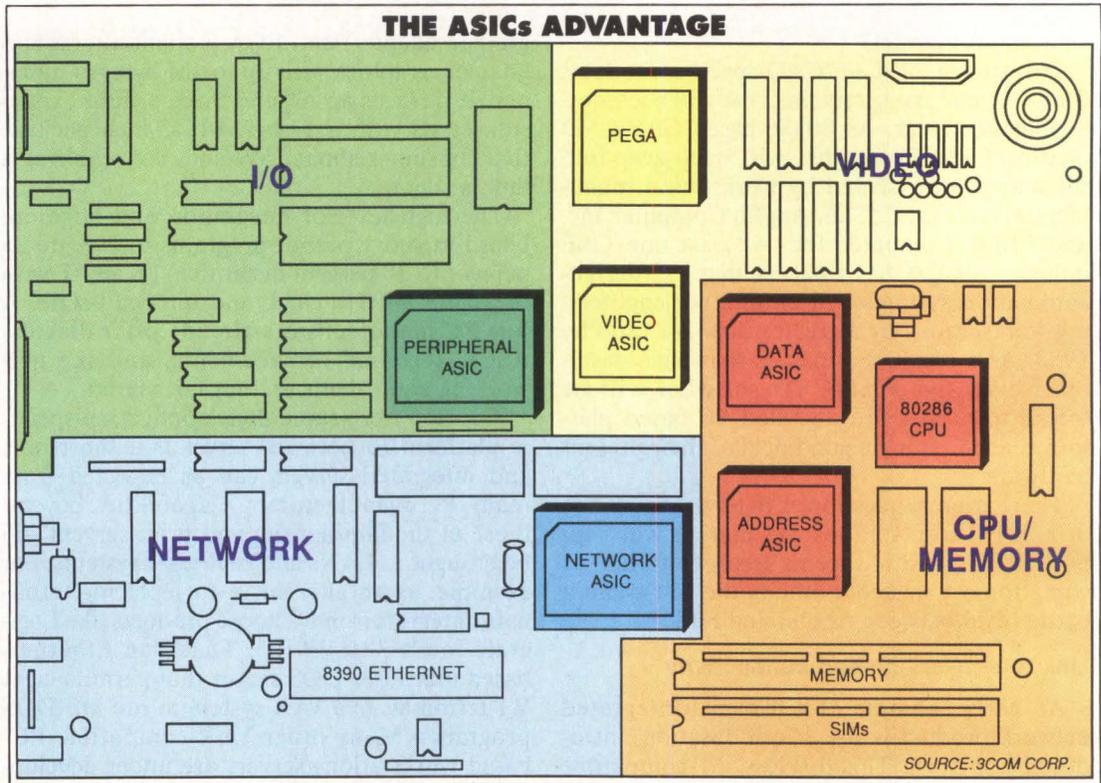
Also during the second half of this year, a 19-inch, high-resolution (1,280-by-960 pixel) color graphics display; an HP ScanJet-compatible scanner; and an IBM Net-BIOS-compatible local area network will be

added to the in-house capability.

The company also is putting together packaged systems for desktop publishing, CAD, CAE, etc. A turnkey desktop publishing system announced in May has the same footprint, page-makeup software and print engine as IBM's Personal Publisher System SolutionPac, but sporting a display with twice the resolution to provide true WYSIWYG presentation, at less cost.



**Multitech Electronics Inc.'s San Jose facility houses technical support, depot repair, sales and administration.**



**3Com's 3Station shrinks the equivalent of an IBM Corp. PC/AT into seven custom ASICs—requiring less board real estate.**

ity products for use in conjunction with its 3000 Series systems: the Vectra 3000 terminal-emulation workstation and the Vectra-Office, which adds electronic mail and host connectivity to the standalone AT-compatible Vectra. In addition to its CAE-specific systems, Olivetti has tailored its personal computer products for financial-service applications, including personal banking systems, teller terminals and user-friendly automated teller machines.

IBM's choice of the XT-compatible PS/2 Model 30 for its initial desktop publishing product notwithstanding, the savings in cost is so small compared with the greater benefits of an AT-compatible compute engine, that the latter will dominate for application-specific implementations. Thus, the baseline requirement is for a scalable, AT-compatible product line offering advanced PC technology. Established application-specific software standards like

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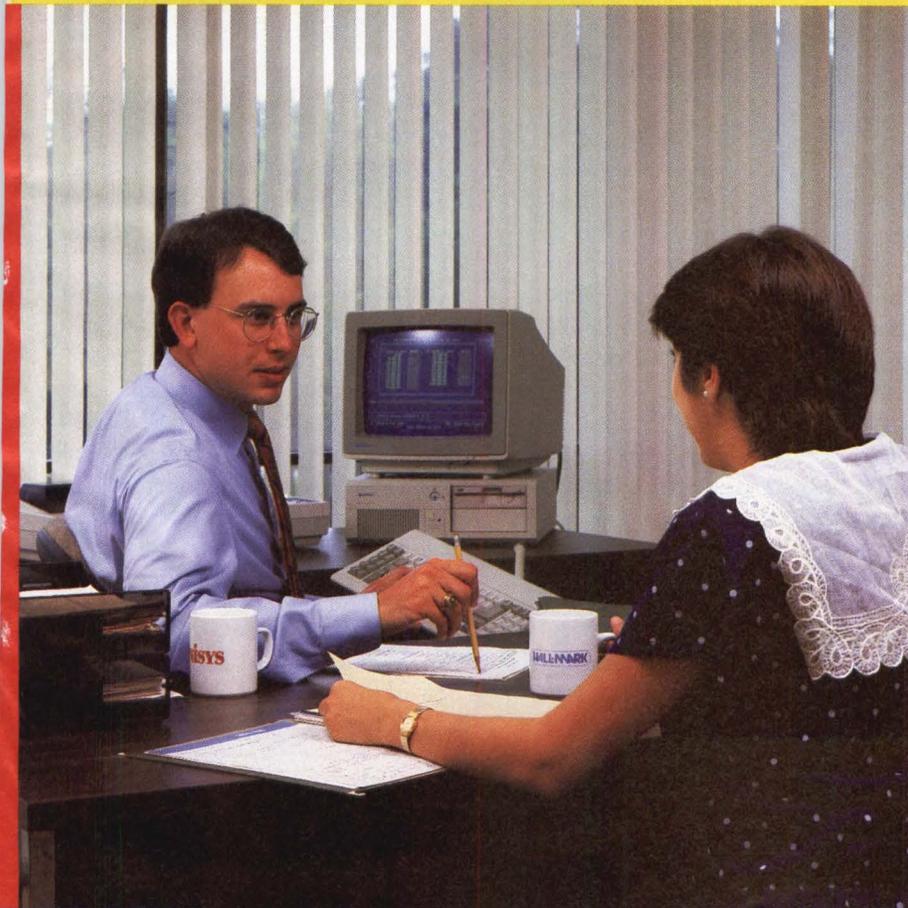
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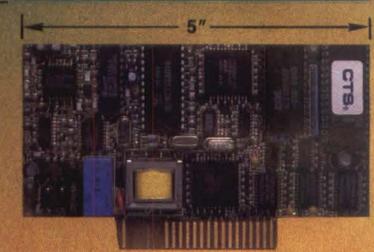
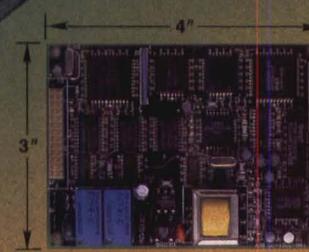
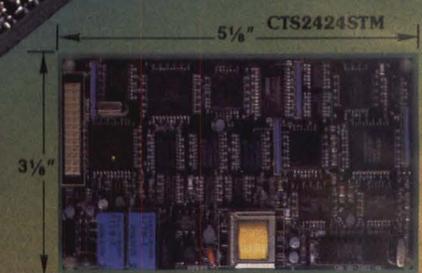
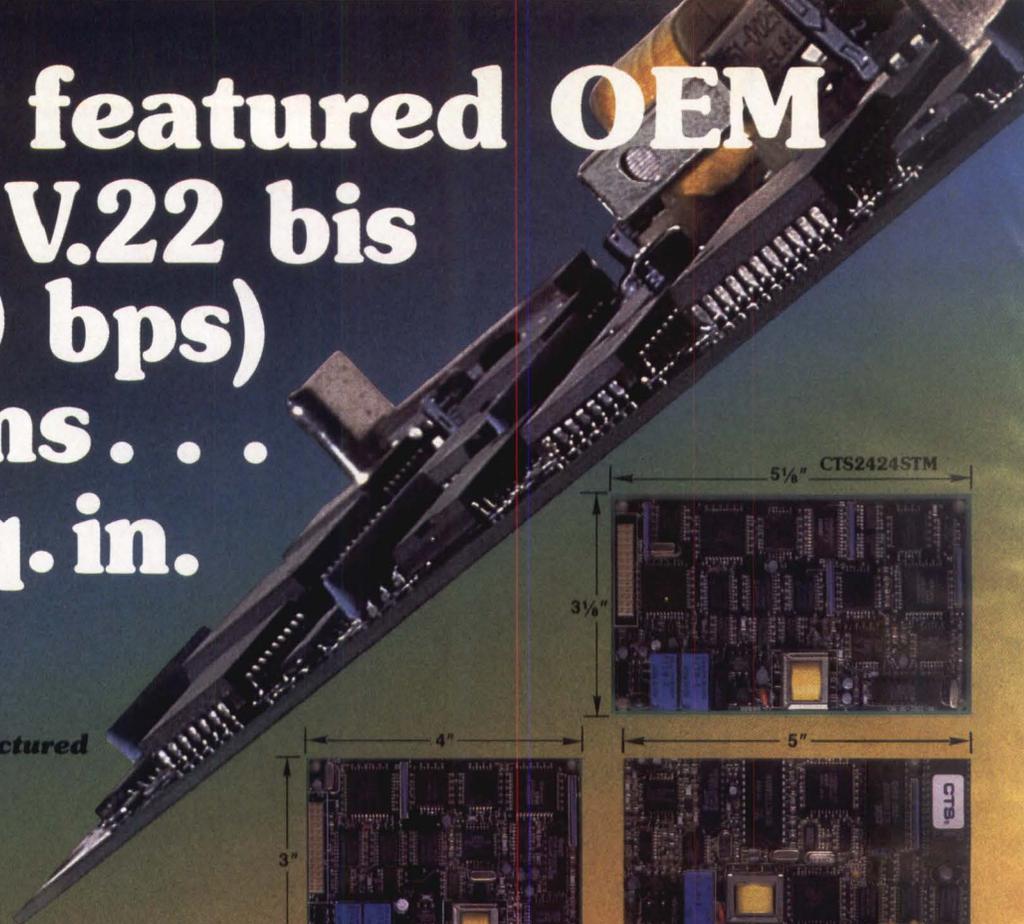
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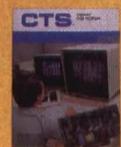
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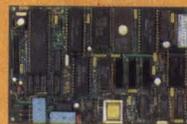
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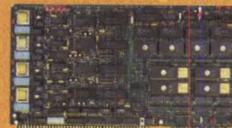
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those discussed above must also be supported, preferably by the system supplier.

Although high-volume (and hence low-cost), production capability is desirable, it implies, at least for the present, overseas manufacture. As a result, the breadth and depth of local support in the geographical areas served by the reseller are a consideration. Resellers of forward-integrated systems rely upon the manufacturer for more than the prerequisite technical support and depot repair capability. Furthermore, the rapid development of PC technology, products and markets within the United States make domestic research and product planning almost indispensable.

Major IBM-compatible PC manufacturers with extensive U.S. R&D capabilities include Daewoo Telecom, Olivetti—which established the Advanced Technology Center in Cupertino, Calif., in the early 1970s—and Multitech (see “Profile of an IBM-compatible system supplier”). Unlike the other two companies, Daewoo established its presence by acquisition: ASIC (application-specific integrated circuit) manufacturer ZyMOS Inc. providing component capability and Cordata systems, development and marketing.

The enhanced performance and single-point responsibility offered by application-specific platforms come at a price. As the proprietary content of a PC-based platform increases, the reseller becomes more dependent upon the supplier, both for support and for product enhancement. Thus, resellers must carefully evaluate the level of commitment on the part of suppliers, to the PC market as a whole and to resellers in particular.

There is, of course, some risk that (as has happened frequently in the minicomputer market) suppliers may conclude that they can bypass the VAR. However, in the case of PC-based systems the risk appears to be fairly small. For one thing, PC products and technology are widely available. For another, the manufacturers have need for diversified channels for distribution and end-user support. Nevertheless, in addition to becoming familiar with the type and depth of support provided by suppliers, astute resellers will also want to evaluate a supplier's overall PC market strategy. □

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**Andrew Allison** is a management consultant specializing in minicomputer and microcomputer technology, products and markets. He had been more than 12 years with Digital Equipment Corp., Rolm Corp. and Advanced Micro Devices Inc., before founding his business in 1977.

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The PM/286 gives you more options. It's easy to add up to 24 users. With the PM/286, you can use IBM PCs,\* other compatibles or TeleVideo diskless workstations. Our \$999 diskless workstations feature built-in network connections, so installation is as easy as plugging them in.

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We maximize your software investment because the PM/286 runs a custom version of Advanced NetWare/286,\* and is compatible with virtually any single user or multi-user application written for MS DOS, NetWare or NETBIOS. We also support the key programming languages.

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**CIRCLE NO. 42 ON INQUIRY CARD**

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1185 and 1186 LISP processors support an 80186 coprocessor card that allows the execution of MS-DOS software and data exchange between LISP and MS-DOS programs. And Texas Instruments' MC68020-based coprocessor card runs TI's version of UNIX System V in its Explorer LX and provides transparent access to UNIX and LISP files.

The Explorer LX's integrated AI and numeric processors suit process control and other applications requiring knowledge-based analysis of data. Data-acquisition equipment transmits information to the 68020 processor, while a "watchdog" knowledge system identifies problems and recommends corrective action.

Such an integrated application is possible because the Explorer LX's UNIX coprocessor card provides multitasking for up to 16 users or devices. The users communicate with the LISP processor via shared physical memory or remote procedure calls. Shared memory allows LISP and UNIX applications to share access to data without moving the data from one processor to another. As a result, knowledge systems can watch the execution or modify the memory of UNIX applications.

**Delivery systems ease costs**

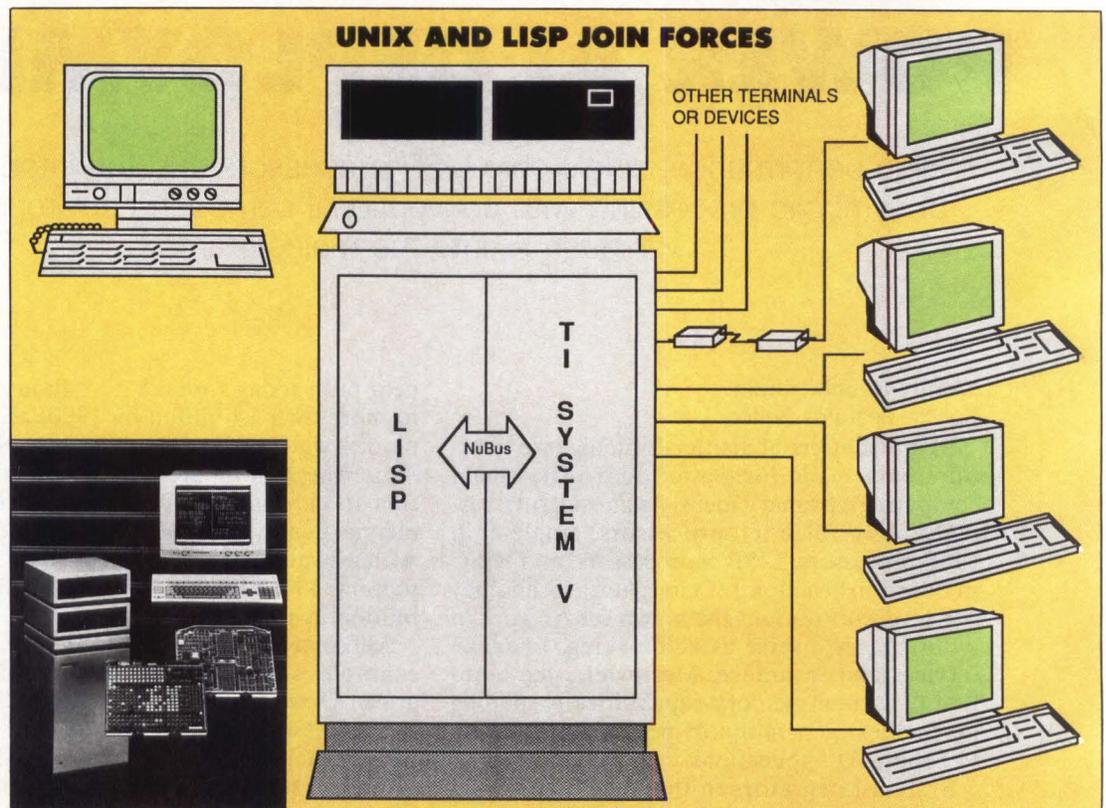
The development of delivery machines is one factor decreasing LISP machine prices. For example, the base price of the Xerox 1185

delivery system is \$10,000. The 1186 development machine sells for \$20,000. Both machines are microcoded for LISP instructions but get economies of scale by using the same hardware (processor, circuitry, etc.) used in Xerox 6805 office products.

Symbolics also sells delivery and development machines for \$31,000 to \$36,000 based on semicustom gate-array technology. In addition, a subset of the Symbolics Common LISP environment will be licensed to run on Intel Corp. 80386 personal computers or workstations, thereby providing a low-cost delivery environment for AI applications developed on Symbolics LISP machines.

A second reason that LISP machines have become cheaper and smaller is an increase in the number of functions implemented in VLSI. For example, Xerox is working on a single-chip VLSI processor, designed to execute the Common LISP programming language and the CommonLoops object-oriented programming techniques. The chip features a 40-bit tagged architecture and a small instruction set, although it is not a RISC chip because it has some complex instructions. Xerox plans to implement the chip in boards for use as stand-alone LISP machines, as a coprocessor board in other Xerox machines or in embedded systems—such as intelligent instrument controllers and online-diagnostic equipment.

**The Explorer LX, (inset) from Texas Instruments, integrates in a single chassis the complete Explorer Lisp machine with multi-user, multitasking UNIX that accommodates up to 16 different channels.**



# Is Your Graphics Terminal?

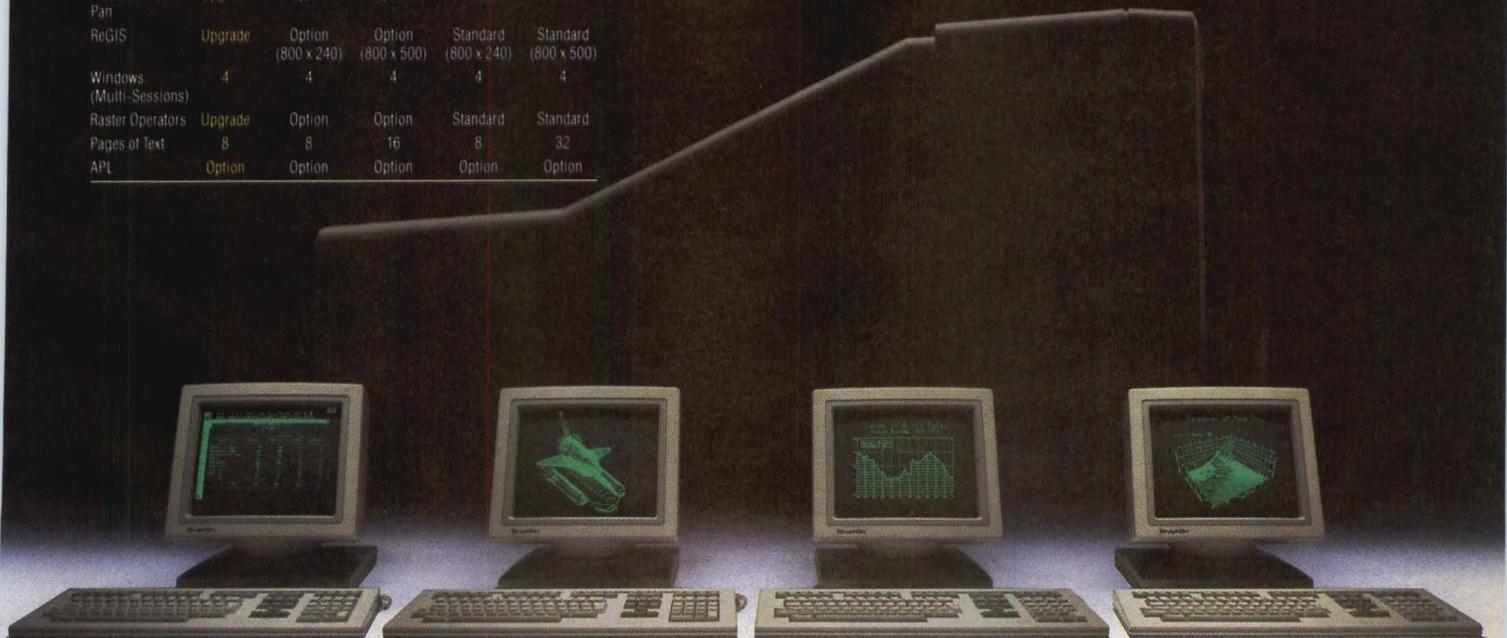
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Windows (Multi-Sessions)	4	4	4	4	4
Raster Operators	Upgrade	Option	Option	Standard	Standard
Pages of Text	8	8	16	8	32
APL	Option	Option	Option	Option	Option



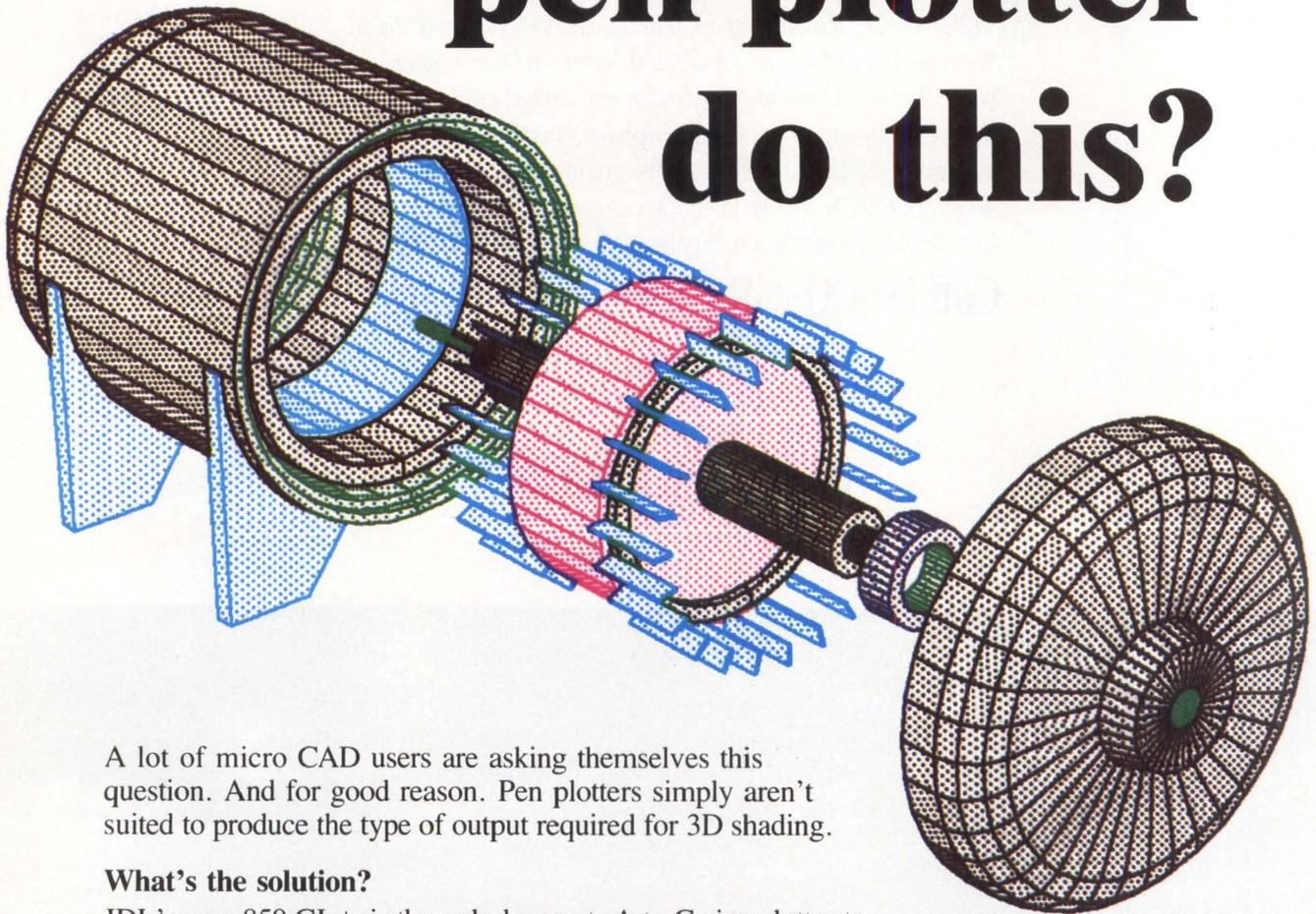
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CIRCLE NO. 44 ON INQUIRY CARD

TI also is leveraging its VLSI prowess to make LISP machines more cost-effective. Under contract to the Defense Department's Defense Advanced Research Projects Agency, TI designed and built a VLSI-based LISP CPU. This 553,000-transistor, 1.2-micron CMOS device reduced 60 percent of the original Explorer's two-board LISP processor into a single chip. A military version of this chip is designed into what TI calls a Compact LISP Machine, which is built for very high performance and ruggedized specifications.

#### Limited price drop expected

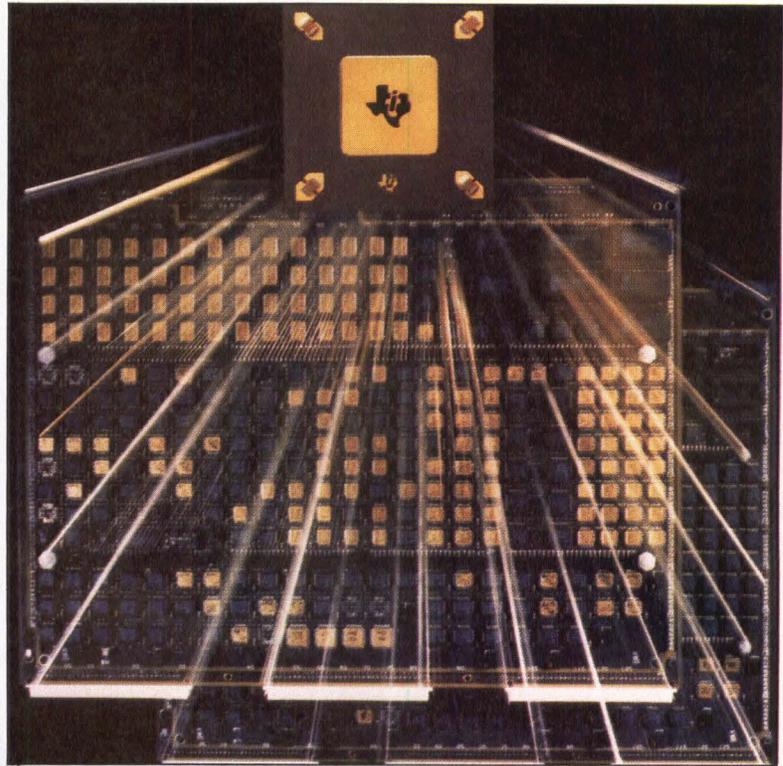
TI's commercial AI strategy is exemplified by its Explorer II, a standalone LISP machine designed around a LISP-processor board containing a standard version of the LISP chip. The Explorer II began shipping in July. It delivers more than five times the performance of the earlier Explorer at a similar price. The prices range from \$56,000 to \$85,000 dollars, depending on configuration. The performance increase is partly due to the LISP chip hardware and partly to features in the Explorer's new software, Release 3.0. These features include new optimized microcode, a more efficient garbage-collection scheme, improved compiler optimization, and a new performance-tuning procedure that significantly reduces disk paging. Application software is object-code compatible between Explorer and Explorer II, and the Explorer is upgradeable to the Explorer II.

The Explorer's II's price is expected to decrease over time. However, price decreases for LISP machines must be somewhat limited, because LISP machine prices include prodigious amounts of physical memory and disk storage. Unfortunately, potential users evaluating AI machines often overlook the fact that conventional computers configured for AI cost about the same.

TI also plans to use the LISP chip-based processor board as a symbolic coprocessor board. This board would be customized to plug into both TI's and other vendors' conventional computers.

#### LISP boards embedded in computers

Symbolics also has mounted an intensive VLSI implementation of the company's entire LISP processor on a single CMOS chip. The chip, which Symbolics hopes will yield three to five times the performance of the existing Symbolics machine, could be available in mid-1988. Performance, however, was only part of Symbolic's design goals. Connectivity and making it easy to embed boards containing the chip into multivendor conventional computers were



major factors driving its development (see "The chips Symbolics built").

The integration of LISP and conventional computers inside a single chassis is a non-trivial engineering feat, because the architectures and memory-handling methods of LISP processors and conventional computers are so different.

Even though Symbolics' original 36-bit word LISP machines had a 4-bit tag, eight bits have been needed for some time. Therefore, the new LISP chip was designed with a 40-bit word: 32 bits for data and addresses, and eight bits for a tag field.

The longer tag field has two major benefits. First, it simplifies programming because it eliminates the need to obtain the effect of eight tag bits from a 4-bit field by assigning different meanings to the four tag bits, depending on the program execution mode. Second, the expanded tag field results in 16 times more address space than is available in Symbolics' 3600 series LISP machines. Programmers have had to devote four bits of the 3600's 32-bit data and address space to use as extra tags. This effectively left the 3600 with only a 28-bit address field.

Compatibility between the 40-bit-word LISP chip and an industry-standard 32-bit bus is not a problem, because the entire LISP machine (including the LISP microprocessor, interface chips and memory) resides on its own board.

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**Texas Instruments' VLSI-based Explorer microprocessor employs 553,000 transistors to pack 60 percent of the product's original two-board LISP processor onto a single high-performance custom chip.**

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This means that the LISP-processor board can perform all the LISP processing by accessing only its onboard memory. Therefore, there is no need to send 40-bit words across a 32-bit bus.

The LISP and conventional computer boards normally communicate across the bus just to exchange data. For maximum throughput, just before the data goes out onto the 32-bit bus, the interface software shears off the tag bits and ships out a 32-bit word. Similarly, when data or messages are received, the interface software pops on the tag bits.

#### **Traditional computers support AI**

Cost and integration requirements also underlie the enormous push that conventional-computer manufacturers have made into AI. For example, Apollo Computer Inc., Digital Equipment Corp., Hewlett-Packard Co., IBM Corp. and Sun Microsystems Inc. made AI a major focus. These companies offer general-purpose workstations. The microprocessors central to these workstations are becoming

more powerful and able to support AI. Clock rates are going up. On-chip caches and memory management units are speeding memory access time.

Garbage collection (cleaning out old data) is still a problem because the architecture of standard microprocessors does not support data tagging. (A tagged architecture, a feature of LISP machines, is necessary to distinguish a pointer, or address, from data.) Symbolic-co-processor accelerators that offload a significant portion of garbage collection from the CPU are possible future solutions. Meanwhile, available bits in the Intel 80386 and Motorola Inc.'s 68030 on-chip, paging unit's page descriptors (and Motorola's 68881 memory management unit for the 68020) can provide some interim help. Application developers can use these bits to classify and tag pages on a page-by-page basis. The idea is to classify the pages according to the length of their lifetimes. This speeds garbage collection because it narrows the areas to look for garbage.

These advantages also apply to the emerging

## **The chip Symbolics built**

To facilitate integration with conventional computing environments, Symbolics Inc.'s LISP architects designed the company's new LISP chip with three major goals in mind.

First, all LISP processing had to be contained on a single-board computer so the processing could be isolated from the conventional computer's bus. This was necessary because the LISP processor has a 40-bit word size with an 8-bit tag field, while target conventional computers have a 32-bit word and bus size with no tag field. Sharing the same bus for memory accesses would result in bus bottlenecks and decreased throughput.

Containing all LISP processing on a single board dictated that the second goal be to fit 100 percent of the LISP processor onto a single chip. Otherwise, there would not be enough room on the board for memory, I/O, bus interfaces and other chips and circuitry in a LISP computer.

The third goal in making integration practical was to provide a programming language, rather than microcode, to perform the LISP-board integration tasks. Microcode is used in traditional LISP machines to define the machine's instructions, its integrated, graphical environment and other features. The microcode is fast and, since it is implemented in RAM or programmable ROM, it is modifiable. However, a lack of available development tools and debugging aids makes programming with microcode difficult. What system integrators needed was an assembly language (a LISP subset on LISP machines), such as

standard microprocessors provide, or a high-level language (full LISP).

Assembly language on standard microprocessors is based on a microcoded instruction set burned into the chip. Unfortunately, microcoded instruction sets used on LISP machines are generally too large to be burned into a single-chip LISP microprocessor and still leave room for all the other LISP processor functions. Therefore, the Symbolics LISP chip architects had to prune the instruction set to a smaller size.

The most obvious way to prune the set was to offload microcoded instructions dealing with such functions as graphics and floating-point computation onto special-purpose graphics and floating-point processors. Other instructions that were identified as rarely used (using statistical code-analysis techniques) were removed, but were emulated in a macrocode routine at the LISP level. Execution-speed losses for these instructions were compensated for by other optimizations.

The one penalty that Symbolics anticipates for the macrocode-based LISP machine is loss of the flexibility to microcode the machine to perform specialized tasks. However, this loss may not be important in a commercial market. For example, microprocessor vendors do not usually sell microcodable microprocessors.

The rest of the chip architecture was designed to occupy minimal space, achieve maximum performance and provide the components expected

generation of PCs because they incorporate the same microprocessors. For example, IBM's new PS/2 Model 80 and Gold Hill Computers' HummingBoard (developed by AI Architects), which plugs into IBM PCs, are designed around the 80386. However, the Apple Computer Inc. Macintosh II is based on the 68020.

Even more important, these PCs will finally incorporate virtual memory—a necessary feature for memory-hungry serious AI programs. "Any attempt to use AI programs on a machine without virtual memory is deeply misguided," says Scott Fahlman, senior research computer scientist at Carnegie-Mellon University. Fortunately, the 80286, 80386 and 68030 support virtual memory, as does the 68020 with the 68881. What held back software for so long in the non-virtual-memory world was the lack of virtual-memory support by MS-DOS and the Macintosh operating system. However, UNIX on the new PCs supports virtual memory; so does OS/2, but to what degree is still uncertain.

The move toward integration of AI with numeric computing has been accompanied by a

move toward delivery of AI systems on workstations running UNIX and the C programming language. The HP 300 series workstation is an example of the next-generation level of integration of AI and numeric computing.

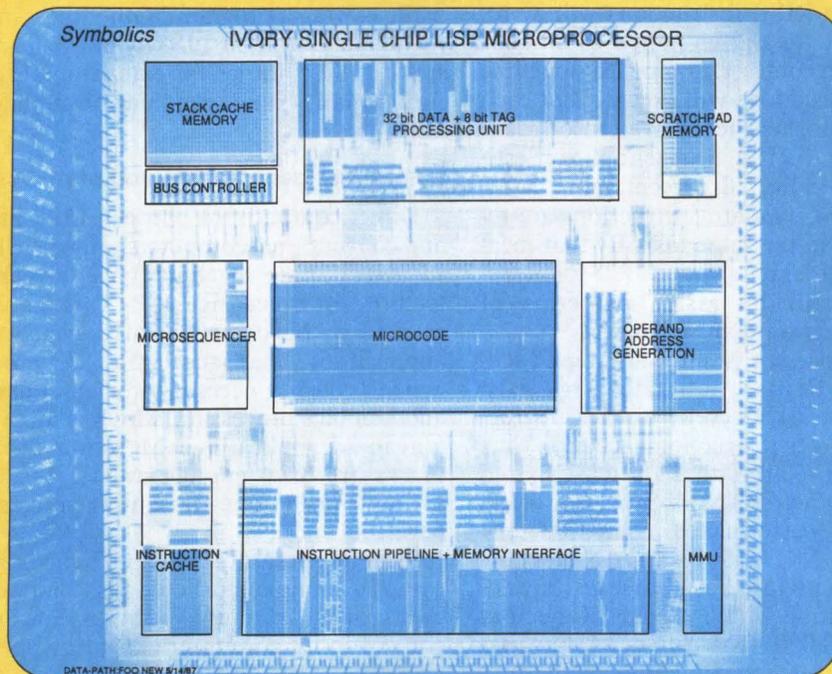
The HP workstations tightly integrate an AI development environment, Common LISP, Prolog, and object-oriented programming with HP-UX (HP's implementation of UNIX System V) running C, Pascal and FORTRAN. Tightly integrated means that the AI system provides the same development capabilities for C, Pascal, FORTRAN and UNIX as it does for LISP and Prolog.

As a result, programmers can incrementally and interactively develop, edit, compile, test, and execute C, Pascal, FORTRAN, LISP and Prolog routines from a single editor (see MMS, February, Page 91). Not only does the editor check LISP syntax and match parentheses, it also checks C, Pascal and FORTRAN programming constructs. Just as the editor performs error checking for LISP, it catches compile errors in C, Pascal and FORTRAN. Without

on standard microprocessors. Like the Intel Corp. 80386 and the Motorola Inc. MC68030, the LISP chip includes the virtual memory-management unit on the chip to speed physical-to-virtual memory mapping. An on-chip instruction cache maintains a high instruction-execution rate. A four-way interleaved memory interface on the chip allows a standard MOS memory to supply the processor with instructions or data four times faster than the nominal cycle time of

the memory.

Other on-chip components include a stack cache, hardware support for garbage collection, on-chip error checking and correction, and on-chip message dispatching to facilitate implementation of object-based software like Flavors. That is not to mention on-chip support for LISP function calls and returns, which is a major source of performance optimization.



**Symbolics new LISP chip** incorporates an entire LISP machine on a single chip with the microcode burned into on-chip ROM, and on-chip support for virtual memory, parallel tag processing, garbage collection, instruction cache, stack cache, interleaved memory interface, function calls, message dispatch and vector instructions. It is expected to be available in mid-1988.

leaving the editor, programmers can fix the errors and execute the traditional program. Then, because the non-LISP object-code files are linked to the LISP system, developers can interactively evaluate their C, Pascal and FORTRAN functions, use immediate feedback to determine a function's behavior, and re-edit the function.

LISP programmers do not have to learn UNIX to develop UNIX-based programs or subroutines. Similarly, UNIX programmers who are newcomers to LISP can develop LISP, Prolog and conventional-language programs using familiar UNIX tools.

#### Everything under the Sun

Unlike LISP machines, engineering workstations are not microcoded for LISP execution. In the past, this meant that they could not match LISP machines for performance. However, with the increasingly powerful microprocessors and fast LISP compilers, workstations have turned out to be very competitive.

Looking to make its workstation performance even more competitive, Sun Microsystems' based its Sun-4 workstation family on a RISC architecture. RISC-architecture machines are characterized by simple instructions designed to execute in one machine cycle. If the microcycle time of the machine compares to that of a Symbolics machine, the speeds may also compare.

Direct comparisons of speed, however, are difficult, because RISC instructions are simpler than standard microprocessor instructions. Therefore, more RISC instructions will be required to execute in a given period of time for the same task. In contrast, fewer LISP-machine or standard instructions will execute, but each instruction performs the equivalent of more operations than a RISC instruction. Sun estimates that, typically, 20 percent more RISC instructions than standard instructions are required to perform the same task. By that measure, Sun considers its Sun-4 RISC microprocessor to still be faster in terms of cycles-per-instruction than its Sun-3s.

The RISC processor is a 1.5-micron CMOS chip based on Fujitsu Ltd. gate arrays. On average, it devotes 1.35 cycles to each instruction with an average instruction-execution time of 81 nsec. Sun claims that its RISC-based Sun-4/260 using a 16.67-MHz processor offers about 10-MIPS performance, compared to 4 MIPS for the 25-MHz, 68020-based Sun 3/260.

An entry-level RISC-based diskless monochrome workstation with 8M bytes of memory costs about \$40,000. The Sun-4 RISC workstations are source-code compatible with Sun's current family of 680X0 computers, and the

Sun-3/200 series can be upgraded to the Sun-4 via a single board swap.

Despite performance increases, when RISC machines are used for AI, their speed may be offset by other factors. For example, RISC machines (and standard workstations) cannot simultaneously achieve maximum speed and data-type checking because data-type checking, which helps insure program correctness, slows speed. Nor does RISC-machine hardware support garbage collection.

Such differences in efficiency make little difference to many workstation users looking to run AI. Their point is that, unlike early AI days, current microprocessor technology has made standard workstations acceptable for many knowledge systems. Beyond that, most users are not looking at standard workstations for performance; they are looking for general-purpose machines that can run multiple types of new and existing conventional and AI applications.

To optimize the Sun-4 and Sun-3 workstations for AI, both the Sun-4 and Sun-3 workstations will host a new Symbolic Programming Environment (SPE). The SPE, a set of LISP development tools built on top of Sun Common LISP, is based on the same style of tools developed at the Massachusetts Institute of Technology for LISP programming. The tools include LISP Listener (a window-based debugger), Data Inspector (to check LISP data structures), a single stepper (for line-by-line execution of LISP source code) and a source-code analyzer (to follow the control of flow while editing a program). Other tools in the set include a Common LISP window manager, a set of LISP libraries for extending the editor's functionality and application-management tools.

#### Misleading benchmarks and statistics

Direct comparisons between LISP machines and conventional computers can be misleading. In general, LISP machines have the best architectures for executing LISP. This fact is often masked by benchmarks not designed for real applications. They ignore most I/O processing, which is clearly necessary for all applications, and graphics processing, which is often important to AI applications. Moreover, the benchmarks are brief enough not to run into the high-overhead, time-consuming process of garbage collection.

System integrators using benchmarks to compare computers should also beware of figures that measure unlike things. For example, conventional-computer execution speeds for programs that perform type checking at compile time may be faster the execution of pro-

**The microprocessors central to these workstations are becoming more powerful and able to support AI.**

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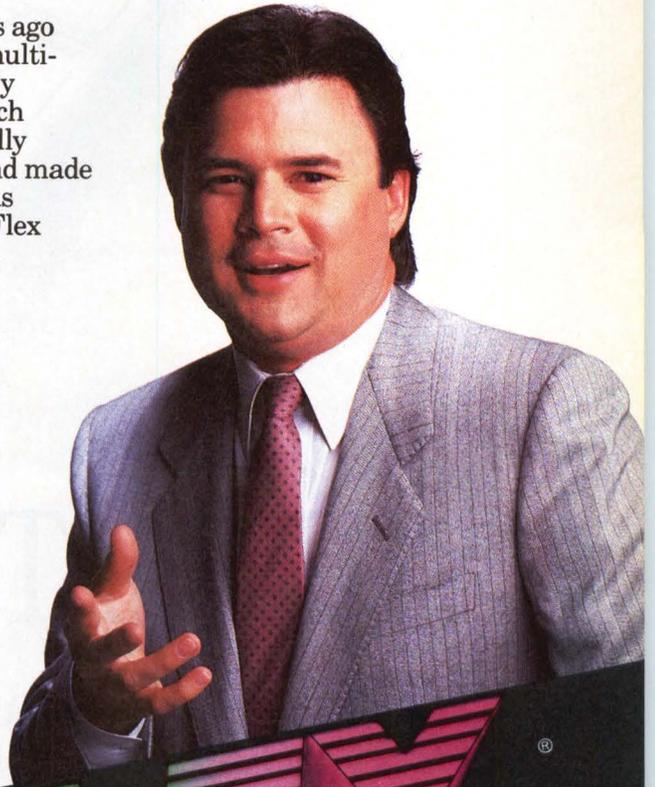
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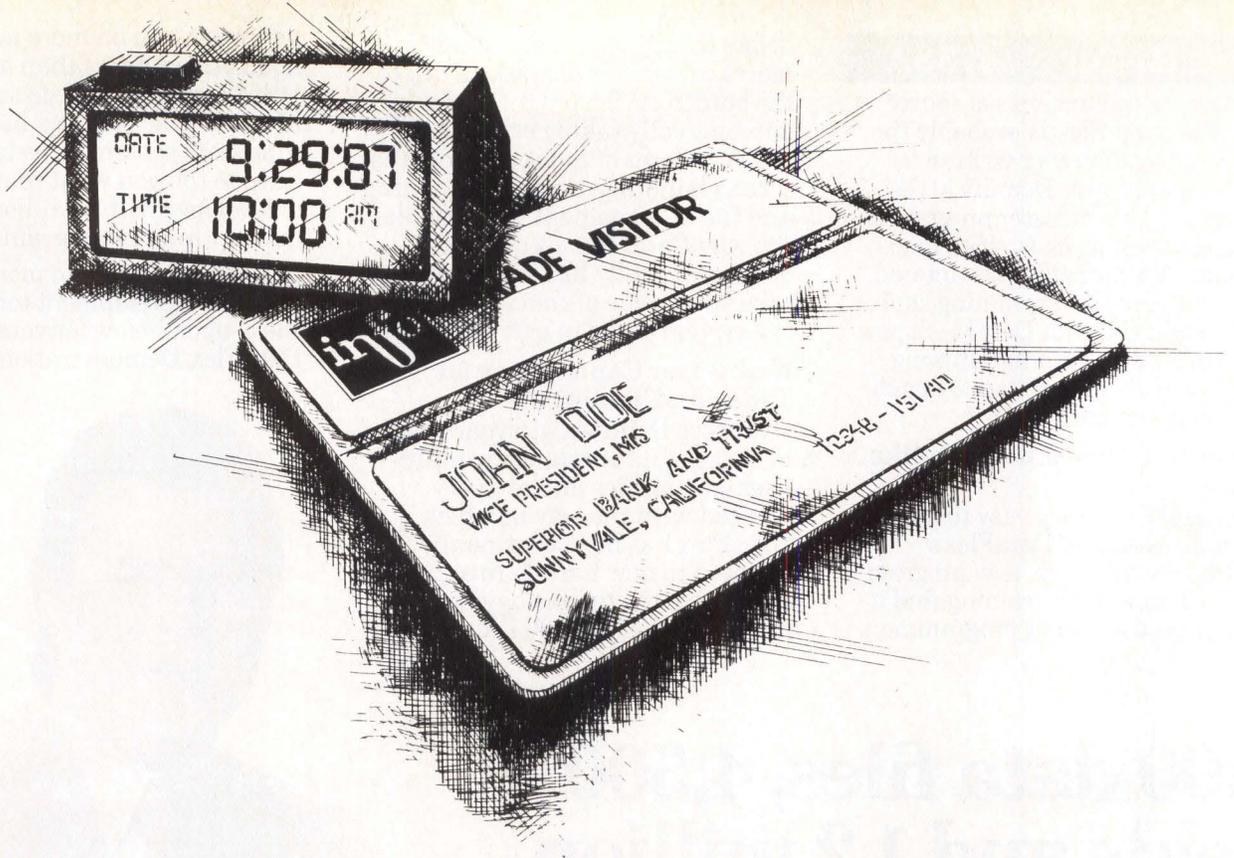
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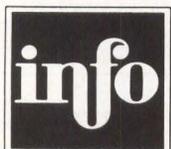
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grams, where type checking is performed at run time. A more valid comparison, would require type checking for the LISP-machine program to also be performed at compile time; in which case, the LISP machine would generally be faster.

Another benchmark pitfall is the comparison of program execution-times where time may be based on user CPU time, system CPU time or total elapsed time. User CPU time, a common measure of time on multiuser systems, measures how much time is spent in the application program. System CPU time measures the time spent in the operating system kernel on behalf of the application program. Total elapsed time, the common measure on LISP machines, is the time the program took from start to finish. On a LISP machine, the operating system kernel and application are so tightly integrated that it makes no sense to distinguish between user and system CPU time. On a multiuser system, however, the distinction is viable.

Direct price comparisons between LISP machines and traditional computers can also be misleading. For example, serious LISP applications on any machine usually need huge amounts of main memory (2M bytes to tens of megabytes) and disk storage (hundreds of megabytes to several gigabytes), which LISP machine prices may include. When these peripherals are added to engineering workstations, the workstations may cost more than LISP machines.

To make matters worse, a conventional machine that emulates the architectural features of LISP machines in software may end up needing more code and therefore require more memory. For example, IntelliCorp recommends that KEE 3.0 run in 12M bytes on a Sun worksta-

tion. However, KEE runs in only 4M to 8M bytes on the Explorer.

### The best hardware to choose

Neither vendors nor users have yet agreed upon the best hardware path to travel, because the data demonstrating what is viable is not all in. However, users' experiences have generated some general rules about what kind of AI is suited for the different classes of machines.

Diagnostics, for example, seems to be an application that can successfully run on PC/AT class machines and workstations. Planning and scheduling applications, however, appear to be in the state that diagnostics applications were in about two years ago. They are less understood and more complex, because they have many more goal states and require more knowledge-representation methods. Consequently, planning and scheduling applications are implemented mostly on LISP machines. Configuration applications seem to be right in the middle and they have been turning up on workstations and minicomputers.

A still-unsolved AI computer issue is security. IBM's Richard Ten Dyke, assistant for business-analysis products and technology, notes that most people want to use a workstation connected to a mainframe. How the work will be distributed between the workstation and mainframe remains an open question. However, many people who view knowledge as a corporate asset do not wish to distribute that asset so that one day their knowledge base can walk out the door and go to a competitor. □

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**These PCs finally will incorporate the virtual memory necessary for serious AI.**

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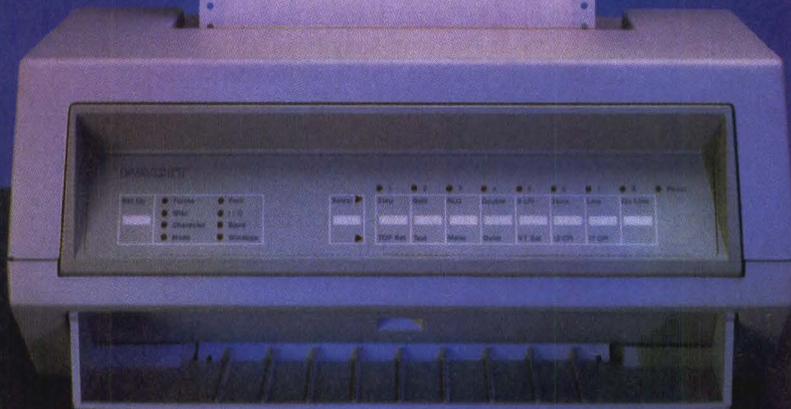
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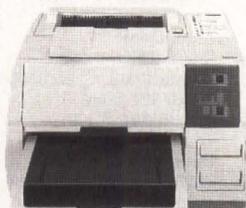
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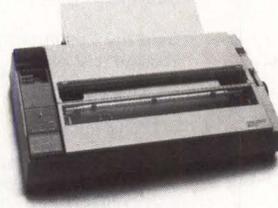
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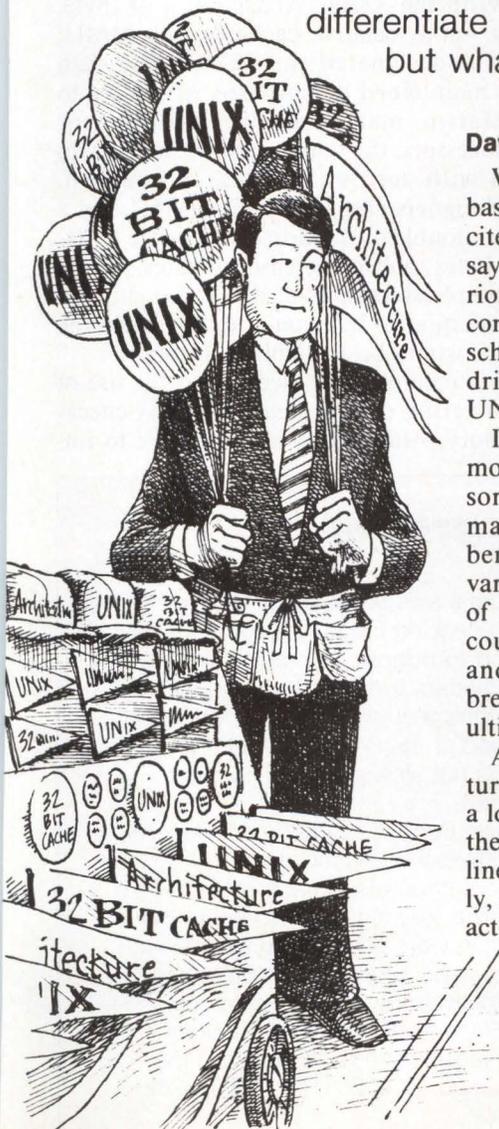
Manufacturers of UNIX and XENIX multiuser systems differentiate their machines with technological wrinkles: but what do their resellers really care about?

**David Simpson**, Senior Editor

What distinguishes one multiuser, UNIX-based microcomputer from another? End users cite cost, speed and name recognition. Resellers say it's the supplier's support, service and superior applications. And manufacturers stress a confusing array of performance factors: caching schemes, memory-management units, disk drive and interfacing strategies and unique UNIX implementations.

In choosing, or switching, multiuser systems, most value-added resellers begin by trying to sort out the often-conflicting claims of the manufacturers. Then they perform extensive benchmarks on their own and evaluate the various "standard" benchmarks (with a grain of salt). But in the end, it's often deep discounts, name recognition, quality of service and support arrangements and product-line breadth that determine which supplier a VAR ultimately signs with.

Although there are more than 50 manufacturers of multiuser systems (see Product Table), a look at how the major suppliers differentiate their machines provides resellers with guidelines for handicapping the field. Not surprisingly, most manufacturers tout architectural characteristics as the keys to performance.



**Although more expensive to implement, ECC reduces downtime in multiuser applications.**

For example, Texas Instruments attributes much of its new Intel Corp. 80386-based System 1300's performance to a 16K-byte cache memory on the main system board. The cache uses 1M-bit dynamic RAM with 70-nsec refresh rates. This caching scheme, TI claims, reduces 80386 processing to zero wait states.

"We noticed in our preliminary benchmark tests that the 80386 has inherently two to four wait states per CPU cycle," explains Raymond Hartfield, product marketing manager in TI's computer systems division, data systems group. "If you add 8K bytes of cache, you reduce that to one to two wait states. And if you add 16K bytes, you reduce the CPU's wait states to zero."

#### Cache size considered

However, the optimum cache size for multiuser systems is a matter of debate because, as the cache size increases, the hit rate increases but not proportionately. Increasing the cache from, say, 2K to 8K bytes greatly increases the hit rate, but as Altos Computer Systems' vice president of systems marketing and planning, Jeff Bork, explains, "Going from 16 to 32K, you pick up maybe another 4 or 5 percent in hit rate, but going over 32K gives you only a 1 to 2 percent hit rate increase." Altos uses a 32K-byte data and instruction cache in its new 80386-based Series 2000 machine (MMS, June, Page 25).

VARs should also be aware of how cache size influences benchmarks. Many benchmark programs are much smaller than typical application programs (often only 1 percent to 2 per-

cent the size of the user's actual application). As a result, benchmarks can exaggerate the effectiveness of caches because, if the program fits into the cache the hit rate approaches 100 percent and yields misleading results.

Another architectural element some manufacturers consider important in differentiating their machines is the MMU. For example, Convergent Technologies Inc. attributes much of its claimed speed advantage to a proprietary MMU on its Motorola Inc. MC68020-based S/Series machines. "With it, we generally match or exceed our 12.5-MHz machines the performance other companies get on their cached 16-MHz machines," contends Dick Nisley, director of marketing.

AT&T Co. considers its cache-MMU scheme to be one of the more innovative additions to its new 32200 microprocessor. (Current AT&T multiuser systems are based on the 32100 processor.) With the 32200, AT&T put a 4K-byte, two-way, set-associative cache on the MMU, which was designated the 32201. The data cache is maintained in hardware. According to Arlon Martin, market segment manager for microprocessors, the scheme allows memory to respond with zero wait states. In addition, system designers can put multiple MMUs in a system to double or quadruple the cache to 8K or 16K bytes and to increase hit rates. AT&T began sample shipments of the 32200 chips in the second quarter but would not say when the new chips would be available in systems.

Another memory consideration is the use of error-correcting code instead of parity-checking memory. Although more expensive to im-

## How to read the benchmark graphs

The test results shown in the graphs on the following pages were collected and written by Neal Nelson, president of Neal Nelson & Associates, using the company's Business Benchmark, a multitasking benchmark program that measures how a computer slows down under increasing processing loads. The Business Benchmark measures a computer's performance in 18 different categories, ranging from calculation-intensive to disk-intensive tasks. In each category a range of one to 100 simultaneous tasks can be executed. The time required for each task is recorded and the "degradation under increasing load" can be determined by plotting the completion times.

The graphs show how specific computers slow down under increasing loads when such factors as the amount of main memory, disk drives and interfaces, clock speeds and floating point units

change. The horizontal axis represents, from left to right, increasing processing loads; the vertical axis represents, from top to bottom, increasing time for the task to be completed. If the line pitches steeply, it indicates that the computer slows down significantly under increasing load. If the line stays 'flat,' it means that the computer is not slowing down as much under increasing load.

Complete, 18-page *Business Benchmark Reports*, available from Neal Nelson & Associates show comparisons of two computers in each of 18 categories tested. The test results included in the sidebars in this article were selected to illustrate particular processing and configuration problems. For a complete description of the 18 tests or more information about Business Benchmark, contact Karen McBride at Neal Nelson & Associates, 185 North Wabash, Chicago, Ill. 60601, (312) 332-3242.

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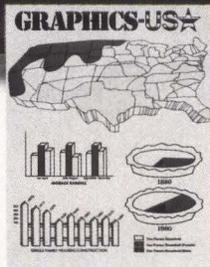
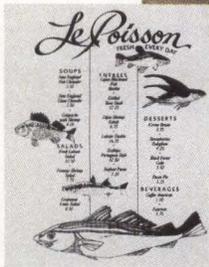
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plement, ECC reduces downtime in multiuser applications compared to parity-checked memory, which is used primarily in single-user systems.

### Disks cause bottlenecks

Memory management, caching schemes and error handling are extremely important in speeding up multiuser applications and reducing the number of disk accesses, but disk I/O itself can be equally, or more, important in I/O-intensive applications. Thus, a manufacturer's disk drive and interfacing options are other important criteria for resellers to evaluate.

"Disks have always been a bottleneck," says Scot Bouman, president of Quest Research, an Altos reseller in Burnsville, Minn. Bouman applauds Altos' use of enhanced small device interface (ESDI)-based disk drives, which he says approach the transfer rates of larger, more expensive storage module device (SMD)-based drives. Quest Research writes vertical-market software programs and sells Altos and Sun Microsystems Inc. hardware in two primary markets: wholesale distribution and office automation.

Altos' most recent systems use ESDI drives, but the company plans to use lower-cost small computer systems interface (SCSI) drives for

future entry-level systems. "We've found that ESDI tends to have higher performance," says Altos' Bork, "It takes a lot of work to get the performance out of SCSI, because there's a fair amount of overhead in managing the drives. In general, ESDI drives tend to be faster." Compaq Computer Corp.'s newer high-end models and IBM Corp.'s PS/2 systems use ESDI disk drives.

### UNIX by any other name

Another major area in which manufacturers try to distinguish their multiuser systems is in UNIX or XENIX implementations. No two UNIX versions are the same, although most comply to, or are compatible with, a standard. Not surprisingly, every manufacturer claims to have a better UNIX port.

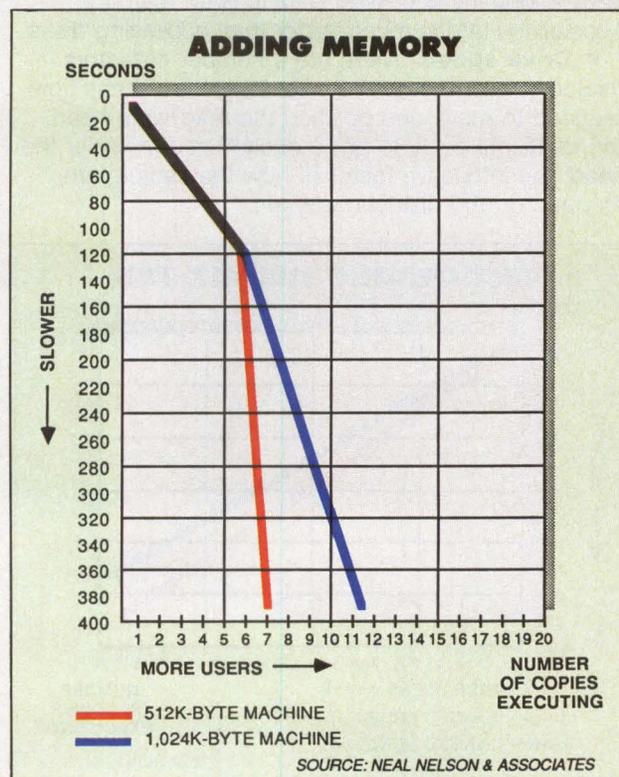
"We put more differentiation in the operating system than in anything else," says Convergent's Nisley. The company's CTIX operating system is derived from and compatible with UNIX System V. It includes enhancements such as dynamically loadable device drivers, which allow VARs to create device drivers that roll in and out of memory; built-in, user-configurable RAMdisk for read-only memory and scratch files; and modifications for real-time applications, including pre-emptive scheduling and priority locks on processes.

**No two UNIX versions are the same, although most comply to, or are compatible with, a standard.**

## More system memory, more users

Adding more main memory to a multiuser system most significantly benefits computers that page, or swap, programs back and forth from disks as they run out of available memory for user tasks. This swapping process not only significantly slows down jobs being swapped but also, by consuming system resources, slows down jobs that might not be swapping. A significant point to bear in mind is that, if the system has enough memory so that all active tasks fit without swapping adding more memory won't improve performance.

The graph compares the performance of a 512K-byte machine (red line) with a 1,024K-byte machine (blue line). At up to five active tasks, the lines coincide, indicating that the additional memory provides no benefit. Beyond five tasks, the 512K machine starts to swap, thus causing it to run two to three times slower than the 1,024K-byte machine.



**'Easy-to-use visual interfaces are a must.'**

Convergent also modified UNIX for I/O handling, while maintaining compatibility with the System V Interface Definition (SVID). "We maintain bit-map images in the kernel of all the volumes on disk and, when you're dealing with large records, we make sure that the records are in contiguous sectors," explains Nisley. Convergent also set up algorithms to do DMA (direct memory access) transfers from disk into the address space of the application, as opposed to the standard UNIX algorithms that require reading data into the operating system and then moving it to the application.

Stressing ease-of-use, Convergent offers the WorkGroup Solutions shell, in addition to the

Bourne and C shells. The WorkGroup Solutions shell, a terminal-independent, object-oriented visual shell, allows multiple concurrent windows. It suits UNIX-illiterate users, particularly in the VAR channel. Convergent also offers value-added dealer (VAD) kits that allow resellers to modify menus and windows for custom applications.

"The everyday user is not interested in UNIX," says NCR Corp.'s Ernest DeVane, assistant vice president in the OEM systems division. "Easy-to-use visual interfaces are a must." With the introduction of its multiprocessor Tower 32/800 (MMS, March, Page 33), NCR faced a difficult UNIX modification

### Smart controllers, faster data

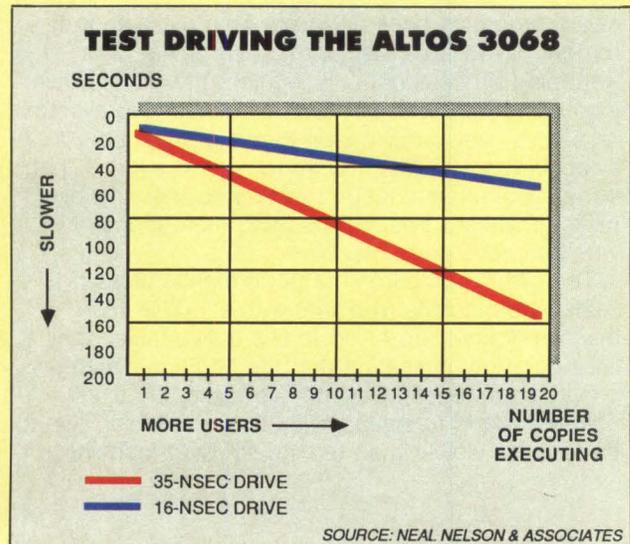
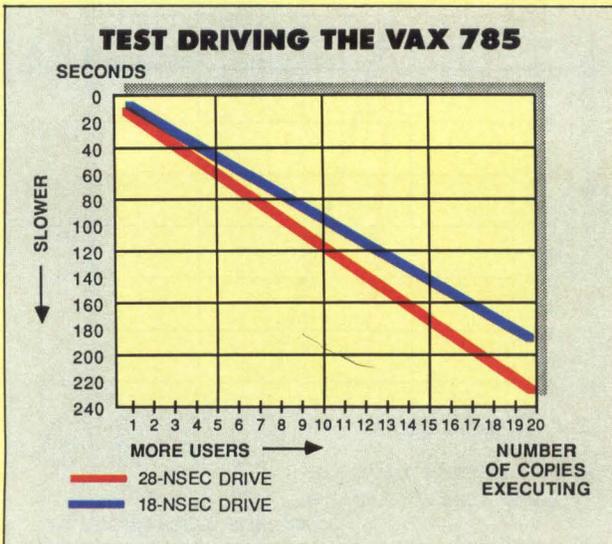
There are many different factors that affect how much improvement will result from installing a faster disk drive on a multiuser system. These include:

- **Drive interface.** The major interfaces, in the order of slowest and least expensive to fastest and most expensive, are ST506, SCSI, ESDI and SMD.
- **Transfer method.** Data transfer between the disk controller and memory. The slowest, least expensive and most inefficient method is the one-byte-at-a-time technique, used on IBM Corp. PCs. The fastest method is direct memory access (DMA).
- **Caches.** Use of disk buffers, or caches. Caches keep frequently accessed data in RAM memory. Accessing RAM is much faster than accessing disks.
- **Drive speed.** There are a number of factors related to a drive's speed, including the access time required to move and position the read/write head, the rotational delay to get a desired sector under the head, the interleave factor of how the sectors are mapped on the disk surface, etc.

Installing a disk drive that is "twice as fast" (which typically means that its average access time is twice as fast) will not necessarily make the system run twice as fast, because the data-transfer technique might be a bottleneck.

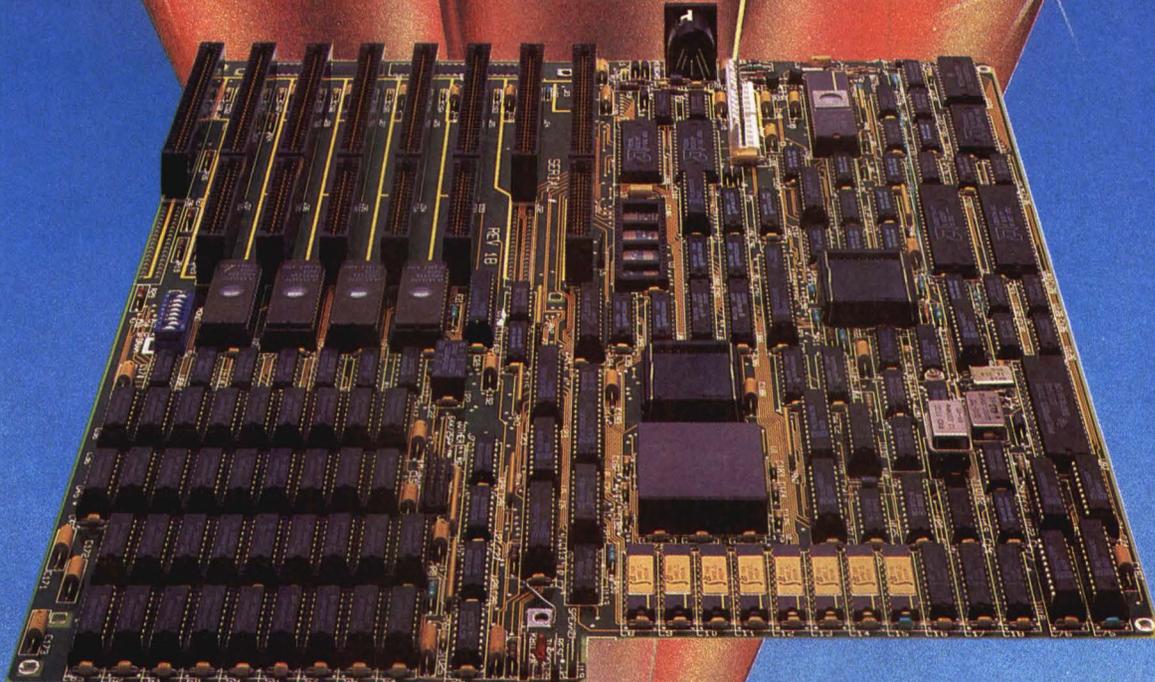
In the graph on the left, a disk drive with a 28-msec average access time (red line) was replaced by a disk with an 18-msec average access time (blue line). In each case, the drives were attached to a Digital Equipment Corp. VAX 785. In spite of the relatively significant difference in drive access times, overall disk I/O performance increased only slightly.

The graph on the right compares an Altos Computer Systems model 3068 that includes an ST506 controller running a disk drive with a 35-msec average access time (red line) to an Altos 3068 that includes an ESDI controller running a disk drive with a 16-msec average access time (blue line). As shown, using the faster drive and the more sophisticated controller results in a 200 percent improvement.



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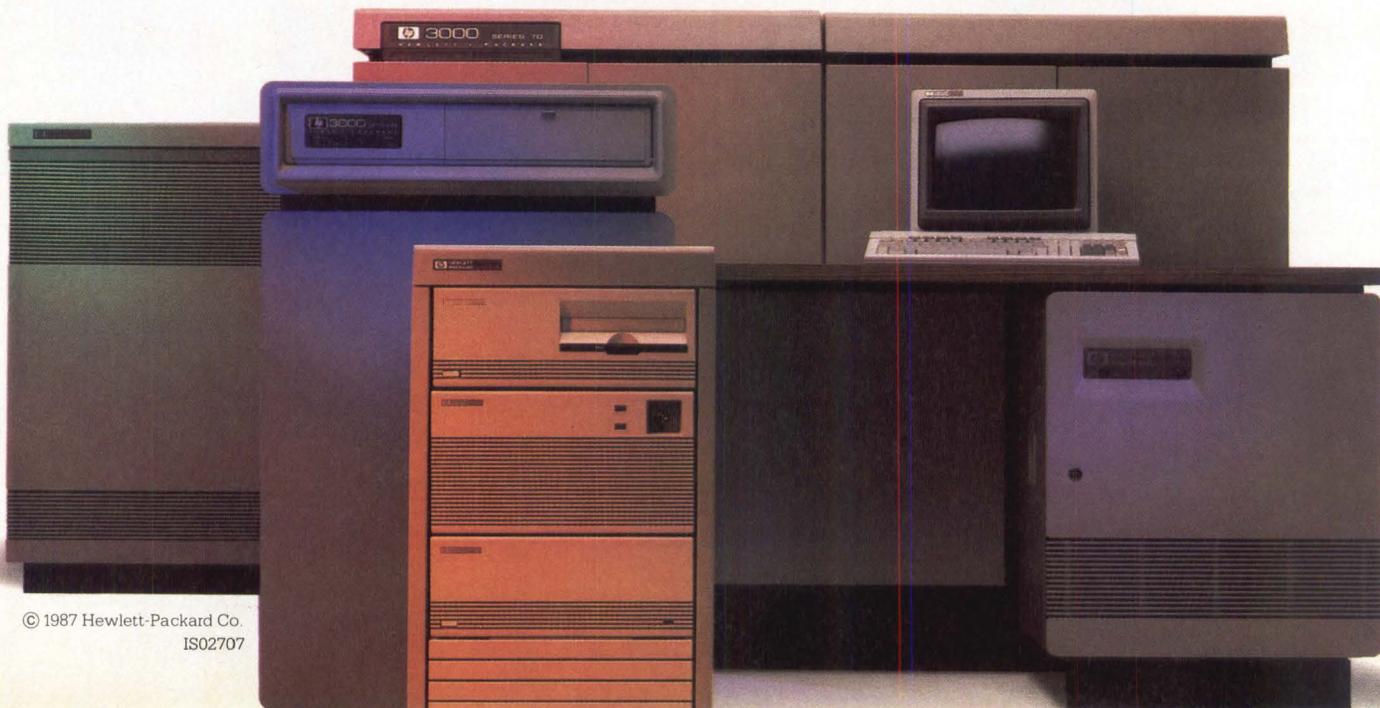
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The 32/800 can include as many as four 68020-based application processors, as well as up to four file processors, 16 terminal processors, two communications processors and one local area network processor, as long as the total does not exceed the 20 available slots. NCR sliced up the UNIX operating system and distributed tasks to the specialized processors. The company divided the UNIX kernel into non-I/O functions, which are executed on the application processors, and I/O functions, which are executed on the I/O processors. For example, I/O tasks are handled by kernel subsets residing in file, terminal, communications and LAN processors. The 32/800 operating system is based on UNIX System V.2 and complies with the SVID.

### Market converges on V.3

The multiuser market is standardizing on UNIX System V, although XENIX-based hardware is growing in share of the total UNIX market largely because of vigorous sales of IBM PC/AT-compatible systems. However, the difference between XENIX and UNIX is fading,

according to Altos' Bork. He contends, "When the migration goes to UNIX V.3, the two operating systems will come together." Altos plans to implement V.3 by the end of the year.

Earlier this year, AT&T joined with Microsoft Corp.—and The Santa Cruz Operation Inc. and Interactive Systems Corp.—to establish a standard UNIX porting base for Intel-based systems by merging XENIX and UNIX technologies.

Currently, the leading UNIX System V vendors are: Convergent (27 percent market share), Sun Microsystems (20 percent), AT&T (17 percent), Hewlett-Packard Co. (7 percent), NCR (5 percent) and Digital Equipment Corp. (5 percent), according to InfoCorp, a Cupertino, Calif., market research firm. Of course, UNIX machines from Sun, HP and DEC include single-user engineering workstations. In addition, a large percentage of Convergent's shipments consisted of the UNIX PC, few of which have been resold by AT&T.

In the XENIX world, Tandy Corp. leads the pack (40 percent market share), followed by IBM (22 percent), Texas Instruments (12 percent) and Altos (11 percent), says InfoCorp.

But competition in the UNIX arena will heat

**NCR sliced up the UNIX operating system and distributed tasks to the specialized processors.**

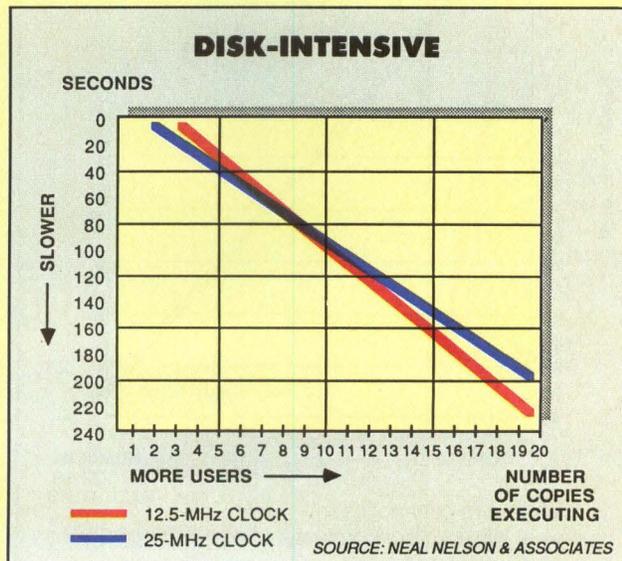
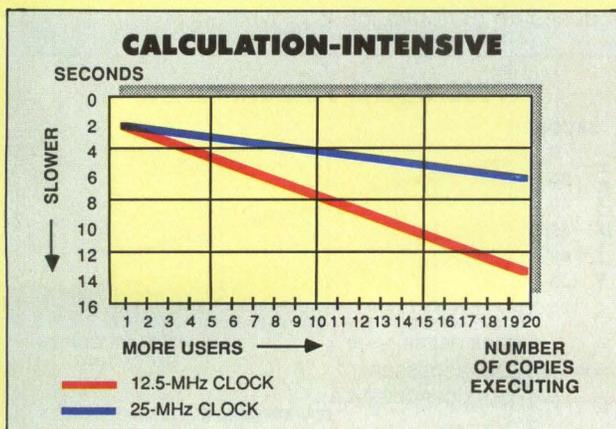
## Fast clock, fast crunching

Switching to a faster clock (or crystal) sometimes, though not always, results in significant speed increases. If the application is limited by character movement or calculation speed, a faster clock will make the application run faster. If, however, the application is limited by another factor, such as disk throughput for a database program, a faster clock speed may have an insignificant positive affect.

The graph on the left shows two Motorola Inc. MC68020-based computers from Convergent Technologies Inc. The red line shows a machine with a 12.5-MHz clock and the blue line shows a machine

with a 25-MHz clock. In this case, the test was calculation-intensive. As shown, the machine with a clock that is twice as fast runs the test twice as fast.

The graph on the right shows the same two machines performing a disk-intensive task. Doubling the clock speed results in only a slight (approximately 15 percent) eventual improvement.



**'In transaction processing, the name of the game is how fast you can make the disk go.'**

up significantly as heavyweights such as DEC, HP and IBM become more willing to supply UNIX, instead of their proprietary operating systems.

HP is committed to offering both HP-UX (its version of UNIX) and the company's proprietary MPE operating system. Likewise, DEC offers VMS or ULTRIX on its VAX line. Unisys Corp., on the other hand, is totally committed to UNIX, supplying it on a variety of OEM machines.

Resellers are still confused about IBM's UNIX strategy. When the company introduced the PS/2 systems in April, it announced that it would supply a version of its UNIX-like AIX operating system for the 80386-based Model 80. Pricing and availability is not due until the fourth quarter. And Big Blue did not endorse any particular brand of UNIX for the rest of its PS/2 systems. IBM currently ships a version of Microsoft's XENIX for the PC/AT. And AIX is the official UNIX for the RT PC. IBM's UNIX

strategies are spearheaded by the IX Systems Management Group in Austin, Texas.

Some companies buck the clear trend toward standardization, to get extra performance out of proprietary operating systems—risking continued compatibility with off-the-shelf third-party applications. Most such companies sell turnkey solutions, as opposed to relying heavily on VARs. One example is MAI Basic Four, which clings to its proprietary BOSS/IX operating system. The company's newest product is the 34-user, 68020-based MAI 3000 multiuser system.

"In transaction processing, the name of the game is how fast you can make the disk go," says MAI's Alan Kiehn, director of hardware engineering, "The physical limitations of the disks are common to all multiuser manufacturers, so the difference between machines is how effective the buffering is between the software file system and the physical disk."

In addition to the main disk cache, which

## Floating-point chips speed processing—sometimes

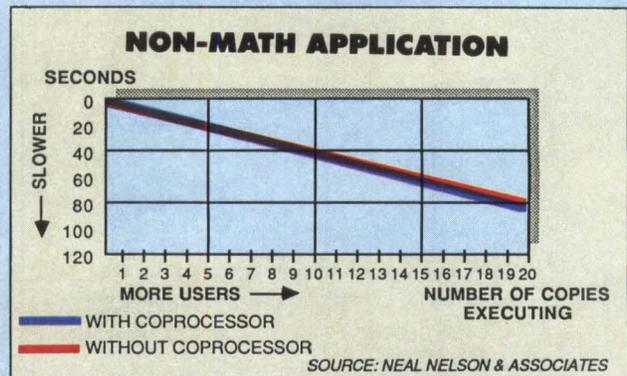
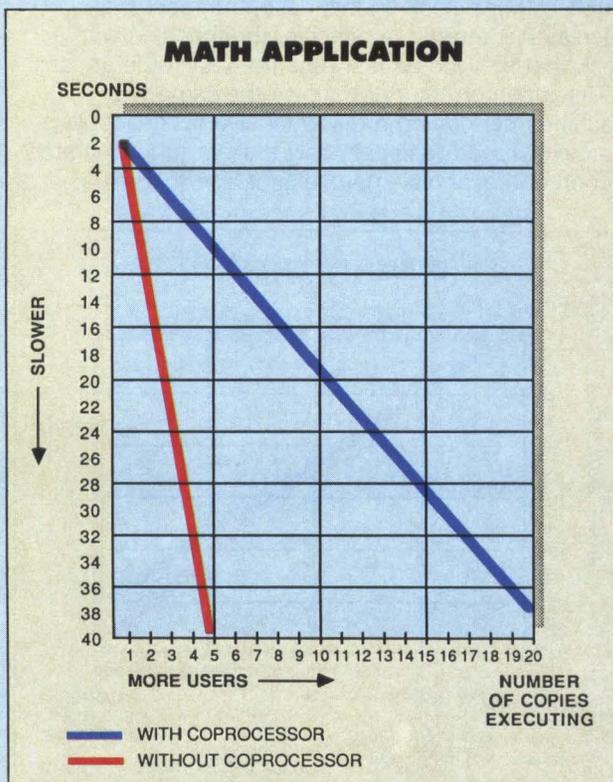
There are many types of hardware floating-point options that can be installed in multiuser systems. Some are very exotic coprocessors, and some are off-the-shelf chips that plug in to the system board.

It should be noted that, if the primary use does not

depend heavily on floating-point math, adding floating-point hardware may bring little or no improvement. For example, many database and word processing packages do not require floating-point calculations.

Custom floating-point options must be measured individually. However, a 200 percent to 300 percent improvement can be gained with common "plug-in" chips (such as the Intel Corp. 80287 or the Motorola Inc. MC68881) for tasks limited by floating point math.

The graph on the left shows a floating-point task running with (blue line) and without (red line) a floating-point chip installed. As shown, the performance improvement is significant. The graph on the right shows the same two machines (Altos Computer Systems 3068s) performing non-floating-point tasks; it is apparent that the additional cost of the hardware math capability produces no performance improvement.



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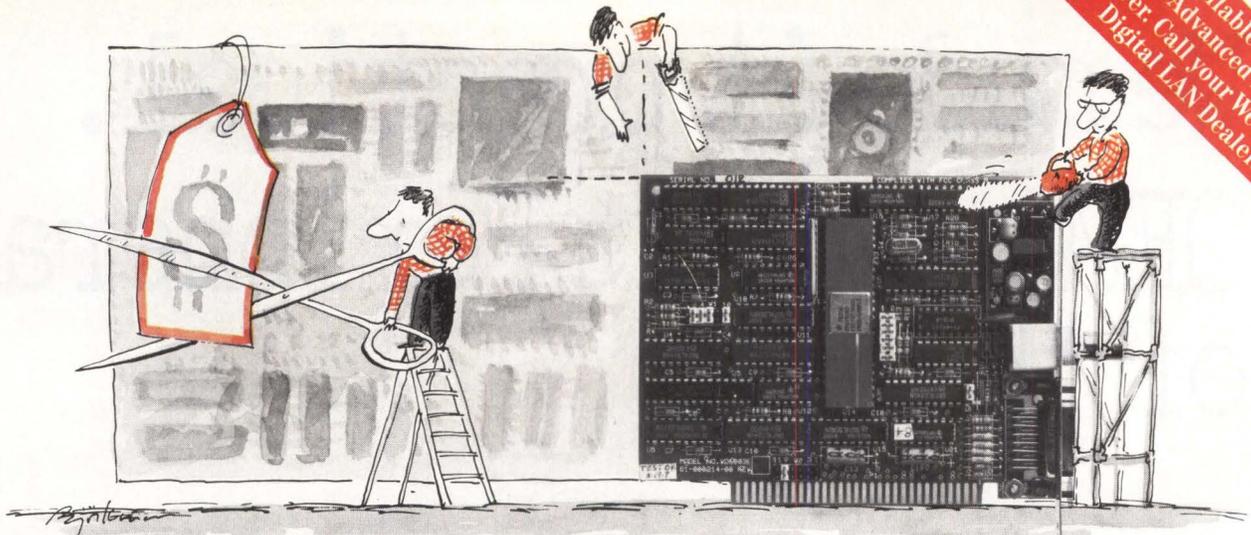
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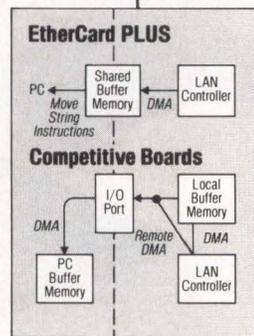
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**WESTERN DIGITAL**

CIRCLE NO. 53 ON INQUIRY CARD

works with blocks that are the same size as the disk blocks, MAI Basic Four has a secondary, or auxiliary, program cache that handles program overlays. The secondary cache can be as large as the programs require. The company claims that this extra mechanism in the operating system gives them about a 15 percent to 20 percent improvement over non-proprietary approaches. "This is one of the motivations to go with a proprietary version of UNIX rather than a standard AT&T UNIX," says Kiehn. "We can put in these performance enhancements."

### The best of the rest

Manufacturers emphasize a variety of other factors that they claim put their products above the masses. For example, NCR points to the automatic power-fail recovery and battery backup capabilities that come standard on its Tower line, eliminating the need for add-on uninterruptible power supplies. NCR also stresses its dial-in, remote diagnostics capabilities, with which VARs can dial in to a port on a customer's system, even while the system is in operation. NCR reports that, with this benefit, VARs can handle about 70 percent of all problems without calling NCR.

As does AT&T, Convergent stresses its networking and communications capabilities. For example, the company's Telecluster 422 option runs as fast as 1.8M bits per second (bps). Convergent terminals run at 305K bps over RS422 twisted-pair cabling, in contrast to ASCII terminals that run at 19.2K bps. Convergent also supplies Appletalk network cards on all systems.

And all manufacturers of multiuser systems proclaim the breadth of their product families and easy upgradability, a prime concern for VARs. However, as Altos' Bork warns, "Everyone says that, but, if you look closely, there are usually a lot of orphans in the family." All of Altos' 80286-based machines are field-upgradable to their 80386 machines via board swaps. Resellers can sell an upgrade from an 80286 machine (if it was purchased since April) to an 80386 machine for less than \$5,000, according to Bork. Altos claims that about 90 percent of all programs written for the company's earlier Intel-based systems will run on the 80386 machines, without modification. A few programs will require recompilation, and a few will require changes in the source code.

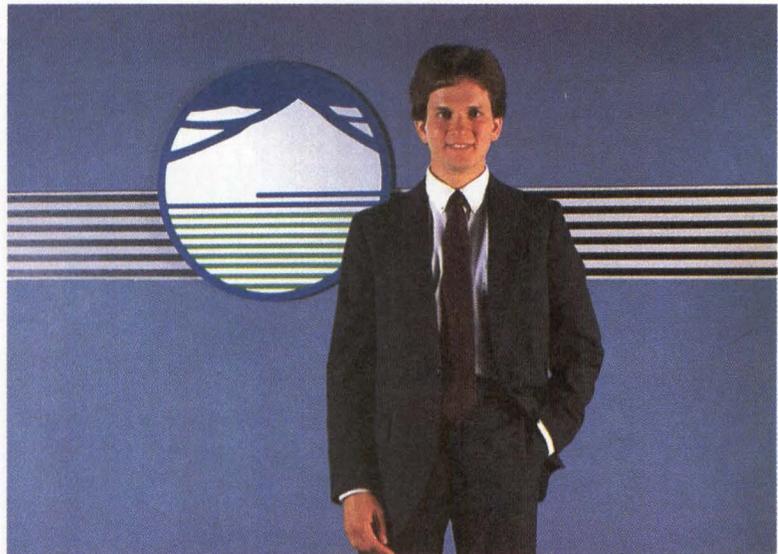
In fact, porting code from one machine to an upgrade machine is usually fairly straightforward. In the case of NCR, for example, taking code from a Tower 32/600 to a multiprocessor 32/800 requires slight code modification. According to DeVane, that typically requires just a few hours or days. Alan McConnell, senior

manager of marketing at Reynolds and Reynolds, a Dayton, Ohio, reseller of NCR equipment corroborates that assessment. "We've had no problems going to the 32/800," says McConnell. "Every once in a while, we have to recompile, that's about it." Reynolds and Reynolds sells customized software and computer equipment to automobile dealers.

### What do VARs want?

Despite technological razzle-dazzle and manufacturers' claims, very few resellers cite caching schemes, memory management, disk performance or UNIX modifications as the reason they selected a certain supplier. To most VARs, business relationships are far more important than machine architectures.

John Meek, vice president of product research at Timberline Software Corp., a Beaverton, Ore., Altos ASAP dealer, says that, "The main advantage is not hardware, it's the dedicated reseller channel." Altos, like Convergent, focuses only on the reseller channel, thus sidestepping sales channel conflicts that some-



times arise when a manufacturer's direct sales force competes with its reseller force. Meek explains that multichannel vendors often don't have competitive reseller programs.

Timberline writes vertical-market software, providing accounting packages to the construction, architecture and engineering, and property-management industries. Its dealer force, in turn, sells the software bundled with various hardware systems. "We wanted to expand our dealers, and the dealers wanted Altos," says Meek, adding that porting to Altos machines was fairly easy.

Name recognition is also important to VARs. David Whitestone, area technical manager for

**Resellers are still confused about IBM's UNIX strategy.**

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**"The main advantage is not hardware, it's the dedicated reseller channel."**—John Meek, Timberline Software Corp., an Altos ASAP dealer.

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**VARs rarely cite technological factors as primary vendor-selection criteria.**

Telic Corp., a Rockville, Md., TI VAR, cites name recognition as a primary reason for his company's selection of TI. "Altos is not a household word," he says, adding that name recognition is extremely important to skittish end users. Whitestone also counts benchmark performance, service and support, and TI's commitment to keep XENIX and UNIX implementations as compatible as possible as primary selection criteria. Telic, which also handles non-TI equipment, develops vertical-market applications for the telephone industry.

Bruce Riegel, president of Austin-based Computer Information Architects, another TI VAR, also cites name recognition as a key reason for selecting TI as a multiuser system supplier. Riegel adds that TI's national maintenance organization and cost-effective upgrade path were also prime reasons. CIA sells customized management solutions to the medical field. The company is also an IBM VAD and has installed its software on Tandy and Compaq machines.

Metroplex Data Systems, a Tandy VAR in Dallas, selected Tandy because of XENIX. Metroplex president Jerry Newton says that the

other primary reason was that Tandy has over 7,000 service facilities in the United States. Metroplex sells systems to the automated coffee service and vending industries. About 85 percent of its sales are Tandy systems, while the other 15 percent are XENIX-based IBM PC/ATs and Compaq machines.

However, underscoring the limitations of carrying XENIX systems that can handle only relatively small groups of users simultaneously, Metroplex recently became an NCR VAR to satisfy customers that need more users per machine.

#### More users on board

Sytek Inc., an NCR reseller in Mountain View, Calif., sells NCR Tower systems as network-management stations in its LAN products. Network managers use the Towers to plan, install, maintain and monitor the network. The machines are also used for network routing. Sytek currently uses the Tower XP (in its NCC 501 station, which is part of the LocalNet 2000 product line), but is evaluating more recent NCR offerings. Sytek's largest customer is Mountain Bell, which has a 10,000-node network that includes four Towers.

David Bayer, Sytek's senior product line manager, says that his company chose NCR because of compatibility with a previous machine the company was using (the now-defunct Momentum), aggressive discount schedules, good service and support and a wide range of products.

Communications capabilities are also important to VARs. For example, Intelus, a Rockville, Md., AT&T "Master VAR" chose its supplier because AT&T's 3B machines handled the communications requirements of the company's systems better than other available multiuser machines. Intelus sells turnkey systems that use bar codes for paper tracking, primarily in the health care and insurance industries. The second main reason for choosing AT&T, according to company vice president Howard Tischler, was name recognition.

VARs rarely cite technological factors as primary vendor-selection criteria. However, they do cite benchmark performance which is, of course, directly related to the technology implemented in a particular machine. Thus, VARs should be aware of machine architectures, but in the end will usually give more weight to factors such as the manufacturers' name recognition, technical support and service, survivability and VAR discount schedules. □

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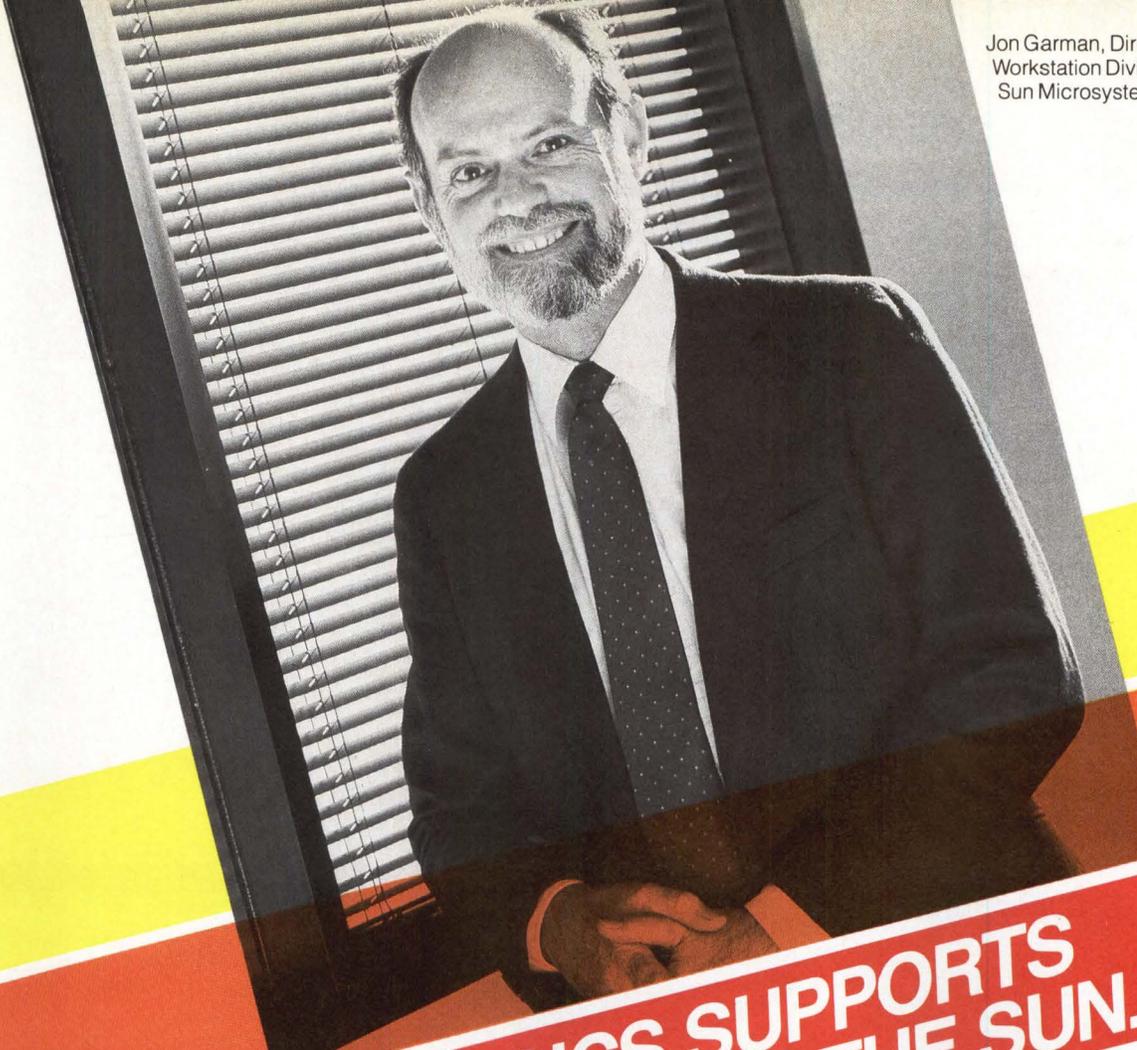
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*"Getting Xylogics' 440 controllers operational with Sun's workstations was a positive experience,"* Garman remembers. *"What the manual said, the Xylogics boards did, and the software interface was simple to use."*

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Next, Sun integrated the Xylogics 450 in its second-generation family of workstations because it was the fastest, most reliable Multibus board they could find.

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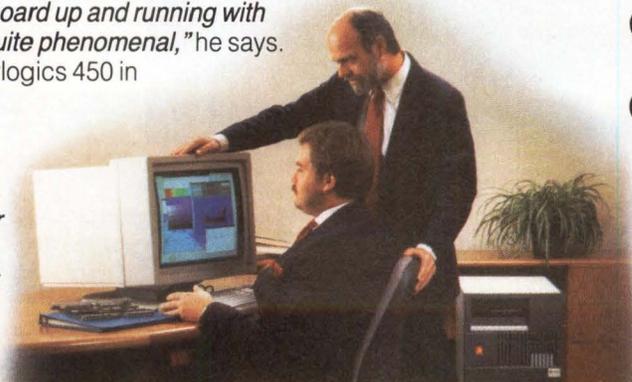
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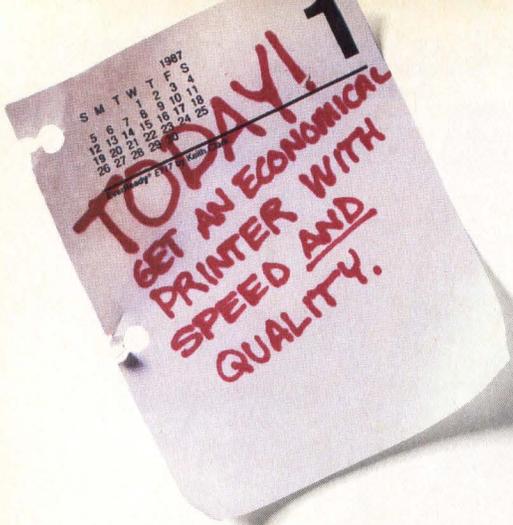
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# MULTIUSER MICROCOMPUTERS

Company	Model	Clock speed CPU type (Word size)	Bus	Main memory min.-max. (bytes)	Max. no. users	Max. mass storage (bytes)	Disk bus/interface	Operating systems available	Price (min.-max. configuration)
<b>ACTION COMPUTER ENTERPRISE INC.</b>									
430 N. Halstead St., Pasadena, CA 91107, (818) 351-5451									
Circle 511									
Discovery		8 MHz 80186 (16-bit)	S-100	512K-1M	16	170M	SCSI	dpc/OS, MS-DOS, Personal CP/M	\$9,000-\$25,000
TransAction		8 MHz 80186 (16-bit)	S-100	512K-1M	64	500	SCSI	dpc/OS, MS-DOS, Personal CP/M	\$9,000-\$50,000
<b>ALPHA MICROSYSTEMS</b>									
3501 W. Sunflower Ave., P.O. Box 25059, Santa Ana, CA 92704, (714) 957-8500									
Circle 512									
AM-1200		8 MHz 68000 (16-bit)		1M-4M	13	580M	SASI	AMOS	\$8,300-\$13,300
AM-1500		10 MHz 68010 (16-bit)	VMEbus	1M-16M	120	3.2G	SASI	AMOS	\$22,500-\$95,870
AM-2000		16 MHz 68020 (32-bit)	VMEbus	1M-36M	240	3.2G	SASI	AMOS	\$28,020-\$148,235
<b>ALTOS COMPUTER SYSTEMS</b>									
2641 Orchard Pkwy., San Jose, CA 95134, (408) 946-6700									
Circle 513									
Series 2000		16 MHz 80386 (32-bit)	Multibus	4M-16M	10-64	80M-170M	ESDI	Concurrent DOS, XENIX	\$22,000-\$35,000
<b>APPLIED DIGITAL DATA SYSTEMS INC.</b>									
100 Marcus Blvd., Hauppauge, NY 11788, (516) 231-5400									
Circle 514									
Mentor 1700		8 MHz 80286 (16-bit)	PC bus	512K	8	60M	STD	Pick	\$9,625-\$11,650
Mentor 2580		8 MHz 28000 (16-bit)	proprietary	512K-1M	32	132M	SMD	Pick	\$18,750-\$42,600
Mentor 6000		16.7 MHz 68020 (32-bit)	Multibus	2M-16M	160	3.5G	SCSI, ST506	Pick	\$24,000-\$456,750
<b>AT&amp;T</b>									
One Speedwell Ave., Morristown, NJ 07960, (800) 247-1212									
Circle 515									
3B2/400		10 MHz WE32100 (32-bit)		2M-4M	25-90	144M-6.5G	ESDI, SCSI	UNIX System V.2, V.3	\$18,100-\$26,000
3B2/600		18 MHz WE32100 (32-bit)		4M-16M	64-90	294M-6.5G	SCSI	UNIX System V.3	\$46,500
3B15		14 MHz WE32100 (32-bit)		2M-16M	60-128	2.2G	SMDC	UNIX System V.2.0, V.2.1	\$60,000-\$400,000
<b>CENTRAL DATA CORP.</b>									
1602 Newton Dr., Champaign, IL 61821, (800) 482-0315, (217) 359-8010									
Circle 515									
CD310-286-1		8 MHz 80286 (16-bit)	Multibus	1M-16M	20	320K-80M	ST506	MS-DOS, RMX-86, RMX-286	\$6,750-\$12,200
CD310-2		10 MHz 8086 (16-bit)	Multibus	1M	9	320K-20M	ST506	MS-DOS, RMX-86	\$5,650-\$8,420
CD310-3		10 MHz 8086 (16-bit)	Multibus	1M	9	320K-40M	ST506	MS-DOS, RMX-86	\$6,190-\$8,960
<b>COMARK CORP.</b>									
93 West St., P.O. Box 474, Medfield, MA 02052, (617) 359-8161									
Circle 516									
Diskstor M-6		10 MHz 8086 (16-bit)	Multibus	1M	16	20M	SASI	Concurrent CP/M-86	\$11,995
<b>COMMERCIAL SYSTEMS INC.</b>									
505 E. Huntland Dr., Suite 160, Austin, TX 78752, (512) 454-9250									
Circle 517									
CSI-75		10 MHz, 12 MHz V30, 80186 (16-bit)	S-100	1M-6M	12	263M	SCSI	TurboDOS	\$5,500-\$20,000

## MULTIUSER MICROCOMPUTERS

Company	Model	Clock speed CPU type (Word size)	Bus	Main memory min.-max. (bytes)	Max. no. users	Max. mass storage (bytes)	Disk bus/interface	Operating systems available	Price (min.-max. configuration)
	HS-1000	20 MHz 80386 (32-bit)	proprietary	4M-32M	32	772M	ESDI	UNIX System V.3	\$25,500-\$81,000
	HS-2000	20 MHz 80386 (32-bit)	proprietary	4M-128M	128	3.088G	ESDI	UNIX System V.3	\$34,000-\$305,000
<b>COMPULAB CORP.</b> 1717 Dixie Highway, Ft. Wright, KY 41011, (606) 331-7227									Circle 518
	DS-140	10 MHz 8086 (16-bit)	Multibus	512K-1M	32	1.3G	STD	DBOS	\$20,150-\$70,000
<b>CONVERGENT TECHNOLOGIES INC.</b> 2700 N. First St., San Jose, CA 95150-6685, (408) 434-2848									Circle 557
	NGEN Series 286	8 MHz 80286 (16-bit)	X-bus	1M-4M	12-16	1G	SCSI, ST506	CTOS/VM, DOS	
	NGEN Series 386	16 MHz 80386 (32-bit)	X-bus	1M-4M	20	1G	SCSI, ST506	CTOS/VM, DOS	
	S/Series	12.5 MHz-25 MHz 68020 (32-bit)	proprietary, Multibus, VMEbus	1M-32M	128	6G	ESMD, SCSI, SMD, ST506	UNIX System V	\$12,000-\$125,000
<b>COUNTERPOINT COMPUTERS</b> 2127 Ringwood Ave., San Jose, CA 94022, (408) 434-0190									Circle 519
	System 19K	16.67 MHz 68020 (32-bit)	proprietary, Multibus I, VMEbus	2M-40M	96	700M-4.1G	SCSI	UNIX System V.2.2, V.3	\$9,675-over \$60,000
<b>DATAMEDIA CORP.</b> 11 Trafalgar Square, Nashua, NH 03063, (603) 886-1570									Circle 520
	2610	16.7 MHz 68020 (32-bit)	VMEbus	2M-16M	32	1.5G	ESDI, STD	UNIX	\$15,500
	2620	16.7 MHz 68020 (32-bit)	VMEbus	2M-16M	32	1.5G	ESDI, STD	UNIX	\$21,000
	2660	20 MHz 68020 (32-bit)	VMEbus	4M-16M	1.5G		ESDI, STD	UNIX	\$29,000
<b>DECISION DATA COMPUTER CORP.</b> 400 Horsham Rd., Horsham, PA 19044, (215) 674-3300, (800) 523-6529									Circle 521
	MPS 5112	8 MHz 80286 (16-bit)		640K	16	138M	SCSI	DDNX, MS-DOS	\$13,600-\$41,100
<b>DIGITAL EQUIPMENT CORP.</b> 146 Main St., Maynard, MA 01754, (617) 493-6647									Circle 522
	MicroPDP-11/53	15 MHz proprietary (16-bit)	Q-bus	512K-4M	6-8	230M	MSCP, SDI	Micro/RXS, Micro/RSTS, RSX-11M, RSX-11M-Plus, RT-11	\$8,600-\$17,500
	MicroVAX II	40 MHz proprietary (32-bit)	Q-bus	2M-16M	49	72G	MSCP, SDI	MicroVMS, ULTRIX-32, VAXELIN	\$20,000-\$70,000
	MicroVAX 2000	15 MHz proprietary (16-bit)	Q-bus	1M-6M	16	142M	MSCP, SDI	MicroVMS, ULTRIX-32	\$10,000-\$25,000
<b>DUAL SYSTEMS CORP.</b> 2530 San Pablo Ave., Berkeley, CA 94702, (415) 549-3854									Circle 523
	Dual Series 1	16.7 MHz 68020 (32-bit)	VMEbus	1M-16M	32	6G	ESDI, SCSI, SMD	UNIX System V	\$19,500-\$29,500
	Dual Series 2	25 MHz 68020 (32-bit)	VMEbus	4M-148M	1,024	6G	ESDI, SCSI, SMD	OS9, pSOS, UNIX System V	\$30,000-\$39,500
<b>FORTUNE SYSTEMS CORP.</b> 300 Harbor Blvd., Belmont, CA 94002, (415) 593-9000									Circle 524
	32:16 SX	12 MHz 68000 (16-bit)	proprietary	1M-3.5M	16	145M	SCSI	FOR:PRO 2.0	\$7,995-\$22,960

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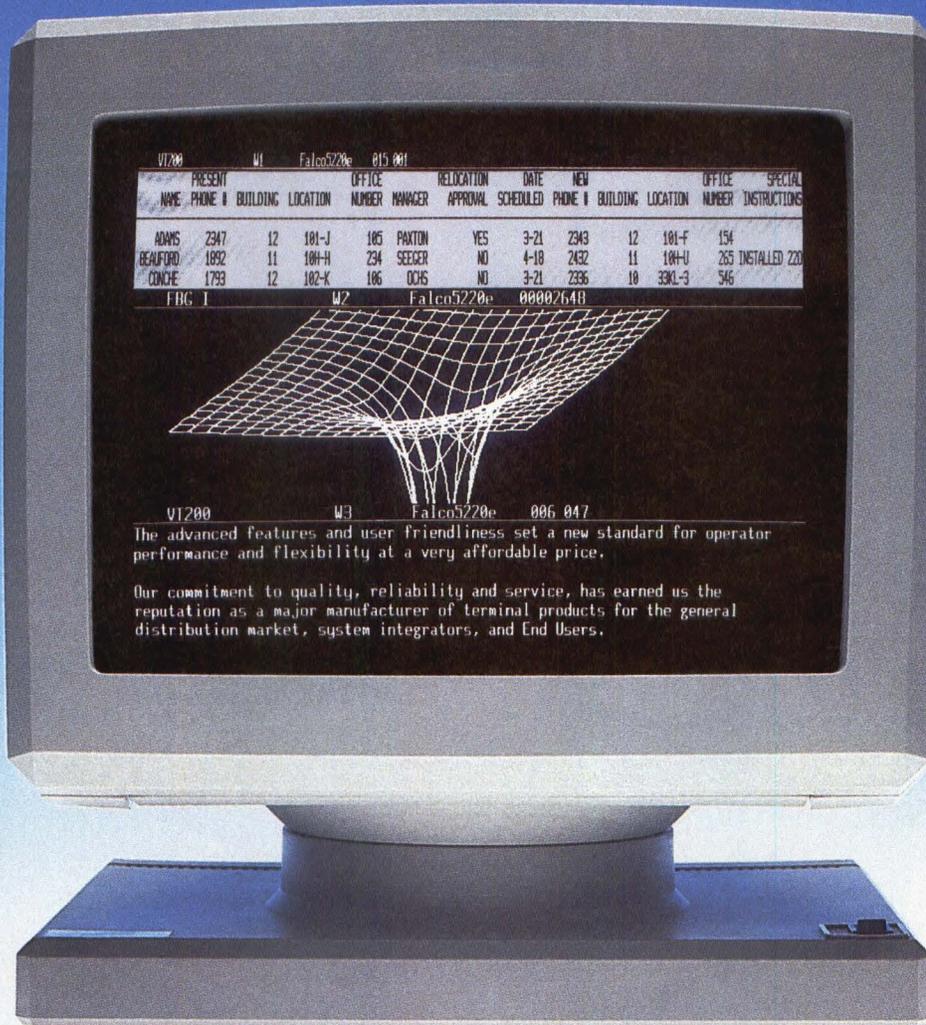
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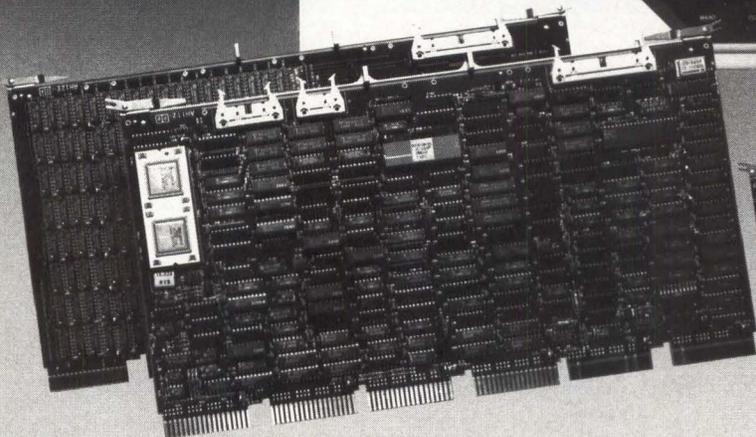
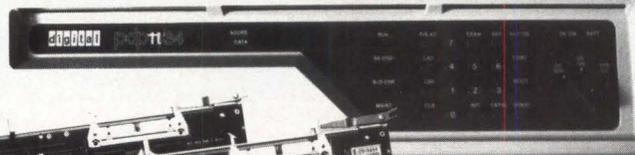
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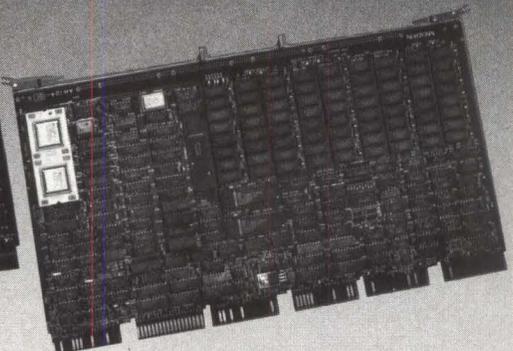


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CIRCLE NO. 58 ON INQUIRY CARD

## MULTIUSER MICROCOMPUTERS

Company	Model	Clock speed CPU type (Word size)	Bus	Main memory min.-max. (bytes)	Max. no. users	Max. mass storage (bytes)	Disk bus/interface	Operating systems available	Price (min.-max. configuration)
Formula	4000	16.5 MHz 68020 (32-bit)	proprietary	1M-8M	22	145M	SCSI	FOR:PRO 3.0, UNIX System V.3	\$9,900-\$28,830
Formula	8000	16.5 MHz 68020 (32-bit)	proprietary	1M-16M	32	290M	ESCSI	FOR:PRO 3.0, UNIX System V.3	\$21,900-\$56,955
<b>GOULD INC. (FEDERAL SYSTEMS DIV.)</b>									<b>Circle 525</b>
801 Brightseat Rd., Landover, MD 20785, (301) 499-2460									
Series 7000		20 MHz 68020 (32-bit)	VMEbus	4M-16M			SCSI	pSOS	\$72,500
<b>HARRIS CORP. (COMPUTER SYSTEMS DIV.)</b>									<b>Circle 526</b>
2101 W. Cypress Creek Rd., Fort Lauderdale, FL 33309, (305) 974-1700									
MCX-3 Model 40		16.7 MHz 68020 (32-bit)	Multibus	2M-10M	12	142M	SCSI	UNIX	\$25,000-\$60,000
MCX-3 Model 60		16.7 MHz 68020 (32-bit)	Multibus	2M-32M	32	690M	Enhanced SMD	UNIX	\$39,000-\$100,000+
MCX-5 Model 70		16.7 MHz 68020 (32-bit)	Multibus	4M-64M	64	>5G	Enhanced SMD	UNIX	\$80,000-\$200,000+
<b>HEURIKON CORP.</b>									<b>Circle 527</b>
3201 Latham Dr., Madison, WI 53713, (608) 271-8700									
Link/X		12.5 MHz, 16.7 MHz 68010 (16-bit)	Multibus I, II; VMEbus	1M-4M	32	380M	SCSI	MTOS, pSOS, UNIX System V.2, VRTX	\$11,895-\$13,495
Real-Time Systems		25 MHz 68020 (32-bit)	Multibus I, II; VMEbus	1M-4M	32	380M		MTOS, pSOS, VRTX	\$3,795-\$19,995
SCALOS		25 MHz 68020 (32-bit)	Multibus I, II; VMEbus	1M-4M	32	380M	SCSI	UNIX System V.2	\$9,895-\$19,495
<b>HEWLETT-PACKARD CO.</b>									<b>Circle 528</b>
300 Hanover St., Palo Alto, CA 94304, (415) 857-1501									
HP 1000 A400		22 MHz proprietary (16-bit)	proprietary	512K-4M	64	5G-20G	HP-IB	RTE-A	\$2,500-\$9,500
HP 1000 A900		30 MHz proprietary (16-bit)	proprietary	768K-24M	64	5G-20G	HP-IB	RTE-A	\$23,900-\$34,000
<b>HONEYWELL BULL INC.</b>									<b>Circle 529</b>
200 Smith St., Waltham, MA 02154, (617) 895-3767									
XPS-100 Model X-10		10 MHz 68010 (16-bit)	Multibus	512K-6.5M	16	120M	QIC-02, SA400, ST506	UNIX System V.2	\$8,300-\$33,600
XPS-100 Model X-20		16.67 MHz 68020 (32-bit)	VMEbus	2M-10M	32	1.396G	ESDI, QIC-02, SA400, ST506	UNIX System V.2	\$16,600-\$98,800
XPS-100 Model X-40		16.67 MHz 68020 (32-bit)	VMEbus	4M-20M	64	1.615G	ESDI, QIC-02, SA400, ST506	UNIX System V.2	\$41,600-\$148,000
<b>INTEGRATED BUSINESS COMPUTERS (IBC)</b>									<b>Circle 530</b>
21621 Nordhoff St., Chatsworth, CA 91311, (818) 882-9007									
Ensign 386:100		16 MHz 80386 (32-bit)	proprietary	1M-24M	100	2.34G	SCSI	PC-MOS, Pick, THEOS, XENIX	\$10,000-\$75,000
Ensign 682:100		16 MHz 68020 (32-bit)	proprietary	1M-24M	100	2.34G	SCSI	UNIX, Pick	\$10,000-\$75,000
<b>INTEL CORP.</b>									<b>Circle 558</b>
5200 N.E. Elam Young Parkway, Hillsboro, OR 97124, (503) 681-8080									
iRMX System 320		16 MHz 80386 (32-bit)	Multibus	1M-16M	32	280M	ST506	iRMX	\$13,300-\$60,000
MultiSERVER System 310		8 MHz 80286 (16-bit)	Multibus	1M-9M	16	140M	ST506	XENIX	\$12,600-\$35,000

## MULTIUSER MICROCOMPUTERS

Company	Model	Clock speed CPU type (Word size)	Bus	Main memory min.-max. (bytes)	Max. no. users	Max. mass storage (bytes)	Disk bus/interface	Operating systems available	Price (min.-max. configuration)
MultiSERVER System 320		16 MHz 80386 (32-bit)	Multibus	1M-16M	16	280M	ST506	XENIX	\$15,900-\$60,000
<b>IRONICS INC.</b>									
798 Cascadilla St., Ithaca, NY 14850, (607) 277-4060 <span style="float: right;">Circle 531</span>									
Performer 16		10 MHz 68010 (16-bit)	VMEbus		16	80M	SCSI, SMD	UNIX System V.2	\$11,000-\$15,000
Performer 32/E		16 MHz 68020 (32-bit)	VMEbus	4M	16	80M	SCSI, SMD	UNIX System V.2	\$17,000-\$21,000
Performer 32/EX		16 MHz 68020 (32-bit)	VMEbus	4M	16	80M	SCSI, SMD	UNIX System V.2	\$21,000-\$25,000
<b>J.C. INFORMATION SYSTEMS CORP.</b>									
161 Whitney Place, Fremont, CA 94539, (415) 659-8440 <span style="float: right;">Circle 559</span>									
JC LIPS		8 MHz, 10 MHz V40 (8-bit)	PC bus	640K	16	160M	ST506	MS-DOS 3.2	\$495-\$3,000
JC LIPS 286		10 MHz, 12 MHz 80286 (16-bit)	PC/AT bus	512K-1M	256	160M	ESDI, ST506	MS-DOS, XENIX	\$995-\$5,000
JC LIPS 386		16 MHz, 20 MHz 80386 (32-bit)	PC/AT bus	1M-4M	256	640M	ESDI, ST506	MS-DOS, XENIX	\$1,995-\$8,000
<b>L/F TECHNOLOGIES INC.</b>									
2800 Lockheed Way, Carson City, NV 89701, (702) 883-7611 <span style="float: right;">Circle 532</span>									
1650		10 MHz 80186 (16-bit)	S-100	1M	32	480M	ST506	Concurrent DOS, TurboDOS	\$9,400-\$67,000
CUBIX <sup>2</sup>		8 MHz 80286 (16-bit)		2M-8M	8	220M	ST506	UNIX System V.2	\$9,995-\$20,500
CUBIX <sup>3</sup>		8 MHz 80286 (16-bit)		2M-8M	16	660M	ST506	UNIX System V.2	\$12,995-\$32,795
<b>LITTLE MACHINES INC.</b>									
4241 Jutland Dr., Suite 103, San Diego, CA 92117, (619) 483-3606 <span style="float: right;">Circle 533</span>									
LMSYS 1600		6 MHz, 8 MHz 80186, 80286 (16-bit)	Multibus I	1M-16M	12		SA450, SA460, ST506/412	RMX, UNIX, XENIX	\$15,300
<b>LOMAS DATA PRODUCTS INC.</b>									
182 Cedar Hill St., Marlboro, MA 01752, (617) 460-0333 <span style="float: right;">Circle 534</span>									
S100PC-286		10 MHz 80286, 80287 (16-bit)	S-100	1M-16M	9	200M	ST506	Concurrent DOS	\$9,295-\$15,000
S100PC-TPM		10 MHz 80186 (16-bit)	S-100	1M	9	200M	SCSI	Concurrent DOS	\$5,995-\$8,000
LO.MAX		10 MHz 80186 (16-bit)	S-100	512K-1M	5	80M	SCSI	Concurrent DOS	\$3,695-\$8,000
<b>MAI BASIC FOUR</b>									
14101 Myford Rd., Tustin, CA 92680, (714) 731-1500 <span style="float: right;">Circle 535</span>									
MAI 1500		6 MHz, 8 MHz 80286 (16-bit)	PC/AT bus	640K	10	230M	ST506	BOSS, MS-DOS	\$3,995-\$40,000
MAI 3000		16 MHz 68020 (32-bit)	proprietary	1M-3M	34	360M	ST506	BOSS/IX	\$19,750-\$100,000
MPx 9500		AMD 2901 (32-bit)		4M-12M	164	4.8G	proprietary	BOSS/VS	\$250,000+
<b>MASSCOMP</b>									
One Technology Park, Westford, MA 01886, (617) 692-6200 <span style="float: right;">Circle 536</span>									
5350		16.7 MHz 68020 (32-bit)	Multibus	2M-4M	4	142M	SCSI	UNIX	\$12,500-\$21,000

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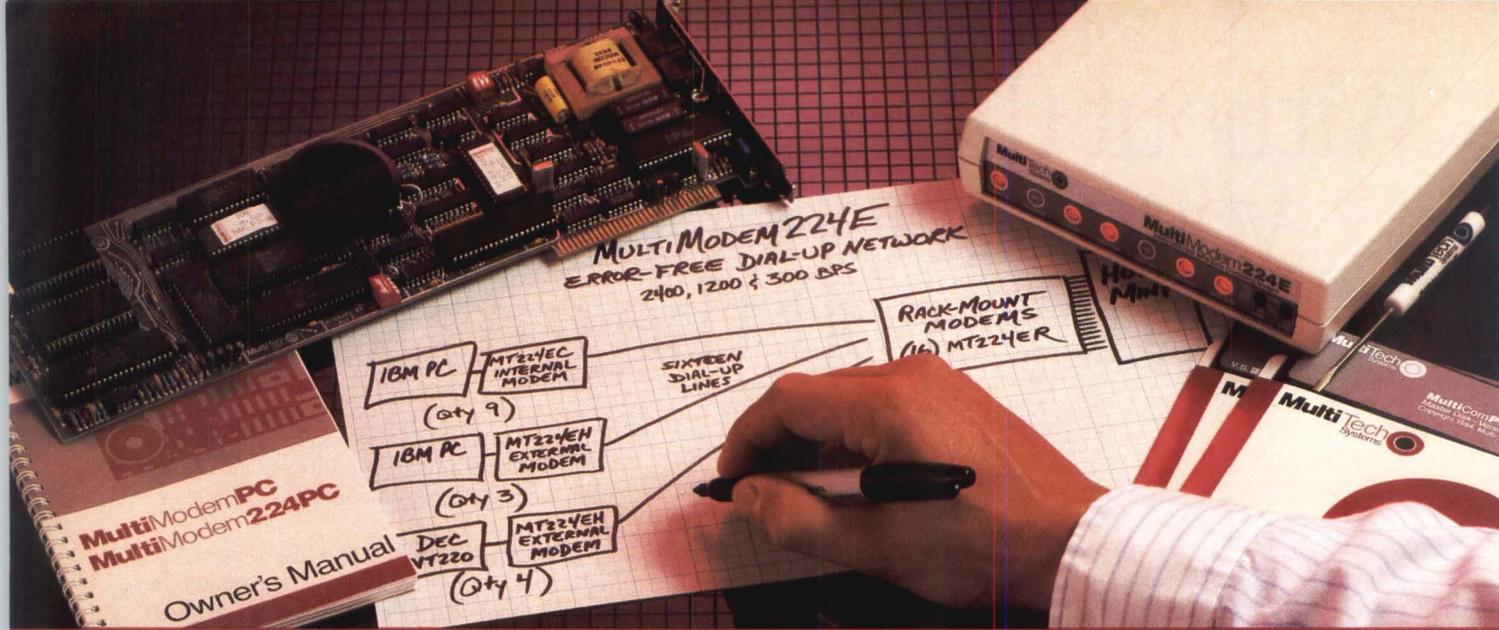
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- Another important point: MNP Class 3 has emerged as an industry standard. It's now in the public domain, and has been implemented in virtually all 2400 bps modems that offer error-correction.

● So, why buy error-correcting modems from Multi-Tech? There are many good reasons, including:

1. Multi-Tech modems are 100% Hayes-compatible (more so than Hayes' own 2400 bps modems\*), and our MultiModem224E with error-correction costs less than a Hayes Smartmodem 2400™ without this feature.
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3. Versatility: the auto-dial/auto-answer Multi-Modem224E runs at 2400, 1200 or 300 bps, with or without error-correction, automatically!
4. Our two year warranty means something. Since Multi-Tech modems are designed and manufactured at our Minnesota headquarters (as they have been for the last sixteen years), you can be sure we'll be here when you need us.

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## MULTIUSER MICROCOMPUTERS

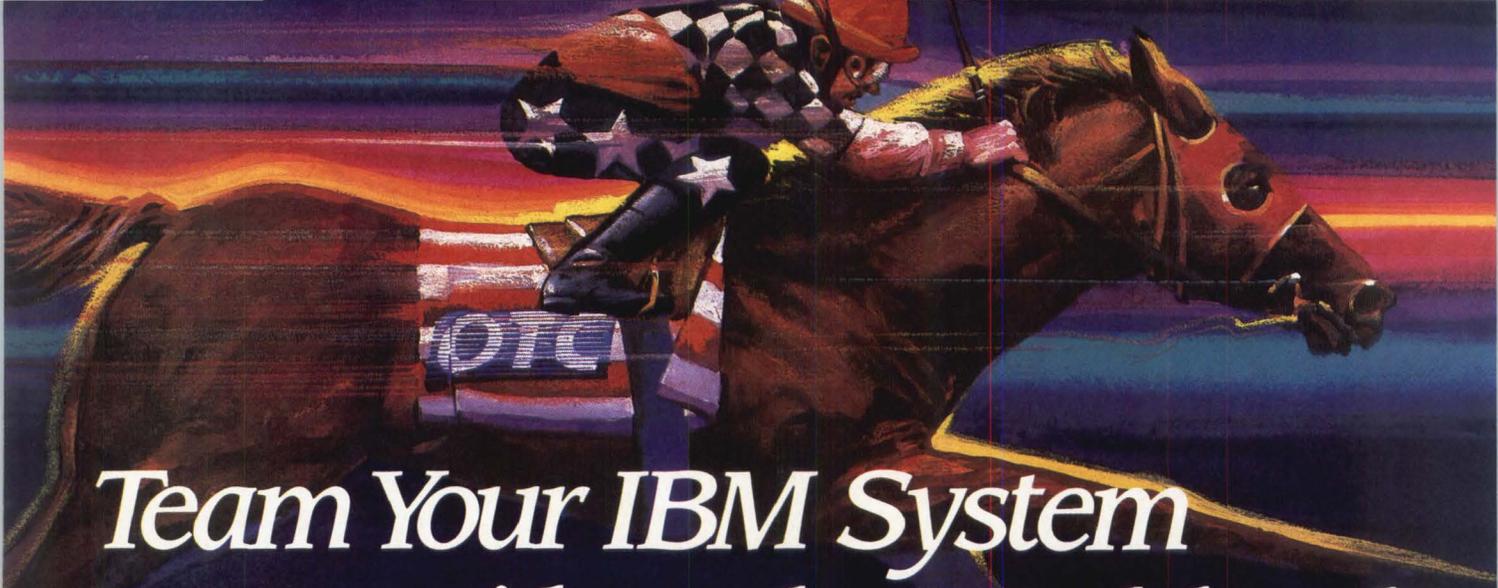
Company	Model	Clock speed CPU type (Word size)	Bus	Main memory min.-max. (bytes)	Max. no. users	Max. mass storage (bytes)	Disk bus/interface	Operating systems available	Price (min.-max. configuration)
	5450	20 MHz 68020 (32-bit)	Multibus	2M-10M	12	142M	SCSI	UNIX	\$18,500-\$27,000
	5550	20 MHz 68020 (32-bit)	Multibus	2M-10M	18	1.548G	SMD	UNIX	\$24,500-\$100,000
<b>MEGADATA CORP.</b> <span style="float: right;">Circle 537</span>									
35 Orville Dr., Bohemia, NY 11716, (516) 589-6800									
	8300-4	16.7 MHz 68020 (32-bit)	Multibus	1M-8M	32	760M	ESDI, ST506	UNIX System V	\$9,131-\$33,894
	8300-6	10 MHz 68010 (32-bit)	Multibus	1M-8M	16	191M	ST506	UNIX System V	\$6,567-\$12,344
	8300-7	8 MHz 68000 (32-bit)		1M-2M	10	102M	SCSI	UNIX System V	\$4,899-\$7,130
<b>MICRO-LINK CORP.</b> <span style="float: right;">Circle 538</span>									
14602 North US Highway 31, Carmel, IN 46032, (317) 846-1721									
	VME-1000	10 MHz 68000, 68010 (16-bit)	VMEbus	512K-4M	4-8	20M-80M	SCSI	P-DOS	\$5,900-\$6,400
<b>MIZAR INC.</b> <span style="float: right;">Circle 539</span>									
20 Yorkton Court, St. Paul, MN 55117, (612) 224-8941									
	MZ 9500	12.5 MHz 68010 (16-bit)	VMEbus	512K-16M	2-18	20M	SCSI	OS9, P-DOS, polyFORTH	\$6,370-\$16,655
	Unistar	14 MHz (32-bit)	VMEbus	1M-33M	3-24	86M	ST506	UNIX System V/VME	\$12,900-\$34,275
<b>MOTOROLA INC. (MICROCOMPUTER DIV.)</b> <span style="float: right;">Circle 560</span>									
2900 S. Diablo Way, Tempe, AZ 85282, (800) 556-1234, (800) 441-2345 in CA									
	VME Delta Series Model 2316	16.67 MHz 68020 (32-bit)	VMEbus	2M-4M	8	160M	ESDI, ST506	UNIX System V.3, VERSAidos	\$7,000-\$11,000
	VME Delta Series Model 2616	16.67 MHz 68020 (32-bit)	VMEbus	2M-16M	34	1.7G	ESDI, ST506	UNIX System V.3, VERSAidos	\$20,000-\$30,000
	VME Delta Series Model 2825	25 MHz 68020 (32-bit)	VMEbus	8M-24M	64	1.7G	ESDI, ST506	UNIX System V.3, VERSAidos	\$25,000-\$40,000
<b>NATIONAL SEMICONDUCTOR DATACHECKER/DTS CORP.</b> <span style="float: right;">Circle 540</span>									
800 Central Expressway, Santa Clara, CA 95050, (408) 986-8560									
	1115	8 MHz LSI-11 (16-bit)	Q-bus	1M-2M	8	228M	STD	RSX-11M-Plus	\$7,000-\$15,000
	1125	15 MHz LSI-11 (16-bit)	Q-bus	1M-4M	16	228M	STD	RSX-11M-Plus	\$9,000-\$22,000
<b>NCR CORP.</b> <span style="float: right;">Circle 541</span>									
1700 S. Patterson Blvd., Dayton, OH 45479, (513) 445-7478									
	Tower 32/400	16.7 MHz 68020 (32-bit)	Multibus I	1M-8M	2-16	140M-5.5G	SCSI, ST506	UNIX System V.2	\$16,995-\$27,500
	Tower 32/600	16.7 MHz 68020 (32-bit)	Multibus I	1M-16M	2-48	280M-5.5G	SCSI, ST506	UNIX System V.2	\$22,175-\$45,250
	Tower 32/800	16.7 MHz 68020 (32-bit)	Multibus II	4M-64M	32-128	850M-6.1G	ESDI, SCSI	UNIX System V.2	\$88,400-\$250,000
<b>NEC INFORMATION SYSTEMS INC.</b> <span style="float: right;">Circle 542</span>									
1414 Massachusetts Ave., Boxboro, MA 01719, (617) 264-8000									
	APC IV Business Mate	10 MHz 80286 (16-bit)	PC/AT bus	640K-10.6M	9	106M	ST506	XENIX V 2.2	\$5,995-\$6,995
<b>NORTH STAR COMPUTERS INC.</b> <span style="float: right;">Circle 543</span>									
14680 Catalina St., San Leandro, CA 94577, (415) 357-8500									
	Dimension 50	8 MHz 80286 (16-bit)	PC/AT bus	512K	4	80M	ST506	North Star Advanced NetWare	

## MULTIUSER MICROCOMPUTERS

Company	Model	Clock speed CPU type (Word size)	Bus	Main memory min.-max. (bytes)	Max. no. users	Max. mass storage (bytes)	Disk bus/interface	Operating systems available	Price (min.-max. configuration)
Dimension 300		7.7 MHz, 8 MHz 80186, 80286 (16-bit)	PC bus	1M	12	150M	ST506	North Star Advanced NetWare	\$16,490-\$34,404
Dimension 1200		7.7 MHz, 8 MHz 80186, 80286 (16-bit)	PC bus	1M	12	240M	ST506	North Star Advanced NetWare	\$23,490-\$41,440
<b>PRIME COMPUTER INC.</b> <span style="float: right;">Circle 544</span>									
22 Meridian Rd., P.O. Box 783, Eatontown, NJ 07724, (201) 542-7340									
Prime EXL 316		16 MHz 80386 (32-bit)	Multibus II	2M-8M	34	1G	SCSI	UNIX System V.3	\$23,900
<b>QUAY CORP.</b> <span style="float: right;">Circle 545</span>									
22 Meridian Rd., P.O. Box 783, Eatontown, NJ 07724, (201) 542-7340									
910		4 MHz Z80A (8-bit)		208K	4	60M		MP/M II	\$8,500
<b>SBE INC.</b> <span style="float: right;">Circle 546</span>									
2400 Bisso Lane, Concord, CA 94520, (415) 680-7722									
300/350		10 MHz 68000, 68010 (16-, 32-bit)	Multibus I	2M-8M	18	280M	SASI, SCSI	REGULUS, UNIX System V.2	\$9,100/\$6,900
400/450		12.5 MHz, 16.7 MHz, 20 MHz 68020 (32-bit)	Multibus I	1M-2M	18	280M	SASI, SCSI	REGULUS	\$9,900/\$9,400
500/550		12.5 MHz, 16.7 MHz, 20 MHz 68020 (32-bit)	Multibus I	2M	18	280M	SASI, SCSI	REGULUS, UNIX System V.2	\$12,800/\$12,300
<b>SCAN-OPTICS INC.</b> <span style="float: right;">Circle 547</span>									
17032 Armstrong Ave., Irvine, CA 92714, (714) 863-7580									
3216		12.5 MHz 68000 (16-bit)		1M-3M	16	85M	SCSI	OS/3200	\$13,000-\$18,000
3266		12.5 MHz, 16.7 MHz 68000, 68020 (32-bit)		1M-15M	64	2G	SCSI	OS/3200	\$40,000+
4236		12.5 MHz, 16.7 MHz 68000, 68020 (32-bit)		1M-8M	36	510M	ESDI	Pick	\$24,000-\$40,000
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5000 Technology Dr., Huntsville, AL 35805, (205) 882-4304									
SCI 1000		8 MHz 80186 (16-bit)	proprietary	1M	8	172M	ST506	IN/ix 2.0	\$10,550-\$12,345
SCI 2000		8 MHz 80286 (16-bit)	Multibus I	2M-8M	24	300M	ST506, SCSI	IN/ix 2.0	\$11,800-\$14,265
SCI 3000		16 MHz 80386 (32-bit)	Multibus I	4M-16M	64	600M	SCSI	UNIX System V.3	\$19,850-\$31,265
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645 Fifth Ave., New York, NY 10022, (212) 759-0140									
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1800 One Tandy Center, Fort Worth, TX 76102, (817) 390-3700									
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Tandy 6000		8 MHz 68000 (16-, 32-bit)	proprietary	512K-1M	9	15M	ST506	TRS-DOS, XENIX	\$3,499
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1170 Morse Ave., P.O. Box 3568, Sunnyvale, CA 94088-3568, (408) 745-7760									
TeleNIX/286		6 MHz, 8MHz 80286 (16-bit)	PC/AT bus	16M	8	40M	ST506	UNIX System V.2	\$5,995

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TeleNIX/386		16 MHz 80386 (32-bit)	PC/AT bus, proprietary	16M	16	over 240M	ESDI	UNIX System V.3	\$8,995-\$11,500
<b>TEXAS INSTRUMENTS INC.</b>									<b>Circle 551</b>
P.O. Box 809063, Dallas, TX 75380-9063, (800) 527-3500									
System 1100		12 MHz 80286 (16-bit)	PC/AT bus	1M-15M	16	48M-280M	ST506	TI System V	\$13,895-\$18,995
System 1300		20 MHz 80386 (32-bit)	PC/AT bus	4M-16M	32	182M-1.8G	SCSI	TI System V	\$27,495-\$34,995
System 1500		16.7 MHz 68020 (32-bit)	Nubus	2M-16M	125	140M-3.5G	SCSI, SMD	TI System V	\$59,995-\$158,485
<b>WANG LABORATORIES INC.</b>									<b>Circle 552</b>
One Industrial Ave., Lowell, MA 01851, (617) 459-5000									
APC		8 MHz 80286 (16-bit)	proprietary	512K-5M	6	68M	ST506	XENIX	
<b>WICAT SYSTEMS INC.</b>									<b>Circle 562</b>
1875 S. State St., Orem, UT 84052, (801) 224-6400									
2250		16.67 MHz 68020 (32-bit)	Multibus	4M	16	364M	SCSI	Pick, WMCS, UNIPLUS+	
2260		16.67 MHz 68020 (32-bit)	Multibus	4M-8M	32	516M	SMD, SCSI	Pick, WMCS, UNIPLUS+	
3220		16.67 MHz 68020 (32-bit)	proprietary	4M-12M	64	516M	SMD, SCSI	Pick, WMCS, UNIPLUS+	
<b>WYSE TECHNOLOGY</b>									<b>Circle 553</b>
3571 N. First St., San Jose, CA 95134, (408) 433-1000									
WY-3216		16 MHz 80386 (32-bit)		1M-24M	32	280M	ST506	MS-DOS 3.2	\$3,799-\$4,999
<b>XEPIX INC.</b>									<b>Circle 554</b>
51 Lake St., Nashua, NH 03060, (603) 881-8791									
3001		12.5 MHz 68020	X-bus	1M-12M	8	800M	SCSI	UNIX	\$6,500-\$25,000
12004		20 MHz 68020	X-bus	4M-24M	32	2.2G	SCSI	UNIX	\$13,000-\$50,000
<b>XTRA BUSINESS SYSTEMS (formerly ITT INFORMATION SYSTEMS)</b>									<b>Circle 555</b>
2350 Qume Dr., San Jose, CA 95131, (408) 945-8950									
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DEC ON X WINDOW

## X Window eases stress of parent-child relationships

Irene McCartney

Digital Equipment Corp.

While the architectures of many window systems are based on a single layer of unrelated windows, the X Window System supports a hierarchical window model. In X Window's model, each window (except the root window) is a child, or subwindow, of a previously created window and may inherit its parent's attributes. Each window may have only one parent, but a parent may have any number of children.

As illustrated in the accompanying diagram, a child window (Window B) is clipped, or intersected, by a boundary of its parent (Window A). The patterned area indicates that, though the defined size of Window B extends beyond Window A's border, only the area within the parent window is actually displayed.

Some applications benefit from a large number of subwindows; one application alone can easily use 50. This is practical only because X's windows

---

*This is the second of two articles describing the X Window System—window software developed by Project Athena and the Laboratory for Computer Science at Massachusetts Institute of Technology, with funding and participation by Digital Equipment Corp. and IBM Corp. The first article (MMS, July, Page 139) discussed the X Window System's underlying architecture. This article outlines X Window's graphics capabilities and describes its human interface.*

---

**Irene McCartney** is a software engineer in the Worksystems Technical Consulting Group at Digital Equipment Corp. in Maynard, Mass.

---

require very little process and resource overhead. Efficiency in this window structure is especially critical to the X Toolkit design.

The X Toolkit is a collection of software functions—such as command buttons, scroll bars, and menus—used principally to build an application's human interface. Each toolkit function, or "widget," creates at least one window. Because a complex and powerful human interface requires a large number of widgets, the high efficiency of windows in X Window is essential.

Users of X Window can create complex widgets, as well, by combining other widgets. For example, a text editor widget could be created by combining a text widget with a scroll bar (to move around within the text) and a menu widget (to input commands).

A primary beneficiary of the X Toolkit's functions is the window manager program, which is used to create a human interface. In a windowing environment, the window manager allows the user to perform such window operations as create, destroy, move and resize.

A user can interact with the window manager in several ways, depending on the user's level of expertise. A novice X Window user, for instance, would probably want to use menus (from the tool kit) to perform windowing operations. An experienced user, on the other hand, might prefer to bypass the menu interface and directly use the mouse to resize a window. An intermediate user probably would choose something in between. Because the X Window System doesn't enforce any policy, the user can select the style of interaction.



---

*Each window may have only one parent, but a parent may have any number of children.*

---

Unlike with other window systems, an X Window user may choose any one of a number of window managers. One policy decision each window manager must make is whether to allow overlapped or tiled window placement. An overlapping manager permits one window to overlap another. A tiling manager ensures that windows abut similarly to the way floor tiles meet.

In addition to window manipulation, the window manager is responsible for other functions. Window managers can determine how windows look. One window manager might place a title bar with the help-request icon over each window, while another might have only a small border around the window.

Some client programs may wish to perform window-management functions on themselves. To perform a function such as moving its own window, the client would make a request to the window manager through the use of a window property. With window properties, any information may be passed between two clients. In this case, the first client passes information about its own new window position to the second client, the window manager.

This communication mechanism is

## DEC ON X WINDOW

not restricted for use with the window manager. It may be used between any two clients, provided they are using the same X server. Thus, clients running on different processors on a network can communicate through this mechanism.

For example, a programmer often edits a program (Client No. 1) in one window while running an interactive debugger (Client No. 2) in a second window. When a breakpoint needs to be set in the programmer's code, the mouse can be used to select a line from the editor window. Then, using the debugger menu, this line can be requested as a breakpoint. The debugger queries the editor, using a window property, to find the selected line number.

Though some of its notions are

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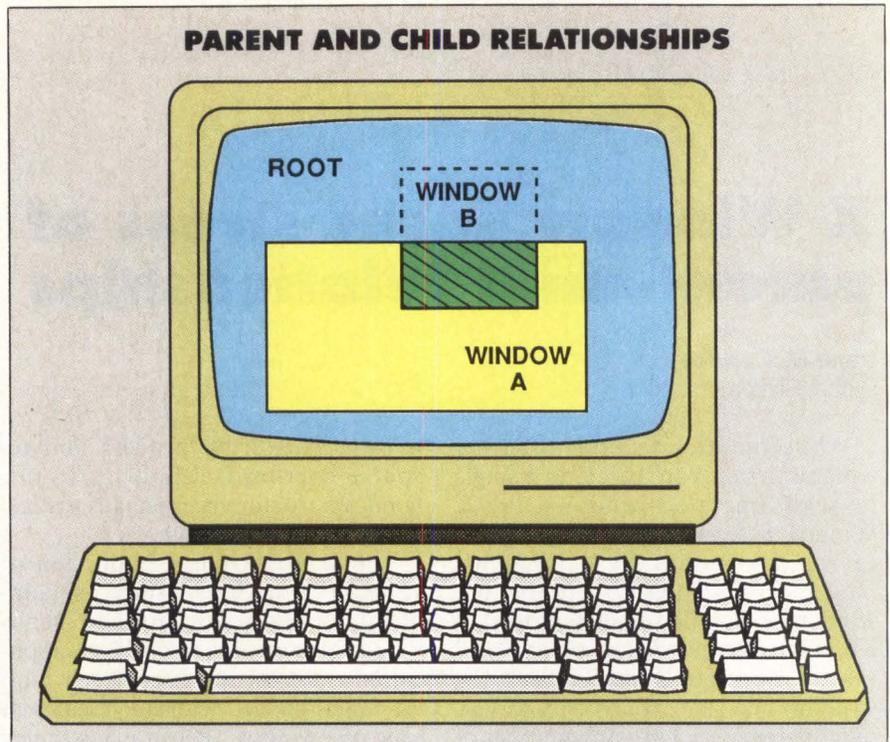
*Each tool-kit function, or 'widget,' creates at least one window.*

---

complex, X Window was designed to be a foundation block for virtually every application. So how does this apply to applications written in other libraries, such as a GKS (graphical kernel system)? The architects of X Window intended for higher-level graphics libraries to be implemented as a layer onto its library. GKS is only one example of a layered graphics library.

As evidence of its ever-growing popularity, the X Window System has been officially adopted as a standard by a majority of workstation vendors. The workstation user's productivity increases exponentially through the window system's advanced interface and networked architecture. Combining flexibility and power in a single architecture, X Window raises desktop computing to a new level of excellence.

Featuring a network architecture, the X Window System allows mechanical and electrical CAD, for example, to use high-speed supercomputers to compute graphics-intensive simulations in real time while displaying output on a workstation.



**The patterned area** indicates that the visible size of Window B, the child, is clipped, or truncated by a border of Window A, the parent. B's defined size extends beyond A's border.

Data-intensive businesses, such as finance and airlines also benefit by being able to execute applications where the database is stored and have results output on local workstations. In all cases, the output can be any combination of graphics, text and window functions.

Along with its architecture, X Window's graphics capabilities fulfill the needs of a variety of technical and non-technical applications. Besides such typical graphics routines as arcs, lines, text and polygons—as well as the usual attributes of color, fill pattern, line width, line style, writing mode and font—the X Graphics Library (Xlib) contains a number of less common features that give more power to the application programmer.

X Window's more advanced features include regions, stipple fill, plane access, 16-bit text and cut-and-paste buffers. New to the latest version of X Window (X Version 11 or X11), regions are collections of one or more polygonal areas that are treated as single entities. Existing regions

may be manipulated to form new regions by performing intersection, union, subtraction or "exclusive-or" operations. Regions formed in this manner may result in disjoint polygons, regions with holes or any other

---

*Because the X Window System doesn't enforce any policy, the user can select the style of interaction.*

---

imaginable shape.

As one example, a graphics editor can take advantage of regions by using them to group one or more objects. An application user could then move the objects as a group, resize them or even change their attributes as a single entity.

A stipple provides another way to fill an object in addition to the traditional fill pattern. Similar to a stencil or template, a stipple is laid over the area to be filled. When an area with a

DEC ON X WINDOW

stipple is filled with the existing foreground color and pattern, only the portions visible through the stipple are colored.

Some workstation applications require more complex functionality. A typical electrical CAD application permits the design engineer to move objects on one layer of a board independently of any other layer. The application must be able to do this without disfiguring any of the objects in its path. X Window provides this capability by allowing separate access to individual planes. Such plane access also lets the application programmer restrict drawing operations to a subset of graphics planes. Operations

*The architects of X Window intended for higher level graphics libraries to be implemented as a layer onto its library.*

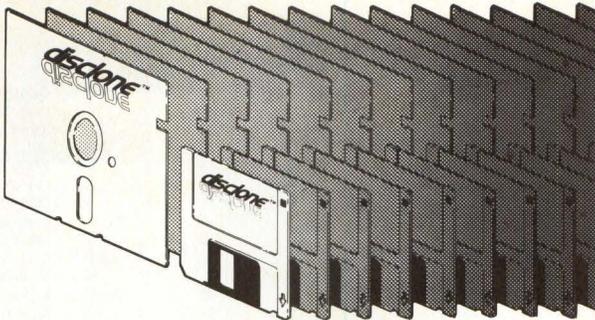
such as nondestructive overlays, rubberbanding, and animation also benefit from plane access.

Also new to the latest version of X Window is 16-bit text, as compared with the 8-bit limitation in most graphics systems. With 256 times as many characters per font as 8-bit systems, 16-bit text accommodates the implementation of such character-rich languages as Kanji.

X Window also has cut-and-paste buffers that allow applications to easily exchange data among windows. Both text and graphics may be moved, copied or deleted.

With the rapid proliferation of windowing software, users have more and more from which to choose in selecting the best system for their needs. The X Window System, in the public domain for several years and available commercially from Digital Equipment Corp., has proved to be a powerful enhancement in a wide variety of markets. □

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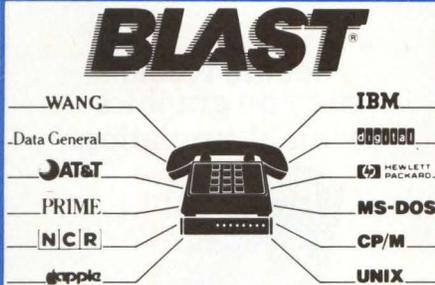


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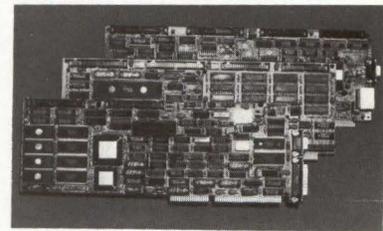
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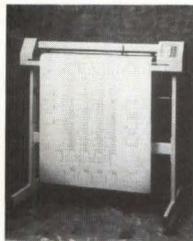
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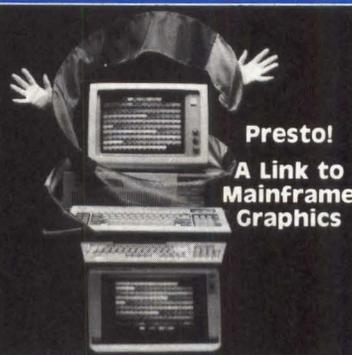


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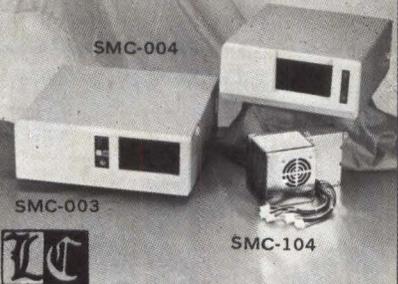
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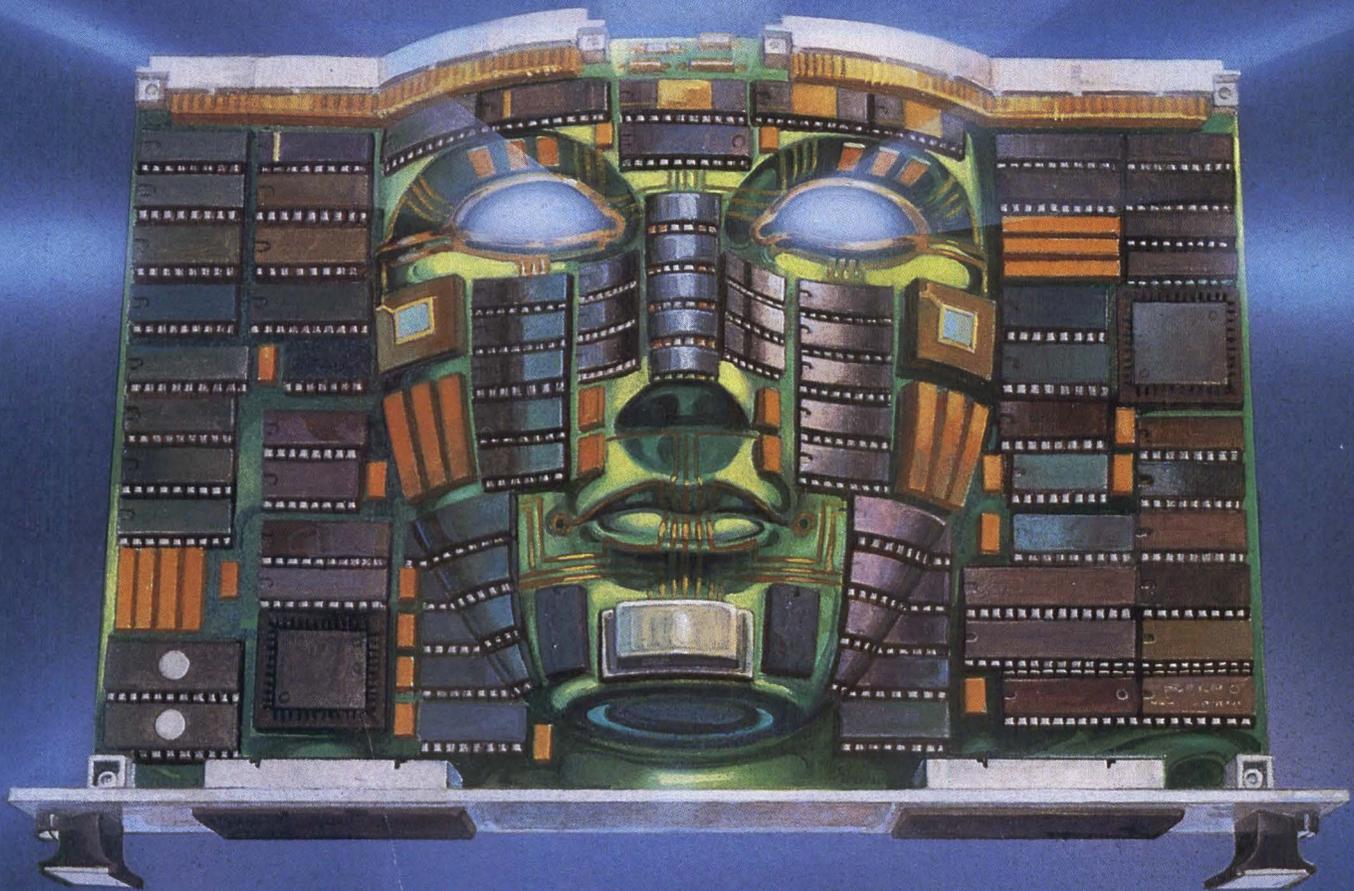


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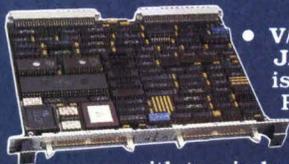
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