

SETTING THE STANDARDS

15
YEARS

BYTE Lab Tests a Dozen Disk Utilities

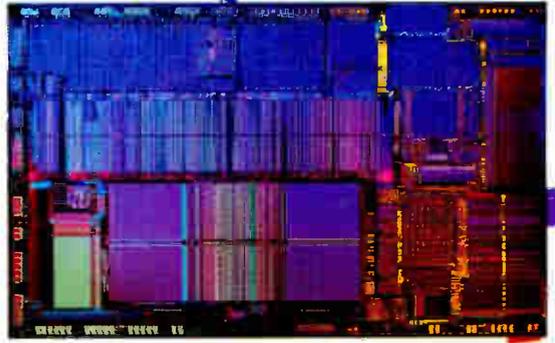
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BYTE

JANUARY 1990

A MCGRAW-HILL PUBLICATION

STATE-OF-THE-ART CHIPS PAGE 234



The Annual

BYTE AWARDS

*The year's best products
and trailblazing technologies*



Apollo's Affordable Workstation

Under the Hood:
Math Coprocessors

Macintosh Expert Systems

On-Line BBSes
Span the Globe

REVIEWS

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Low-Cost Laptops

3 BIG Mac Hard Disks

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OS/2 with CommonView

Ethernet Speed
for Mac LANs

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Bricklin's PageGarden

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The perfect low profile mainstream computer, combining 386SX power and compatibility with unprecedented value and support.

STANDARD FEATURES:

- Intel 80386SX microprocessor running at 16 MHz.
- Choice of 512 KB, 640 KB, 1 MB or 2 MB* of RAM (expandable to 16 MB (8 MB on the system board).
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- LIM 4.0 support for memory over 640 KB.
- Integrated diskette and high performance 16-bit VGA video controller on system board.
- Socket for Intel 80387SX math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
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- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
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Prices reflect 512 KB of RAM. 640 KB versions of the above systems are available for an additional \$50, 1 MB versions for an additional \$150, and 2 MB versions for an additional \$300.



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12.5 MHz 286

The price says it's an entry-level system. The performance says it's a lot more.

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- LIM 4.0 support for memory over 640 KB.
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THE NEW
DELL SYSTEM® 316LT

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40 MB, 2 MB RAM	\$3,999

For a limited time, get an extra battery free with every 316LT purchase.



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Prices listed reflect 1 MB of RAM. 322 MB hard drive configurations also available. 4 MB versions available for an additional \$600.

*Performance Enhancements: Within the first megabyte of memory, 128 KB (316SX, 316LT and 210), 384 KB (325) of memory is reserved for use by the system to enhance performance.
All systems are photo graphed in their optimal state. All prices and specifications are subject to change without notice. Dell cannot be responsible for errors in reproduction or photography. **Payment based on 36 month open end lease. Leasing arranged by Leasing Corp. Inc. In Canada, computers and prices may vary. DELL SYSTEM is a registered trademark of Dell Computer Corporation, Midway, MS, MS 1305 and MS 1310 are registered trademarks of Microsoft Corporation. Intel is a registered trademark and 8086 is a trademark of Intel Corporation. DELL SYSTEM is based on INTERACTIVE Systems Corporation's 386 system. UNIX is a registered trademark of AT&T in the United States and other countries. Other trademarks and trade names are used to identify the entities claiming the marks and names of their products. Dell Computer Corporation disclaims any proprietary interest in trademarks and trade names other than its own. Our service may not be available in certain remote locations. For information on our extended warranty, call 1-800-4-A-Dell. Total System Guarantee, limited warranty, on-line service contract, please write to Dell Computer Corporation, 9525 Alvarado Road, Austin, Texas 78759-2299. Attn: Warranty. ©1989 Dell Computer Corporation. All rights reserved.

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SATISFIED.**

When customers asked us to lower prices on the 25 MHz 386™ system that won *PC Magazine's* Editor's Choice and *PC World's* Best Buy, we gave a typical Dell response: OK.

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Equipped with VGA, optional Intel or WEITEK coprocessor, and hard drives ranging from 40 MB to 322 MB, it still leaves 6 expansion slots free.

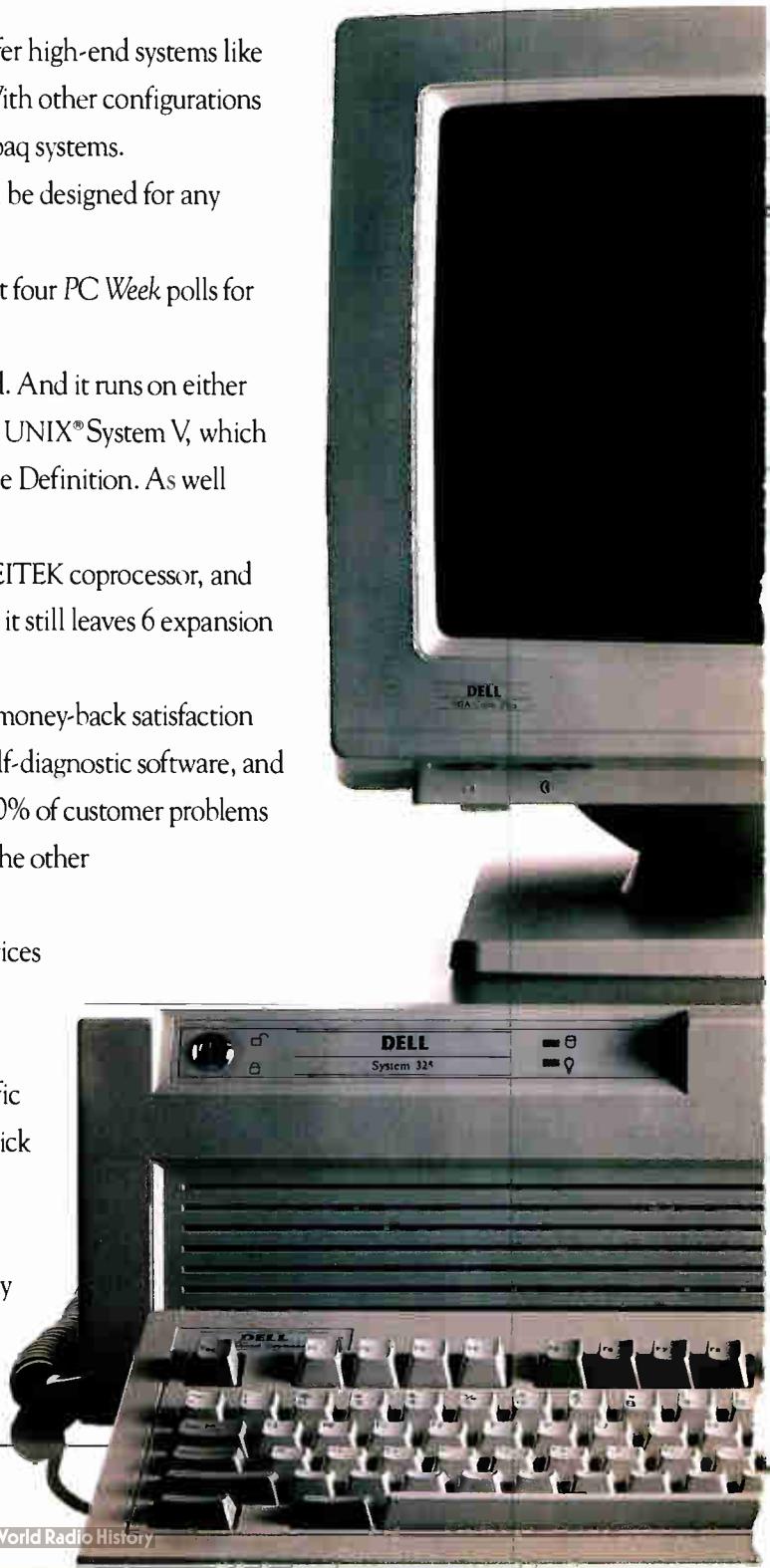
And every Dell system includes a 30-day money-back satisfaction guarantee. As well as a full-year warranty, self-diagnostic software, and toll-free technical support that solves over 90% of customer problems by phone. With next day on-site service for the other 10%, provided by Xerox Corporation.△

Why don't you check out the specs and prices on the next page. Or look through some of our other new systems.

Then, if you'd like information on a specific configuration, or have any questions at all, pick up the phone and talk with one of our sales representatives.

For that one out of five, the computers may not be free. But the phones are.

ANNOUNCING UP TO \$1100 OFF DELL SYSTEMS



7) If you could make any changes or improvements to our products, what would they be? (Please list your top three suggestions)

Just keep lowering your prices

(28-30)

7) If you could make any changes or improvements to our products, what would they be? (Please list your top three suggestions)

Reduce Cost

(28-30)

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Sell them at an even lower price

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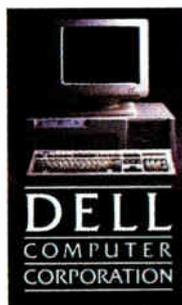
(28-30)

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GIVE THEM AWAY FREE.

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We've lowered, reduced and dropped the price of the Dell System®325. See inside for details.



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PC MAGAZINE, January 1989.
"In a field of powerhouse machines
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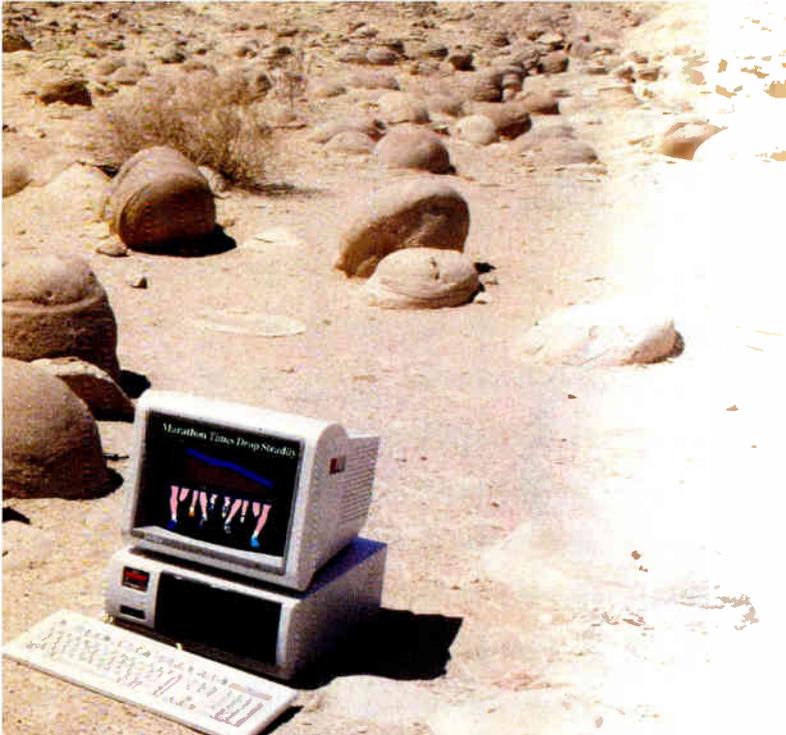
INFO WORLD, July 1989.
"ALR Systems Unleash 486 Power. The
PowerCache 4 shines in the CPU-
specific portion of the InfoWorld Auto-
mated Benchmark Test, gaining a score
of 16.3."

PC WEEK, July 1989,
"Based on a series of benchmarks run
last week on Advanced Logic Research,
Inc.'s prototype 486 desktop system,
ALR will enter the 486 market with a
bang."

At ALR, we will never rest on our laurels. We strive to be the best, as proven by our past achievements. Now with the introduction of the new ALR PowerCache 4™, we've designed a system that is far beyond comparison. Again, we have taken PC-microprocessing power a step further by designing a unique proprietary PowerCache 4 cache controller using ALR's custom ASIC chips which deliver the fastest processing speed ever.

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	ALR M130 Desktop	ALR M150, M350 M650 Floor-Standing	IBM M70-A21 Power Platform™
CPU	25 MHz i486	25 MHz i486	25 MHz i486
Bus	MCA	MCA	MCA
External Cache	128 KB cache Read and Write-Back	128 KB cache Read and Write-Back	None
Video Opt. on board	640x480 1024x768	640x480 1024x768	640x480 None
I/O Slots	6 expansion slots	6 expansion slots	3 expansion slots
Storage Expansion	4-3 1/2'	1-full height 2-1/2'-height 2-3 1/2' drives	3-3 1/2' drives
Disk Capacity	130 MB-260 MB	150 MB-650 MB	110 MB
Price	\$9,990	Starting at \$11,490	\$12,990



**California Anza-Borrego
Desert State Park**

(Cannonball-shaped sandstone. These concretions are formed of onion-skin layers of minerals resistant to erosion.)

i486TM system in the world. from the leader in 386TM technology.

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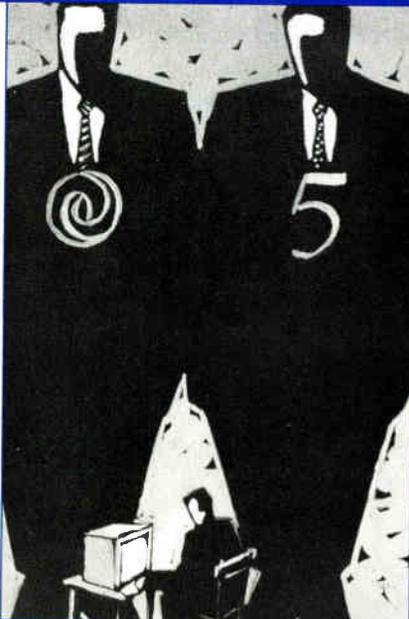
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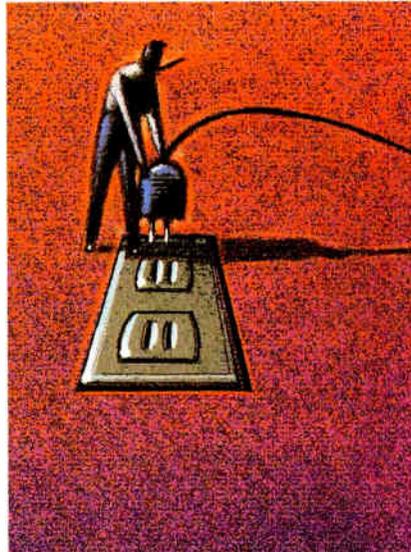
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1 The NeXT™ Computer System is the first computer in the world (and so far the only) to use read/write/erasable optical storage. While PCs today are typically equipped with Winchester drives that store 20 to 40 MB, a single optical disk can store 256 MB. Plus, it is removable, for portability and added security.



This dramatically new technology provides storage that is simultaneously vast, reliable and cost-effective—a combination unmatched by computers of any size.

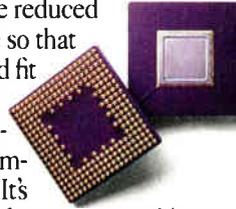
2 NeXT has made the power of UNIX® usable by mere mortals.

UNIX is the high-performance operating system used by workstations to achieve true multitasking and superior networking. Unfortunately, it has



always been the antithesis of user-friendly. NeXT has given UNIX a revolutionary new interface—one that is both visual and intuitive. Now computer users of every level can instantly wield this tremendous power, with no technical knowledge whatsoever.

3 To achieve the power needed for the 90s, NeXT bypassed traditional workstation architecture and went directly to that of a mainframe. This eliminates bottlenecks and attains an extraordinary level of system “throughput”—the true measure of computer performance. Only through the use of VLSI (Very Large Scale Integration) technology could this architecture be reduced in size so that it could fit inside a desktop computer. It’s a mainframe on two chips.



4 While PostScript® has long been the industry standard for printing, NeXT has made it fast enough to also be used on the display. This “unified imaging model” ensures that what you see on



the display is precisely what you will get on paper. All your work, in any size type and any degree of rotation or magnification, appears with perfect 92-dots-per-inch clarity on the NeXT MegaPixel Display. And with laser precision at 400 dpi on the NeXT Laser Printer.

IN THE 90s, WE'LL ONLY TEN REAL BREAKTHROUGHS. HERE ARE SEVEN.



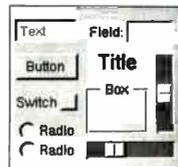
5 The NeXT Computer System is the first to be capable of producing CD-quality sound. Without requiring any additional equipment. This feat is made possible by a chip that has been specifically designed for the task of manipulating sound—the Digital Signal Processor (DSP). Because this processor is standard in every NeXT machine, software developers will be able to call upon its power to enrich programs we use every day. Now computers will not just be seen, but heard.



6 NeXT Mail takes electronic communications beyond anything you've seen on a personal computer before. Now you can send and receive multimedia mail—including text (with varied type fonts, styles and sizes), graphics and voice messages. And despite its high level of sophistication, NeXT Mail is so intuitive, you may not ever need to open the manual. NeXT Mail is built into the system, along with Ethernet and TCP/IP, so the NeXT machine can quickly become a part of existing networks.



7 Programmers can create software on the NeXT Computer up to ten times faster than on any other computer—the result of a breakthrough called NextStep.® It gives software developers the power to create the graphical user interface portion of their applications (often the most time-consuming and difficult part) without any programming at all. This revolutionary environment means we will see more programs, and better ones, in less time than ever possible before.



These seven breakthroughs will change the way we use computers in the 90s. Which is why Businessland, the leading supplier of computers to corporate America, chose the NeXT Computer System as the workstation they will offer. Call us at 800-848-NeXT, and we'll send you a 28-page brochure describing the NeXT Computer. We'll also give you the address of your nearest Businessland Center. There, you can experience for yourself the first seven breakthroughs of the 90s. And get a good idea where the next three will come from.

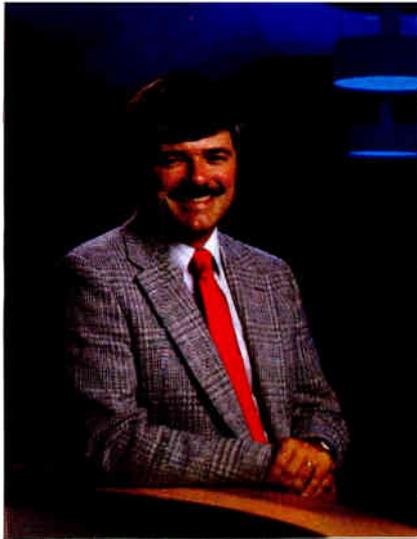


YOU'LL PROBABLY SEE BROUHOUS IN COMPUTERS. EVEN OF THEM.



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World Radio History



PROJECT NOTIFY

Out of the California earthquake, a plan to use laptop computers to assist in disaster communications

Did you try to telephone into or out of California after last fall's earthquake? Or into or out of North Carolina after Hurricane Hugo? It wasn't easy. In both cases, lack of adequate communications slowed emergency services, disrupted lives, and, in the days that followed, hindered the business of recovery.

The problem wasn't the telephone systems themselves. In fact, in both instances, the telephone systems came through remarkably well. Instead, the systems simply bogged down from the incredible volume of calls.

To those of us inside the quake area (the BYTE senior staff was in Palo Alto that day), the inability to call out was frustrating. To families and friends outside the quake area who saw the televised images of fire and destruction and had no idea what was happening to loved ones, the inability to communicate was frightening, even painful.

Laptops to the Rescue

The voice circuits bogged down, but some data circuits—especially the dedicated lines serving packet-switching systems, such as Tymnet—remained relatively open. Heather Barbara Clifford and Stephen T. Satchell discovered this when they began to use BIX as an informal message center for those cut off by the quake.

Here's how it worked: Using battery-powered laptop computers, people in the San Francisco area would call BIX on a packet-switching service's local dedi-

cated data line. Once connected to BIX, they'd send Heather E-mail containing the names and telephone numbers of family members who needed to be contacted, plus a brief message. Heather and Stephen (living outside the quake area) then used their normal voice telephones to relay the messages.

Volunteering their time and telephones in this fashion, Heather and Stephen ("bjc" and "ssatchell" on BIX) helped people from as far away as Argentina stay in touch with family and friends in the Bay Area.

Besides performing a much-needed humanitarian service, Heather and Stephen also realized that they were onto something: an idea that could be useful during any disaster, anywhere there were laptop computers, dedicated data lines, and volunteers. Thus, "Project Notify" was born.

Project Notify

The purpose of Project Notify is to provide supplementary communications channels for private citizens in areas hit by certain disasters of natural or human origin.

Using the dedicated, nonvoice data lines managed by Tymnet, Telenet, and similar carriers, Project Notify's volunteers can help shift personal traffic (e.g., messages of reassurance from people in affected areas to friends and family in other parts of the country) away from voice lines and the ham-radio network, leaving those media freer for use by emergency-aid agencies and other authorities.

Project Notify already has been incorporated as a not-for-profit business and has started work in a number of areas, including the following:

- researching ways to use existing and emerging commercially available computer technology
- working with network and information-service vendors to

- establish communications channels
- organizing volunteers with computers, particularly battery-powered laptops and systems with power sources other than the electrical-power utilities
- working with emergency services and other organizations to draw up plans for coordination and cooperation during disasters
- developing software for the central message database and to automate telecommunications access for volunteers
- developing and distributing procedural manuals and field kits for volunteers
- producing educational materials for schools, TV, and newspapers to promote Project Notify and encourage the public to use its services (concentrating on explaining why blindly calling into a disaster area is ineffective and even harmful)
- coordinating with the American Red Cross, the Salvation Army, the United Way, the American Radio Relay League, the Federal Emergency Management Agency, and numerous other organizations involved in disaster relief

Heather and Stephen are trying to do something very worthwhile here, and I hope that they succeed. Right now, they need volunteers and tax-deductible donations. If you would like to be a part of Project Notify, please write, call, or send E-mail to:

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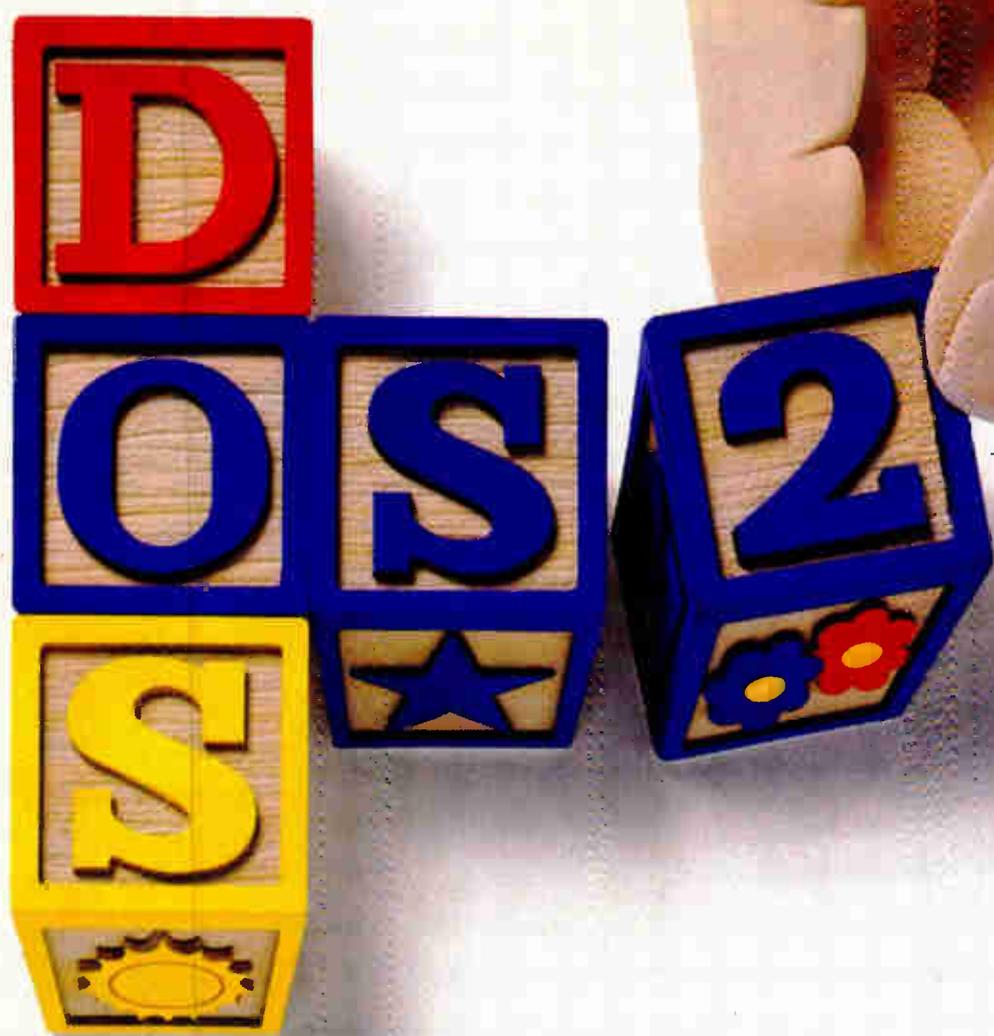
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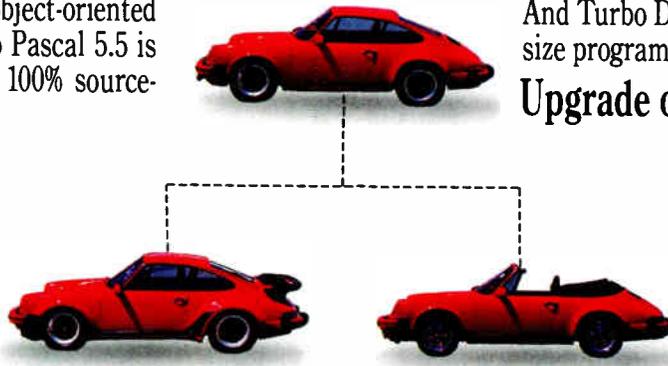
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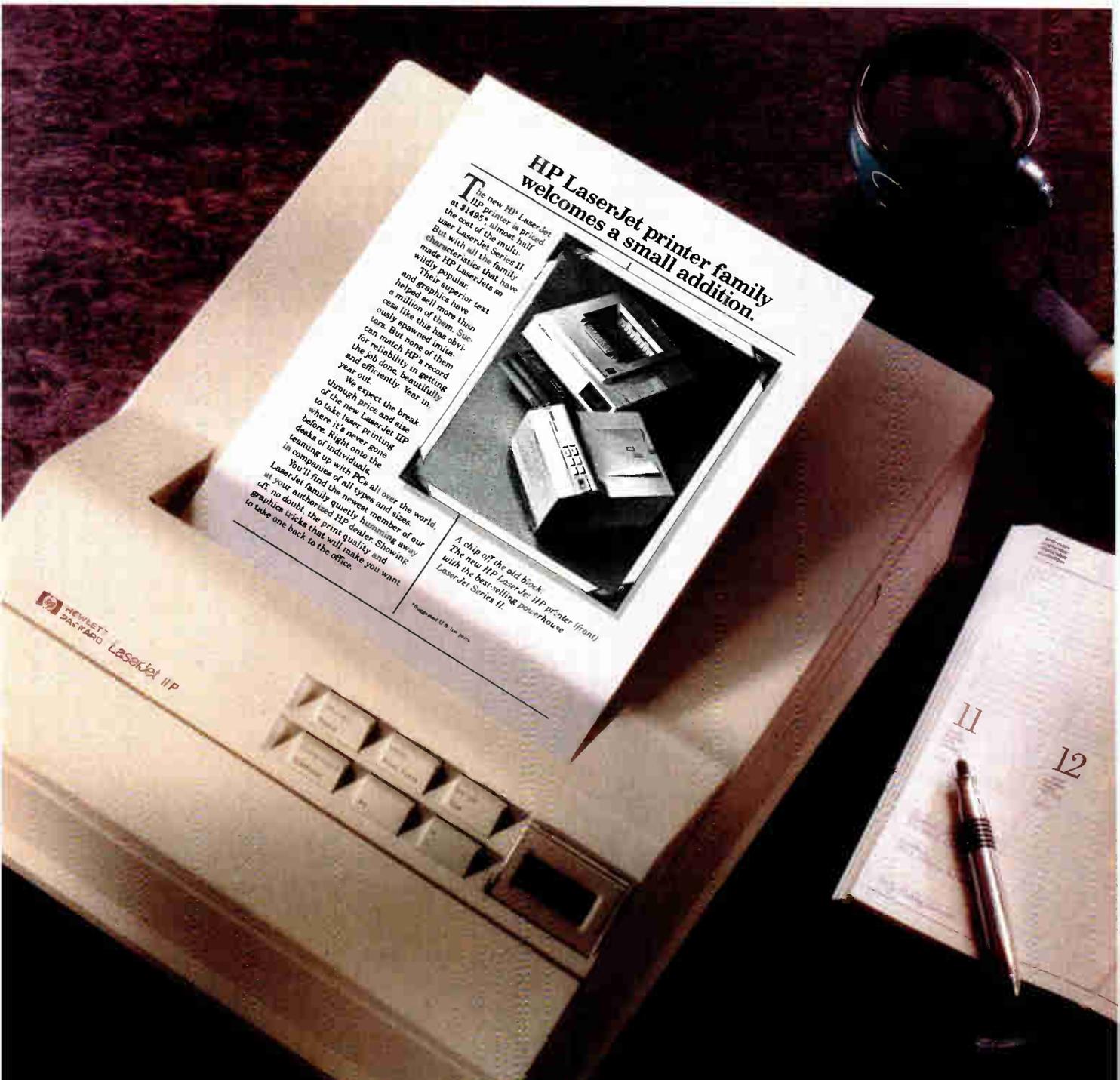
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MICROBYTES

Staff-written highlights of developments in technology and the microcomputer industry, compiled from Microbytes Daily and BYTEWEEK reports

POSIX to Reach Beyond Unix to Other Systems

A major force in guiding Unix computer vendors and applications developers toward operating-system standards has been the IEEE's POSIX committees. POSIX basically consists of a set of standards designed to ensure the portability of software applications among various implementations of Unix.

But the POSIX standards will go well beyond the Unix operating system, according to Digital Equipment's Jim Isaak, one of the POSIX committee chairpersons. The Washington, D.C., based IEEE has set up working groups that are ironing out standards for networking, security, real-time operating systems, administration, and other aspects of a complete computer system. Isaak says it is likely that other operating systems will eventually conform to POSIX standards.

DEC, Hewlett-Packard, and Unisys, for instance, are in the process of standardizing their proprietary operating systems on POSIX. Isaak says that Microsoft has been very active in POSIX committees and could conceivably adapt OS/2 to conform to POSIX. But since one of the basic assumptions of the standard is a multitasking operating system, single-tasking systems such as MS-DOS or the Macintosh Finder could not

conform to POSIX (even Apple's System 7.0 could not conform, since it will not include shared memory and preemptive task scheduling).

While POSIX might be the best hope for consistent software standards, little of the work is complete. Thirteen committees are at work on different standards; the only proposal completed is the System Services and C Language Binding standard, which defines the operating-system interface and file structure. Virtually all Unixes on the market today claim to conform to this standard, and U.S. government procurement contracts require that Unix systems conform to it.

The next to be completed, according to Isaak, will be the Shells and Utilities standard, expected in March. The Real-Time Extensions standard will follow in about a year, he says.

But POSIX is no panacea promising a single harmonious standard. "There will always be incompatibility," Isaak says. "It's the difference between specification and implementation." And POSIX ensures compatibility only at the source code level. Binary incompatibility will always exist among different hardware platforms. However, the closer all systems come to conforming to POSIX, the better the environment will be for software developers.

Proposed Interface Could Take the Pain out of Connecting Peripherals

Hooking up a personal computer to a "standard" peripheral like a hard disk, CD-ROM, or optical disk drive is a common task that can be an exercise in frustration for some computer users. That's because there's no truly standard way for different kinds of drives to communicate with standard personal computers. Even the so-called SCSI standard isn't always standard; each manufacturer essentially does its own thing.

Realizing that the problem will only get worse when Extended Industry Standard Architecture (EISA)

bus personal computers start appearing this year, a group of six peripherals manufacturers has united to define a standard interface for connecting peripheral controllers to personal computers. The Common Access Method (CAM) committee consists of hard disk drive makers Maxtor, Seagate, and Quantum, as well as hard disk drive controller makers Western Digital, Adaptec, and Distributed Processing Technology.

The CAM group's proposed interface, called EATA (for Enhanced

continued

NANOBYTES

As we were leaving the 1980s, it seemed a day didn't go by without someone announcing an Extended Industry Standard Architecture machine. The decade in which personal computers had become commodity items ended with manufacturers rushing toward high-end, high-ticket systems. Compaq, formed seven years earlier by a few Texans whose other business alternative was starting a Mexican restaurant, announced two 80486-based EISA machines that run in the neighborhood of \$20,000.

One company that did not announce an EISA system is Epson, even though it was one of the nine companies that helped develop the EISA bus. Epson will "wait and see" if there's a big demand for computers based on the new 32-bit bus. "Our customers don't expect us to be at the forefront of technology," said Epson's vice president of marketing, Steve Lapinski.

NCR (Dayton, OH) declared itself to be a Micro Channel house. The company introduced an 80486-based MCA system, featuring a high-speed bus-mastering SCSI disk drive controller, and said that this year it would come out with MCA systems ranging from the low end up to workstations and servers.

AT&T and Unix International started shipping the new Unix System V release 4 to developers. One of the most notable features of the new operating system is its support for three graphical interfaces: the X Window System, X11/NeWS, and Open Look. Unix V.4 incorporates features from several flavors of Unix, including Sun's SunOS, Microsoft's Xenix, and BSD 4.2 and 4.3. Some of the companies that have said that they will adopt the new version are Motorola, Lotus, NEC, Toshiba, Dell, Commodore, and Fujitsu.

NANOBYTES

Intel (Hillsboro, OR) announced a version of **Unix** for its processors that takes advantage of the Applications Binary Interface codeveloped by Intel and AT&T and incorporated into the latest Unix. Intel's Unix System V/386 release 3.2 is ready now, and release 4.0 should ship during this quarter, the chip maker said. That version will incorporate the functionality of Unix V.4, as well as support X Window and TCP/IP.

The Software Publishers Association (Washington, DC) reports that **U.S. software houses** are doing enormously well in certain **overseas markets**. The SPA polled 20 companies for their international sales figures, including Microsoft, Lotus, WordPerfect, Borland, Computer Associates, Software Publishing, and Claris. According to the SPA's figures, the 20 companies sold \$308 million worth of software in Europe and Australia during the first half of 1989. Most of the activity was in England and Ireland (\$77 million). The fastest growing market for American software was Iberia. Total sales were lowest in Italy (\$10 million).

Borland has handed over its Turbo Basic programming environment to the man who developed it, Robert Zale. Zale in turn reached a deal with **Spectra Software** (Sunnyvale, CA) whereby Spectra will publish future versions, including the new 2.0, under the name of PowerBasic.

IXI Limited (Cambridge, UK) has brought its X.desktop to OSF/Motif. Earlier versions of the graphical file manager were built on top of the X Window System. X.desktop gives you an iconic representation of files, directories, and programs on a Unix-based computer or network. As an alternative to a Unix shell command line or just a menu, X.desktop lets you run programs and manage files by manipulating icons. IXI says that IBM is evaluating the product for its AIX line (which is rumored to be coming this quarter).

AT Attachment), was developed by DPT and is supposed to give peripherals makers a growth path to higher-performance EISA systems while maintaining backward compatibility with existing software (i.e., both applications and operating systems) and the hardware.

CAM wants the industry to standardize on one method for attaching SCSI host adapters and other disk drive controllers to both AT-bus and EISA-bus systems. This would eliminate the need for different device drivers for each operating-system/controller combination. As conceived by the CAM committee, a controller using the EATA interface would work with SCSI, ESDI, ST506, and all other peripheral interfaces.

In designing the interface, the CAM group is using a layered approach to standardization. At its highest level, the common access method consists of specific library calls for different operating systems. The lowest layer (the actual hardware interface) is where EATA comes in.

EATA is actually an extension of the Western Digital WD1003 controller interface, a commonly used hard disk drive controller interface.

The CAM committee is proposing two compatible versions of EATA—one for the AT bus and one for the EISA bus. Even though the EATA specification is designed to eliminate special device drivers, it won't prevent manufacturers from writing their own special high-performance device drivers. The key point is that a device driver won't be required for the peripheral to work with the computer.

Although the main focus of the EATA standard is on hard disk drives, EATA adapters will also need to communicate with nondisk devices, such as tape backup drives or CD-ROM readers. EATA will allow this by "passing through" SCSI commands directly to nondisk devices.

For copies of the proposed EATA standard, contact Distributed Processing Technology, 132 Candace Dr., P.O. Box 1864, Maitland, FL 32751, (407) 830-5522.

Intel, Alliant Develop Specifications to Boost Parallel Applications for RISC Processor

Intel and Alliant Computer Systems are developing specifications and products that they hope will boost parallel computing applications for Intel's 80860 processor. They hope that their new Parallel Architecture Extended (PAX) specifications will allow shrink-wrapped programs to run unmodified on computers ranging from single-processor desktops to multiprocessing supercomputers.

PAX is a set of rules and software extensions to the existing binary interface of the 80860 chip. Intel says that compliant applications will be able to take advantage of an arbitrary number of 80860 processors to spread their work around and thus improve performance.

PAX is designed to facilitate loop-level, or "medium-grained," parallelism, in which multiple processors execute loop iterations of a single problem by passing variables and semaphores through a shared memory space. This is different from course-grained or program-level parallelism, in which each processor addresses its own private memory, requiring source programs to be structured into separate tasks or threads.

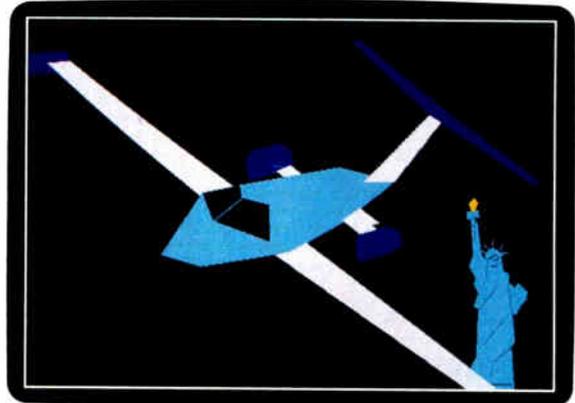
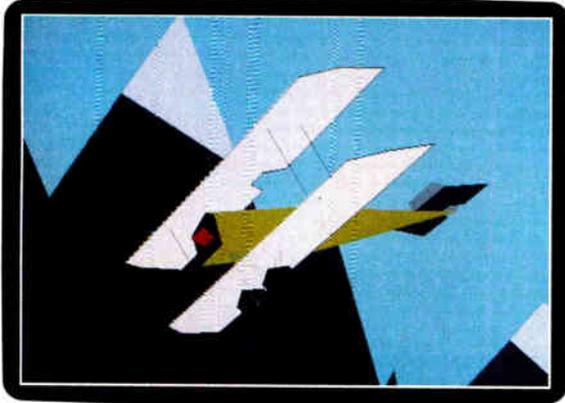
The two companies plan to specify conventions ranging from the high-level application programmer interface (API) to the binary interface (ABI) of the 80860. The heart of the standard will be a set of new compilers and libraries licensed by Alliant to Intel. Alliant will port its parallelizing C and FORTRAN compilers to the 80860 and develop libraries of scalar and vector math functions for use by PAX programs.

Alliant's PAX-compliant compilers will take advantage of the 80860's instruction-level or fine-grained parallelism. The 80860 permits integer, floating-point add, and floating-point multiply functions to occur simultaneously through three separate ALUs built into the chip. The compiler must divide and synchronize instructions between the ALUs.

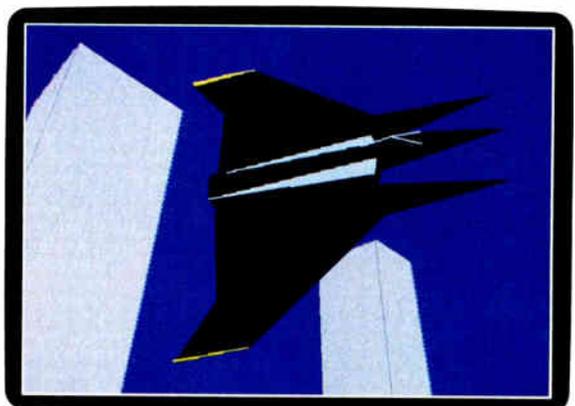
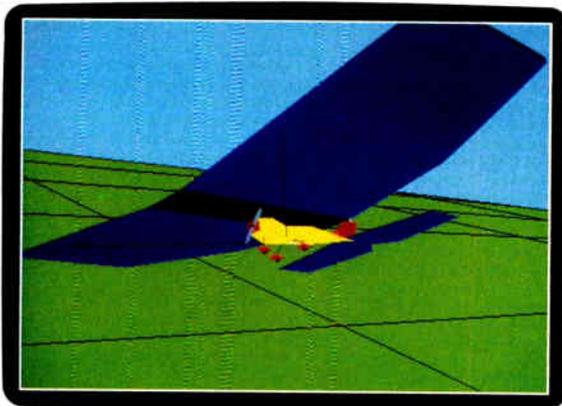
Alliant plans to use 80860s in future generations of its supercomputers, while Intel will incorporate new PAX standards into the 80860 binary interface. The first available PAX-compatible product, under development now by Intel and other companies, will be a multiprocessor version

continued

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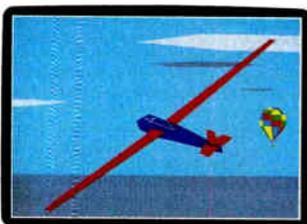
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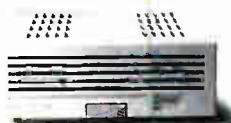


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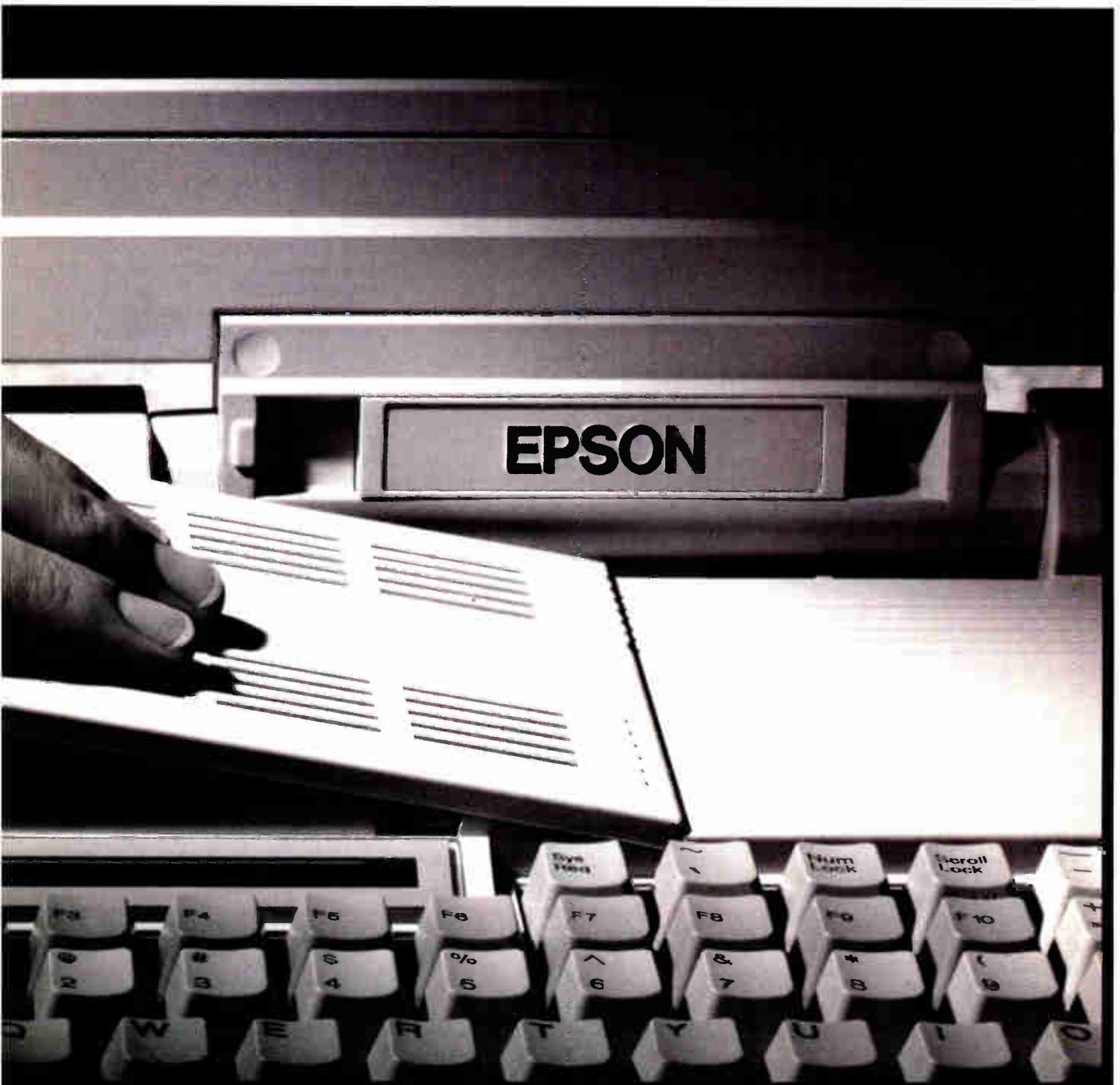
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NANOBYTES

The NeXT cube, which Steve Jobs calls the computer of the 1990s, is getting some support from mainstream software companies, which is what the machine will need to make it through the 1990s. Informix, WordPerfect, Aldus, and Lotus have all said that they will bring programs to the NeXT system. SouthWind Software (Wichita, KS) claims to already have a spreadsheet for the NeXT; Tactician Plus (\$425) can read Lotus 1-2-3 files using a translation utility. So it looks like the cube will have not one, but three, spreadsheet packages. Jobs says that the question corporate computer users ask him most often about the NeXT machine is, "Where's your spreadsheet?"

Meanwhile, NeXT (Palo Alto, CA) came out with a "network user" model of the cube that comes with a 40-megabyte hard disk drive but without the standard 256-megabyte optical disk drive. The hard disk is meant to be used for swapping applications out of RAM rather than temporarily storing them on the slower optical drive; it's not designed for storing files permanently. In one of the better upgrade policies of the century, NeXT says that people who bought one of the optical-only cubes can get the hard disk drive for free. With this new configuration, "NeXT now has the equivalent of a 'diskless' workstation, allowing it to compete more readily with Sun, Apollo, etc.," said Bruce Webster, author of *The NeXT Book* (Addison-Wesley) and former BYTE columnist. According to Webster, the network model is faster than true diskless workstations because it swaps files locally rather than over the network.

Bellcore (Livingston, NJ) is testing an E-mail system among elderly citizens in Miami. Response to the prototype Plain Old Mail Service has been quite favorable, a spokesperson said. The participants in the experiment, none of whom had used computers before, have organized social events and put together a cookbook using the E-mail system. Each user gets a terminal and a dot-matrix printer.

of the new Unix System V release 4.

The advantage of PAX, Intel and Alliant say, will be its effect on the growth of parallel computing. With a standard ABI that accommodates varying hardware configurations,

developing programs that use parallelism should be faster, easier, and less expensive. That, in turn, should boost both the number of available applications and the hardware platforms on which to run them.

Microsoft, IBM Define Their Intentions for Windows, New Editions of OS/2

For weeks there were headlines about "user confusion" over Windows and OS/2, stories about IBM developing its own Windows kind of program for DOS, analyses and commentaries that Microsoft was now pushing Windows because "OS/2 is a dog," and gossip about a "falling-out" between the two companies. Microsoft chairman Bill Gates and manager of IBM's Personal Systems division Jim Cannavino called a press conference at Comdex to state some of their intentions regarding those two operating environments.

Gates made several announcements and promises. The 32-bit version of OS/2 designed to exploit the 80386 and 80486 processors will be in developers' hands by now and available to users sometime this year. OS/2 2.0, as it's likely to be called, will include demand paging, 32-bit linear addressing, and capability to run multiple DOS applications concurrently; it will do a few things the 16-bit implementation never will, such as symmetrical multiprocessing and support of object-oriented modules, Gates said. Besides the 80386 or 80486 CPU, this luxury edition of OS/2 will need 4 megabytes of RAM to run, he said.

OS/2 1.2, then, will be the "low-end" OS/2, the one for people using an AT-type machine with 3 megabytes of RAM. Gates said that they will eventually get the memory requirement down to 2 megabytes, but he didn't say how. They've already reduced the RAM needed to run version 1.2, partially by making the

DOS compatibility box "swappable," which means its 512K bytes of reserved space can be liberated when DOS applications aren't running.

As for Windows, it will be positioned as the entry-level environment for IBM systems with less than 2 megabytes of RAM, Cannavino said. He also pointed out a few things that Windows will not be: It won't be a server platform, he said, and it will never have the features found in OS/2, such as distributed processing, a 32-bit flat memory model, multiple threads, and long filenames.

Both companies said that by the middle of this year, they'll bring out new graphical applications, first for OS/2's Presentation Manager and then, if at all, for Windows. Some people at Comdex speculated that this primary emphasis on OS/2 was evidence that Gates had been taken to the woodshed and told to stop monkeying with Windows.

As for "PM Lite," the junior version of PM for DOS that IBM was considering, that would appear to be stalled in the "technical feasibility" stage. This graphical interface would have run on extended DOS and possibly competed with Windows (although IBM hasn't had much luck with DOS shells; remember TopView?).

IBM and Microsoft have now defined their united vision of graphical operating environments, and it looks sort of like the U.S. economic model: There's a lower class (Windows users), a middle class (OS/2 1.2), and an upper class (OS/2 2.0).

Programming Tool Brings PM Look to DOS

So maybe PM Lite will never see light of day. One of its likely would-be components, though, could have an impact of its own on software developers. That component is a programming tool designed for in-

house use by Cyco, an Atlanta company known for its usually mispronounced name (it's "seeko," not "psycho") and for its AutoManager program (basically a graphical

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Historic.



NANOBYTES

Motorola's new 96002 floating-point **digital signal processor** is compatible with its 24-bit multiply, fixed-point DSP56001 used in the NeXT Computer. The 96002 supports 32-bit multiplication and floating-point operations. The chip is targeted primarily at three-dimensional graphics and image processing applications, as well as simulation and large-memory applications. Some of the targeted algorithms to be supported by the 96002 are Phong shading, matrix multiplication, and polynomial evaluation, Motorola says. The 96002 will be available in sample quantities early this year, the chip maker says.

Newer Technology (Wichita, KS) has a new line of memory-expansion kits for IBM PS/2s. The snap-in modules of 80-ns RAM can add from 512K bytes to 16 megabytes of memory.

Interactive Systems (Santa Monica, CA) said at Unix Expo that it has the first commercial operating system based on the new Unix System V.4. Interactive's 486/ix will run on 80386- and 80486-based computers and will use the company's 386/ix X11 windowing system.

Toshiba (Irvine, CA) has released the first commercial **battery-powered gas-plasma display**. The orange-on-black VGA-type screen made its debut in Toshiba's battery-powered 80386SX-based T3100SX. The company says that the display, which can show 16 shades of gray, consumes only 3 to 10 watts, while similar units need as much as 35 watts. The display system can also generate the image on the built-in screen onto an external monitor simultaneously.

Dell Computer (Austin, TX) seems to drop its prices every month. This time it's memory products. For example, 512K-byte kits dropped by \$50 to \$150, 1-megabyte kits fell by \$180 to \$299, a megabyte of static RAM slid by \$250 to \$399, and 4-megabyte memory kits now sell for \$799 instead of \$1299.

database for AutoCAD drawings).

Cyco PM brings a subset of the OS/2 Presentation Manager application programmer interface to the DOS world. This subset, which takes up only about 70K bytes of RAM, integrates text and graphics into a graphical environment with little overhead. Cyco used PM to produce its latest version of AutoManager rather than port the program to Microsoft Windows (product manager Ronald Van Woensel says he rejects Windows because it puts an operating system on top of DOS and limits applications to 350K bytes).

Cyco PM is intended to enable programmers to develop code for both Presentation Manager and DOS graphics applications without extensive rewriting. It's done with some interesting tricks, such as treating text essentially as low-resolution (80 by 20 pixels) graphics screens.

The company hasn't decided if it will release Cyco PM as a stand-alone product for developers. Van Woensel claims that developers who have seen it have responded favorably. If Cyco does release Cyco PM as a commercial product, it could change things for programmers. DOS applications developed under Cyco PM don't require users to lay out extra dollars for a graphical user interface, such as Windows. Although products like Ventura Publisher (which runs under GEM) do include an integrated GUI, the important point is that Cyco PM applications would look similar to PM programs. For users, this would eliminate at least some of the PM learning curve when (and if) they later upgrade to OS/2. But for software designers, Cyco PM could provide a streamlined way of developing applications for both DOS and Presentation Manager.

X Interface Designer Coming to Workstations

A new user interface management system for the X Window System will bring to developers interactive design capabilities similar to those of the NextStep interface, one of the key selling points of the NeXT Computer. Visual Edge Software (Quebec, Canada) says that its UIMX will allow developers to design and prototype user interfaces running on top of Unix-based applications under the X Window System, building "X Widgets" such as icons, command buttons, windows, sliders, and pop-up menus. The program incorporates an ANSI C interpreter for linking the designed interface to the application.

Visual Edge says that it has signed distribution agreements with Hewlett-Packard, AT&T, and Control Data to put the development tools on their hardware. According to HP marketing manager Ed Lee, HP will announce a

version of UIMX for its 68000 and RISC-based Unix workstations early this year.

Whereas NextStep is "primarily oriented toward end users," UIMX is more for software developers, Visual Edge president Michael Foody says. "You could use it [UIMX] to build the NextStep interface."

One of UIMX's main features is its ability to interactively prototype and modify the interface while the underlying application is running (you cannot do that using the NextStep environment). This is made possible by use of the C interpreter.

UIMX will support the Open Software Foundation's Motif interface and AT&T's Open Look interface, Visual Edge says. This means that developers will be able to use UIMX to design interfaces that are compatible with Motif or Open Look.

Microsensors Closer to Commercial Reality

One of the most promising technologies associated with ICs is the microsensor, a miniature electronic sensing device made of silicon and other organic and inorganic materials. Microsensors could revolutionize the way we measure physical conditions, from blood

pressure to the lubricating capacity of the oil in your car's engine.

While microsensors have been talked about for several years, Teknekron and SRI International have formed a new company called Teknekron Sensor Development

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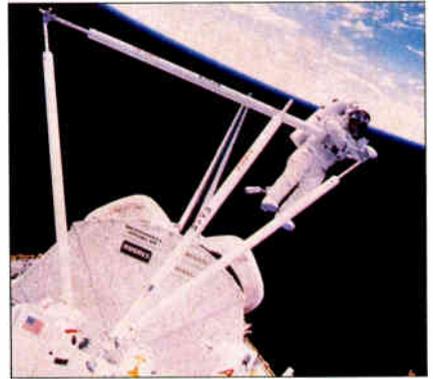
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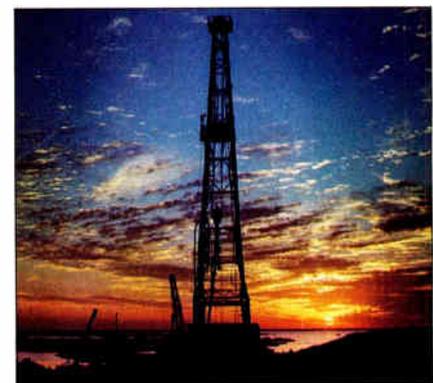
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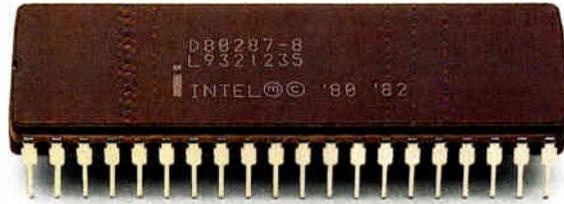
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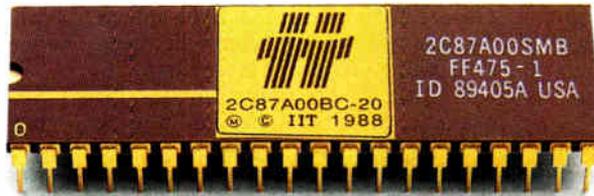
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NANOBYTES

Traditional suppliers of DOS-based applications software aren't ignoring the growth of Unix.

WordPerfect Corp. (Orem, UT), which already makes a Unix version of its word processor, says that it will upgrade that version to be more like WordPerfect 5.0 for IBM PCs. It will allow graphics mixed with text and supply more printer drivers. A release for Xenix is scheduled for this quarter.

Borland (Scotts Valley, CA) intends to develop **Unix** versions of its Quattro spreadsheet and Sprint word processor using the XDOS CAPS computer-aided porting tool from **Hunter Systems**. The new versions, slated originally to be ready this month, will work on Unix systems running Hunter's XDOS Transformer Utility. XDOS Sprint will sell for \$239 and XDOS Quattro for \$299, Borland said.

Quickview Systems has filed suit against **Apple Computer** over HyperCard, which the plaintiff says violates a patent that it holds. Quickview has a patent (no. 4,486,857) for its technology for displaying parts of a database. Quickview president Paul Heckel says he created the software for displaying overlapping "cards" in his program Zoomracks, which has been on the market since 1985. "We don't believe we've infringed any valid claims," an Apple spokesperson said. Apple filed suit in federal court to have Quickview's patents declared invalid.

Nintendo says that it will offer a **financial-services computer network** that operates with the Nintendo Entertainment System. The service will connect the video game machines to the existing on-line financial network operated by Fidelity Investments (Boston). The financial line will be part of a proposed Nintendo Entertainment System Network that is slated to open this year. The NES Network will also offer interactive games and information services, the toy giant says. We can't wait to play Super Mario Brothers Do a Leveraged Buyout.

(Berkeley, CA) to bring these minuscule devices to commercial reality.

The initial applications of microsensors will most likely be in medicine and automobiles, according to the new company's top executive, George Turin. Doctors will be able to use microsensors to bypass the time-consuming process of laboratory testing of blood or tissue samples, for example. Microsensors could also be implanted in patients to monitor conditions such as insulin levels. When certain measured values are abnormal, the sensor might be able to take corrective action—triggering the

release of more insulin, for example, or sending a small electrical charge to the heart to restore normal rhythms. In automobiles, microsensors could monitor the condition of fluids and vital engine components, determining when the oil needs changing or parts need replacing.

Microsensors "are essentially here," Turin says. The research has been done, and now the trick is to make them affordable. Microsensors won't be a success "until they cost a few bucks apiece," says Turin, but they're likely to start appearing commercially in the next few years.

Sun's Joy Forecasts Good Decade for Hardware

This is the decade in which Unix will grow like the Blob and at the same time do the Invisible Man routine. That's sort of the picture drawn by Bill Joy, Sun Microsystems' vice president of R&D, at Unix Expo in New York recently. Joy, who as a graduate student helped build AT&T's 32V Unix for Digital Equipment's VAX into what's known as Berkeley Unix (a.k.a. BSD), says the operating system will be taken for granted in the near future. The really interesting changes will take place in hardware. The era of innovation in operating systems is apparently over: "Operating

systems are not the frontier for the 1990s," Joy said.

Every desk will be topped with systems capable of producing realistic sound and video, Joy predicted. The world's first affordable 100-million-instruction-per-second desktop computer will run Unix, he said, and it will not have a monochrome display, an Intel processor, or an AT bus; these are as good as dead, in Joy's scenario. "It's clear to everyone that RISC is the next wave," and it's that technology, which is used in Sun's SPARCStation, that will allow systems to double in performance every year, he said.

New Adapters Reduce Headaches, Genoa Says

Genoa Systems (San Jose, CA) has developed new graphics adapters that the company says are the first to offer 70-Hz refresh rates in standard VGA mode (640 by 480 pixels) and under. The 70-Hz rate of the new Model 6000 series means a "more stable," flicker-free display with better picture quality, Genoa spokesperson Betty Chin says.

You need a multifrequency monitor to see the benefits of 70 Hz. "From across the room you can't tell the difference between 60 and 70 Hz, but if you sit in front of the monitor,

70 Hz means fewer headaches," Chin claims.

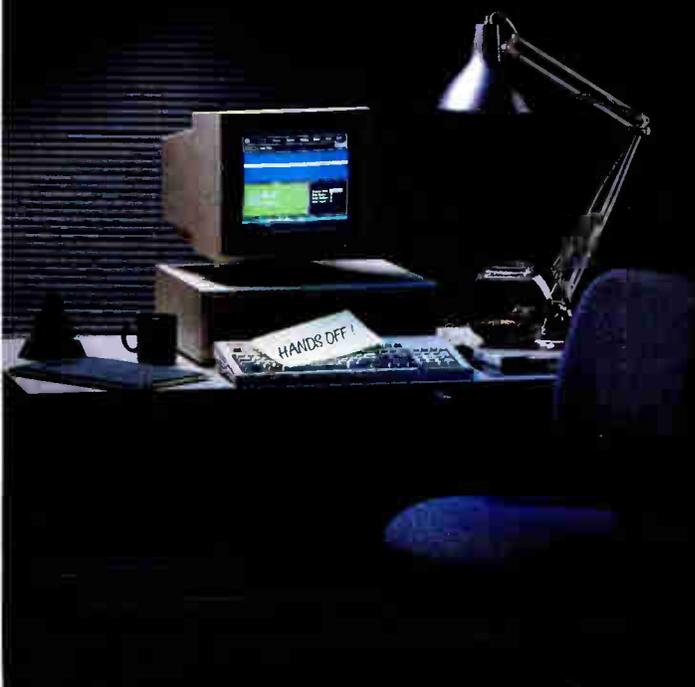
The top-of-the-line adapter is the Model 6600 (\$549), designed for IBM's PS/2 Micro Channel Architecture systems. It offers 1024- by 768-pixel resolution with 16 colors.

Genoa also has a new Super VGA application-specific IC chip, which supports the 70-Hz refresh rate in normal VGA mode on multifrequency monitors. The chip implements the new Video Electronics Standards Association (VESA) technical standards for Super VGA performance.

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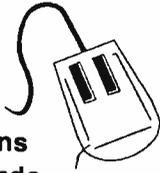
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LETTERS

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Multiuser Mail

I found your September 1989 Product Focus on multiuser operating systems ("The Multiuser Solution") biased and inaccurate.

First, the benchmarks included functions that networks might be expected to perform the least well (biased heavily toward raw file I/O) and that a multiuser operating system (not having the overhead of the network communications) might be expected to perform to greatest advantage.

Second, your cost comparisons are skewed. A Novell LAN can cost less per workstation than the multiuser operating system approach. You can buy a perfectly fine AT-compatible workstation for \$1000 or less—not the \$2100 that you stated.

Your price comparison also quoted \$400 for a network card. Current street prices for the SMC ARCnet cards are about \$130, and the clone ARCnet cards cost \$70 to \$80 each.

Perhaps the most outrageous misrepresentation was the use for comparison purposes of SFT NetWare at \$4695, even for a three-user system. One would typically use ELS Level I (around \$500) for up to four users, or ELS Level II (around \$900) for up to eight users. Even for the 20-plus user solution, one would be more likely to use Advanced NetWare 2.15, which has a street price of around \$2000.

You also talk about 10 and 20 or more user systems, when, by the article's own admission, not one of the multiuser systems tested even worked for all tested software in any such configuration. A

multiuser system is no bargain at any price if it doesn't work.

As a pioneer of the modern LAN (Datapoint introduced my ARC System 12 years ago), I find it offensive that blatant misrepresentations of relative cost and performance figures continue to perpetuate the myth that multiuser shared-processor systems are either significantly less costly or better performing under nearly any real-world situation than a properly configured LAN.

Gordon E. Peterson II
Paris, France

Your letter brings up a few points that deserve clarification.

We ran these systems both as LAN equivalents and as a workgroup of individual computers. The line graphs (page 152) reflect the performance of the multiuser software as a LAN equivalent. While it's true that these tests are heavily I/O-based, they were designed to show the multiuser operating system's effectiveness as a LAN substitute. Applications such as AutoCAD redraws use no disk I/O and would not be affected by a LAN. The repagination and other CPU-intensive testing that you mentioned were done between operating systems—the results are shown in the bar graphs (page 153). Including the LANs in this test would have been the same as including a naked DOS machine.

A LAN workstation can be had for much less than our stated list price of \$2100. In the same fashion, the multiuser hardware can be purchased for a street price far below the standard list. As a rule, we use name-brand products and manufacturer's list pricing for comparisons whenever possible. As for using SFT NetWare on a small network, clearly that would be overkill. The performance charts demonstrate that the SFT NetWare overpowered the multiuser network by a good margin. Although you would never specify the network that way, I priced the configuration the way it was tested. ELS would certainly have cost less, but it would have provided less performance.

continued

WE WANT TO HEAR FROM YOU. Please double-space your letter on one side of the page and include your name and address. We can print listings and tables along with a letter if they are short and legible. Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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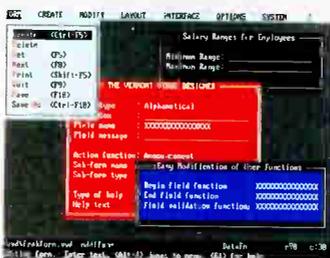
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On one of your points, you and I agree completely: No software is a bargain if it doesn't work. Anyone looking to use a multiuser operating system instead of a LAN should evaluate his or her needs carefully. The operating system might not run all software and might not provide the same level of performance as the separate CPUs on a LAN. Workgroups that run CAD, for example, would not be a good place for a multiuser operating system.

Pricing a large number of components from different manufacturers is always a tricky business. You may not agree with our "list price" policy, but even if we reduced the chart to street prices, we still believe that a multiuser operating system can be an effective alternative to a LAN for some applications.

—Howard Eglowstein

"The Multiuser Solution" was an interesting and timely article. I have been us-

ing an 80386 clone with two Wyse WY-60 terminals for three years now. My initial system was a Suntech 386 with 2 megabytes of memory using PC-MOS/386. Six months ago I replaced the computer with a 20-MHz Northgate 80386 with 4 megabytes of memory and replaced the operating system with Concurrent DOS 386. My total costs were as follows: computer, \$4000; two Wyse terminals, \$1200; Concurrent DOS 386, \$300; and wiring, \$25; for a total of \$5525. This breaks down to \$1842 per user—less than half the price quoted in your article.

Concurrent DOS can use the shadow RAM above 640K bytes for the operating system, allowing almost a full 640K bytes for applications. In addition, by changing the setup for LIM emulation, maximum memory per process, and the align command, I suspect that there will be fewer compatibility problems than you think. Having spent two years living in fear and awe of PC-MOS/386, I find Concurrent DOS 386 a joy to use.

Philip R. Loria Jr.
Metairie, LA

MinisPort Disappoints

When I saw the picture of the new Zenith MinisPort ("The Ever-Shrinking, Ever-Expanding Laptops, August 1989), I was excited that a new, small, and relatively inexpensive laptop computer was on the market. But after reading the article, I was disappointed.

Compared to the Toshiba T1000, the MinisPort uses the same 80C88 CPU, weighs about the same, is about the same size, and has a little more memory and a few more features. The big difference is that the Zenith costs \$2000, while the Toshiba usually sells for under \$700. To top it off, the MinisPort has a 2-inch floppy disk drive that is compatible with nothing.

Good grief—don't these companies look at their competitors' products before they market something?

Ron Kurtus
Los Angeles, CA

Lonely at the Low End

Sometimes the last page happens to be the best one in your magazine. This is true for Nick Baran's Stop Bit piece, "The Loneliness of the Low-Budget User" (August 1989). I feel the same as Nick when he writes that most hardware manufacturers concentrate on high-end machines.

There is a simple reason for this: the poor code produced by programmers. Scroll through a few programs with

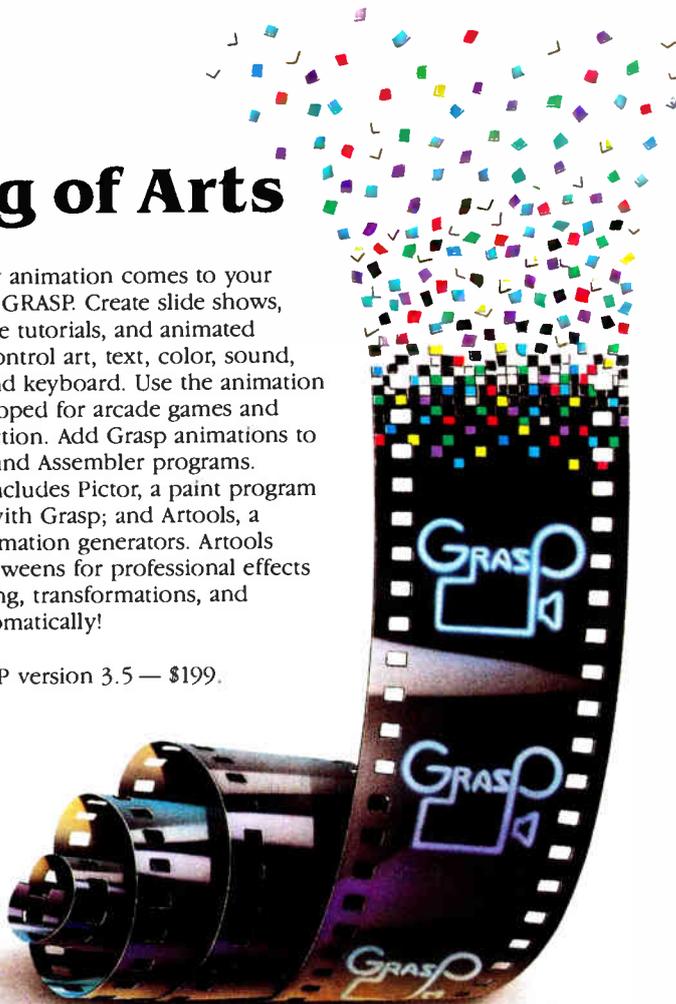
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World Radio History

Debug, and you'll find kilobytes of NULs, never-called run-time modules, and inefficient subroutines, such as putting an ASCII character into an 8-bit register using two 16-bit stack operations.

Therefore, we require more and more memory and even faster hardware to achieve the same performance as in the old days, when much software was pure assembly code. Is this real progress?

Herwig Feichtinger
Petershausen, West Germany

In reference to Nick Baran's August Stop Bit: Amen!

Erwin Fix
Fort Myers, FL

"First Computer" Debate Continues

In correcting G. Michael Vose's claim that Atanasoff invented the first electronic computer, John William Mauchly Jr. resurrects the ENIAC's claim to this title (July 1989 Letters). However marvelous an accomplishment that early postwar machine may have been, the British wartime vacuum tube machines have a truer claim.

Brian Randell's chapter in *A History of*

Computing in the 20th Century (Academic Press, 1980) tells the story. His account makes clear that the Colossus machines, of which about 10 were operating on a 24-hour duty cycle by the end of the war, were like the ENIAC in being plug-programmable only, not stored-program, universal machines in the modern sense.

The fact that those of us who worked with the Colossus range were inhibited until the 1970s by wartime secrecy from mentioning their existence explains the widespread persistence, especially in the U.S., of the false belief that the ENIAC was the first electronic computer.

Donald Michie
Chief Scientist
The Turing Institute
Glasgow, Scotland



ASK BYTE

Write Protection, Revisited

In your September 1989 issue, you provided a procedure to hard-wire a write-

protect switch for a hard disk drive. The concept is correct, but you neglected to mention three associated problems.

The first and most obvious problem is the very real danger of voiding the warranty on both the controller and the disk drive.

The second problem is noise. Modifying the controller cable might allow stray signals to enter the cable, thus affecting the reliability of the data.

The third problem is electromagnetic emissions. Every computer and peripheral has been designed and tested to prevent the release of RF energy. Modifying the controller cable will alter the design specifications and, in all likelihood, will allow RF energy to escape.

If the author of the letter, Louis Robichaud, really requires write protection, he might want to try a software package that I have used, Vfeature Deluxe, from Golden Bow. It lets you partition a disk in such a manner that you have to "mount" the disk before you can access it. You can also specify a password, thus providing a second level of access control. If the drive has not been "mounted," then for

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all intents and purposes, it does not exist to the operating system.

Modifications such as what you suggested are obvious deviations from the manufacturer's specifications, and—if there is a problem—Robichaud will probably have trouble getting warranty service. The stiff fines that could be imposed by the FCC are also something to consider.

Richard Levey
Elmont, NY

My cable modification was carefully concocted so that there would be no modifications to either the disk drive controller or the drive itself and so that the modification would be easily reversible. Your point concerning noise may be a valid one, but not for corruption of the data. The cable modification was done only on the control cable. The data cable on a modified frequency modulation (MFM) drive is separate. Any noise entering through the cable split would affect the

WRITE GATE signal, not the data. I did a fair amount of testing with a modified cable before printing the response. Considering the low bandwidth of the signal on the affected lines, noise should not be an issue.

On the warranty issue, I checked with Western Digital, the manufacturer of the most popular MFM controller and a number of MFM hard disk drives. The company agreed with me that if the cable is modified as I suggested and the controller and drive are left unmodified, there is no reason why the warranty should be voided.

Your last point, concerning RF emission, is an interesting one. Western Digital does not specify a maximum length for the ribbon cable between the controller and the hard disk drive. Indeed, no one does. Ribbon cables radiate RF like crazy, and there's no reason why the WRITE GATE line on a separate cable should be any worse. The metal case of the computer prevents radiation from leaking into the air.

Lastly, several software solutions would solve the original problem. None of them, including Vfeature Deluxe, can be considered "foolproof." Robichaud did not specify why he wanted the write protection, so I assumed that it was for virus prevention. A clever virus could go right out to the controller and do whatever damage it wants, regardless of any software that you run. Mounted or not, a hard disk drive is always in danger from a virus.

As long as the leads are kept short (in a shielded cable, if you prefer) and housed completely within the PC's outer case, I believe that the modification I suggested would neither void any warranties nor run the risk of data loss.—H. E.

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First, the machine without the Above-Board runs just fine. However, one of the other machines simply refuses to recognize the disk on the hardcard. When we boot the machine, no drive D is available. We tested this unit in an IBM AT, and we got the same result. The other machine works only after a warm boot. When we start the machine cold, it does not recognize drive D—we must first

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Martin Strobel
 Stuttgart, West Germany

Assuming that I've properly interpreted your descriptions, here's my best guess: First, the hardcard in the system without the AboveBoard is fine. Next, the hardcard that you tested in the AT, as well as the 80286 XT, is simply dead. Send it back to the manufacturer for a replacement or a refund. Finally, the hardcard that works after a warm boot may need reformatting. It could be that you have a head-alignment problem that goes away after the drive unit has warmed up. Copy all your data off the drive and run the low-level reformatting program (not DOS's FORMAT command) that I hope came with the drives. Then partition the drive with FDISK and run the DOS-level FORMAT. If you didn't get a low-level formatting program with your hardcards, any one of a number of the disk utility products mentioned in this month's Product Focus will do the job.—R. G.

Was He Scuzzy?

I have an Apple Macintosh SE. Recently, a friend gave me an old but functional Hitachi external CD-ROM model CDR-1503S. It used to be connected to an IBM AT compatible. Is it possible for me to connect this drive to my Macintosh? I don't know if this model is SCSI-compatible or not. If I can connect his drive to my Mac, where can I get the driver software, and will it be able to read Macintosh CD-ROMs?

Robert Lin
 Rockville, MD

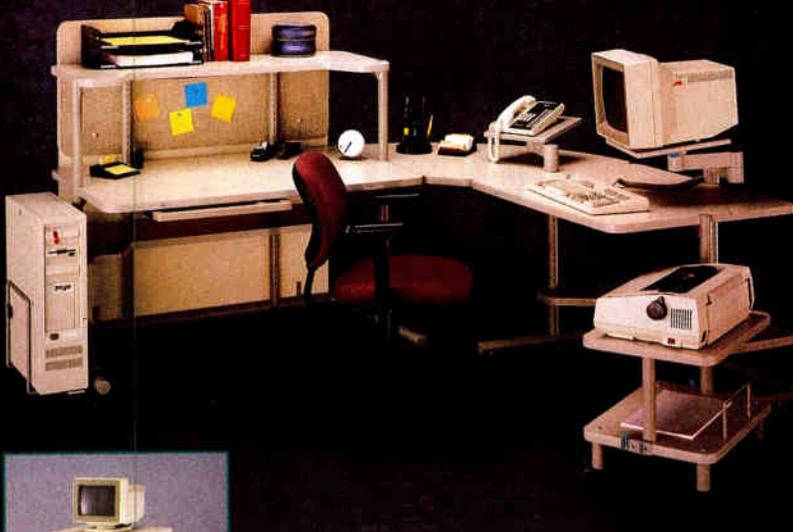
The CDR-1503S was not a SCSI device. The SCSI adapter (PN CDISI4A) was available until September 1989. You might be able to find one from a Hitachi distributor, or call Hitachi at (415) 244-7783—someone there may be able to help you locate it. Had you purchased the adapter with the drive, Mac driver software would have been included. Again, Hitachi may be able to help you locate a copy.

Presumably, a CD-ROM drive connected to a Mac, and running with Mac drivers, should be able to read a Mac CD-ROM. At least I'd hope so.

If worse comes to worst, maybe you can sell that unit and then get a new one.

continued

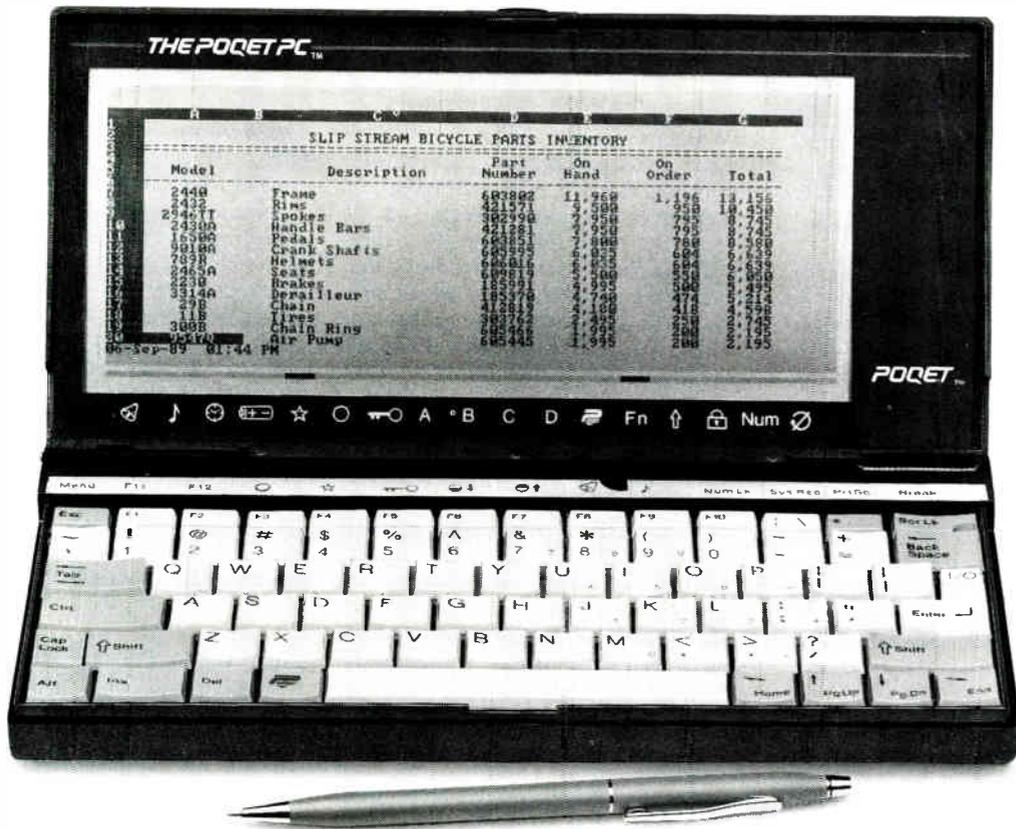
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Circle 251 on Reader Service Card

Hitachi's CDR-3650 comes complete with a SCSI interface and Mac software.
—H. E.

Compatible Graphics

I own an XT with a CGA controller on the motherboard. I can't deactivate the graphics controller, but I want to use VGA (or EGA, if I have to). Is it possible to add VGA to a CGA system?

Regis Rampnoux
Paris, France

Unfortunately, that's not possible. There are address conflicts between the CGA and VGA adapters that can't be avoided. The good news is that it is possible to configure an EGA card to coexist with your on-board CGA. If the CGA really can't be disabled, then you may have to settle for EGA.—S. A.

Dying Data

We have suffered data losses on three different computers, with three different versions of MS-DOS and different BIOSes, and at different times. The phenomena took place on 360K-byte and 1.2-megabyte disks.

While executing a DIR A:*.* or similar command, we got an error message concerning disk A. After changing to a second disk, we got a directory on the screen. But after reading another disk, we discovered that the directory displayed was the directory of the first disk. Often, disks have been wrecked because a wrong file allocation table (FAT) got written. On each of three machines, this happened only once, with no further faults.

Why didn't the machines detect that we had switched disks? Is this a bug inside MS-DOS?

Heinz Oppenländer
Lauffen, West Germany

Boy, that's a good one. MS-DOS detects a disk change in one of two ways: On most 1.2-megabyte drives, a special signal indicates a physical disk change. When the BIOS sees this signal, it "remembers" that the disk was swapped and rereads the directory and FAT. On other 1.2-megabyte disk drives and most 360K-byte drives, DOS reads the boot sector and volume label, compares it to the last read, and makes its decision. Usually, a

combination of these methods works fairly well, as long as you don't change the disk while files are open.

I would have said that it was your copy of DOS, except that you used several versions. My next guess would have been the drive controller and cable, but you used different machines. The only thing that I can think of is that you didn't let your application close its files before you swapped disks. Also, make sure that you aren't trying to write to a 360K-byte disk in a 1.2-megabyte drive. That doesn't work very well.

It's as if an occult hand had reached out and intentionally destroyed your data. Not to be an alarmist, but have you considered the possibility of a virus?
—H. E.

Hard Disks, Hard Problems

I recently read "Hard Disk Maintenance Software" by L. Brett Glass (August 1989). I've never had any problems with my hard disk drive; I never realized that such problems were so common.

I have a "shutdown" program. How do I know if it parks the heads on my hard
continued

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- Socketed for 8MHz 80287 math coprocessor.
- 5.25" 1.2MB or 3.5" 1.44MB floppy drive.
- Enhanced 101-key keyboard.
- Graphics adaptor features a full 256K of video RAM and 16-bit interface for full VGA capabilities on VGA Color System.
- 200-watt power supply.
- 2 serial/1 parallel port standard (on add-in card).
- ROM based set-up and diagnostics.
- Motherboard designed and manufactured in the U.S.A. by PC Designs.
- Toll-free technical support.
- On-site Service for one year.



Oct. 13, 1987



GV386/25

- 80386 running at 25 MHz zero wait state.
- 2MB RAM on motherboard.
- System is capable of expanding to 16 MB of 32-bit RAM.
- Proprietary, 64KB on-board RAM cache circuit using high speed static RAM.
- Socketed for 25 MHz Intel 80387, or 25 MHz Weitek 3167 math coprocessors.
- 5.25" 1.2MB or 3.5" 1.44MB floppy drive.
- 2, 8-bit, 5, 16-bit and 1, 32-bit memory expansion slots.
- Graphics adaptor features a full 256K of video RAM and 16-bit interface for full VGA capabilities on VGA Color System.
- 2 serial/1 parallel port standard (on add-in card).
- ROM based set-up and diagnostics.
- Motherboard designed and manufactured in U.S.A. by PC Designs.
- Toll-free technical support.
- On-site Service for one year.



GV386/20 PLUS

- 80386 running at 20 MHz zero wait state.
- 1MB RAM on motherboard.
- System is capable of expanding to 16 MB of 32-bit RAM.
- Proprietary, 64KB on-board RAM cache circuit using high speed (35ns) static RAM.
- Socketed for 20MHz Intel 80387, or 20MHz Weitek 3167 math coprocessors.
- 5.25" 1.2MB or 3.5" 1.44MB floppy drive.
- 2, 8-bit, 4, 16-bit and 2, 32-bit memory expansion slots.
- Graphics adaptor features a full 256K of video RAM and 16-bit interface for full VGA capabilities on VGA Color System.
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- Graphics adaptor features a full 256K of video RAM and 16-bit interface for full VGA capabilities on VGA Color System.
- 2 serial/1 parallel port standard (on add-in card).
- ROM based set-up and diagnostics.
- Motherboard designed and manufactured in U.S.A. by PC Designs.
- Toll-free technical support.
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"Overall, PC Designs' latest effort effectively integrates brand-name components and a proprietary motherboard to yield generally swift and solid performance. If you're in the market for a 386, this system is worth a look."

— PC MAGAZINE — May 30, 1989

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disk? Should I run this shutdown program every time I turn off the machine?

Another question: If I turn off my machine one or two times a day, is that too often?

Francine Epstein
San Jose, CA

The hard disk drive problems described in the article are not common, but they do occur.

When you run the shutdown program, the disk activity light should blink as the heads are moved to a safe position on the disk. I would run this program every time you turn off your computer.

Most disk drive manufacturers recommend that you keep the computer and hard disk drive on all the time. The most wear on a computer occurs when it is turned on. However, turning off the computer once or twice a day should not cause any serious problems.—S. W.

What's the Difference?

Other than the fact that they cost twice as much money, what is the difference between a 1.44-megabyte 3½-inch floppy disk and a 720K-byte 3½-inch floppy disk with a hole burned in the lower right side with a solder gun? Both seem to work equally well. Are the disk manufacturers becoming greedy again, the way they were when we had single-sided and double-sided 5¼-inch floppy disks?

I burned a hole in the correct spot on one of my low-density floppy disks, and it seems to work just fine as a 1.44-megabyte floppy disk. What do the manufac-

turers do to certify a high-density floppy that is not done on the 720K-byte floppy disks?

Douglas R. Thompson
Hyattsville, MD

Yes, Virginia, there is a 1.44-megabyte floppy disk. The primary difference is in the density of the magnetic media. A high-density disk has a higher-density magnetic coating. No kidding.

The extra hole that you refer to is a mechanical indication that gets read by a switch on some 3½-inch disk drives. The drive uses that information to determine the media type of the drive. Some computers, like the PS/2 series, format a disk willy-nilly without looking for the extra hole. As you found, it does seem to work.

"Seem" is the operative word. The real problem comes in when the drive tries to write densely packed information on the relatively sparse coating of the double-density disks. Recording a flux change on magnetic media requires a certain amount of magnetic material per bit of information. The high-density format puts the bits closely together, too close for the double-density media to handle. Most people who have done what you're suggesting report that the data gets corrupted pretty quickly.

Burning the hole in the case causes another kind of problem. True, it fools the drive into thinking that it's a high-density disk. You have to make absolutely sure that no plastic bits get into the disk housing. Either drilling or burning a hole can leave small pieces to get onto the disk and

destroy both the disk and your drive.

No, I don't think that the manufacturers are being greedy by selling special high-density disks. You may not agree with the prices, but the disks are different and will work much more reliably than double-density disks pressed into high-density service. Drill holes if you must, but don't bet your bits on it.—H. E.

Flaky Floppy

I am new to the field of computing, and to make things easier for myself (or so I believed), I bought a new IBM PC model 5150 in June 1989. At the same time I bought my PC, I also bought a Zuckerkboard expansion board with 384K bytes of memory. This brought my system's total memory to 640K bytes.

I followed all the installation instructions, but I am having difficulty running my PC. I continue to receive an error message that reads General Failure, error reading from drive A. Is there anything that you can suggest?

Michael Faturoti
Roxbury, MA

The IBM 5150 is the model number for the original PC. It is anything but "new." I think that your drive A (most probably an original 5¼-inch, 360K-byte floppy disk) is out of alignment. Take your computer to any good computer repair shop to get your drive realigned.—S. W.

FIXES

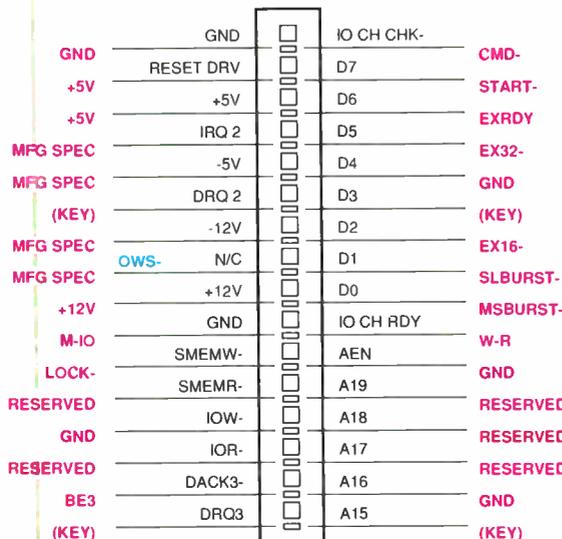
• Our March 1989 review entitled "Advanced Floppy Disk Drive Controllers" stated that some Mitsubishi floppy disk drives cannot read and write Macintosh disks reliably, incorrectly suggesting a fault with those drives. We should have explained that the Mitsubishi drives are designed to read only FM and MFM (modified frequency modulation) encoded disks, not the GCR encoding that the Mac uses.

• September's Short Take on Solutions International's SuperGlueII incorrectly stated that there was no licensing fee for distributing that product's SuperViewer utility. Solutions International includes a free-to-distribute Viewer, which is a scaled-down version of SuperViewer.

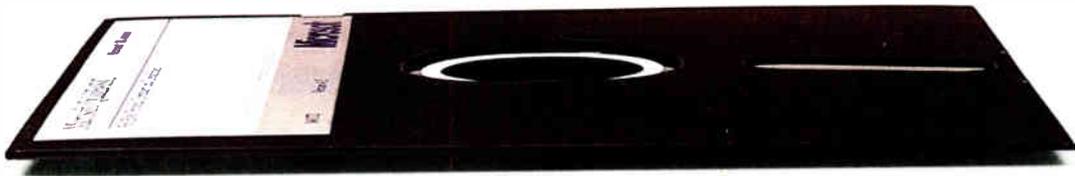
• The top part of figure 1 in the November 1989 Under the Hood was incorrect. The corrected portion is shown at left.

• The photo credit on page 93 of the November 1989 issue is incorrect. The photo should have been credited to Lindstrom Photography. ■

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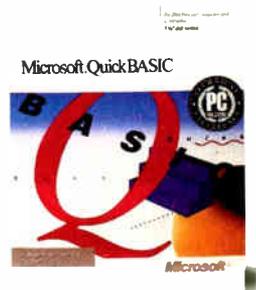
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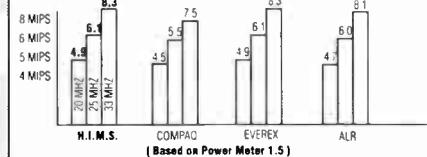
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CHAOS MANOR MAIL

*Jerry Pournelle answers questions about his column
and related computer topics*

High-Tech Fakery

Dear Jerry,

I just read Kurt Heintz's letter to you pointing out how easy it is to fake photographs (May 1989). If you think that's troublesome, what about these new 400-dot-per-inch photocopiers that allow image manipulation? These machines are effectively scanners linked to laser printers, and they can be easily linked to a computer.

Do you remember the fuss a few years back about the erasable ballpoint pen? Banks wouldn't accept checks written with them. When the printed word can't be trusted, what will replace it as an incorruptible medium?

Paul Hardy
Osaka, Japan

That's a good question. When you can get in and manipulate images with Fat-Bits, what's safe? I always sign legal documents in blue ink just in case.—Jerry

Interpretation vs. Compilation

Dear Jerry,

I'm a faithful reader of Chaos Manor Mail, and the letter from Harold Hallikainen (June 1989) compels me to write to you.

You were basically right in saying that interpreted systems are slower than compiled systems because either the source code or its equivalent token(s) must be looked up in a table before the actual code takes over. As a result, every source statement or token is slower—not just those inside of loops. An interpreted program is akin to having all the tools you'll need on the wall of your workshop, but having to ask for each one each time you need it. Compiled code, on the other hand, is more like having a table of tools lined up in the order in which you need them for a task.

On the subject of GOTOs and GOSUBs in interpreted BASIC, Hallikainen is correct in noting the advantage of a RETURN over a GOTO when leaving a subroutine. Typically, the interpreter stores a pointer to the next statement after the GOSUB, and retrieving the

pointer is indeed faster than executing a line-number search with a GOTO. However, the IBM/Microsoft BASIC manual (second edition, May 1982, page I-12) states that, "In some BASICs, this search must be performed each time the branch occurs in the program. In IBM Personal Computer BASIC, the search is only performed once, and thereafter the branch is direct. So placing frequently used subroutines at the beginning of the program will not make your program run faster."

Hallikainen should be more careful in his statements about compilers, which do not "compile the source code down to a bunch of subroutine calls." In reality, the compiler merely translates the source code into equivalent object code, which will be one or more machine instructions.

Some operations in the source language may require the compiler to include calls to some subroutines that are supplied with the compiler, but, in general, the subroutine calls in the compiled program are the ones that the programmer put in the source code. The programmer decides what subroutines to call, and where, when he or she is writing the program.

Robert C. Dowling Jr.
Richmond, MA

Thank you.—Jerry

CD-ROM Source

Dear Jerry,

About your article on CD-ROM ("The World on CD-ROMs," September 1989): I'd appreciate it if you could tell me a source for a unit to connect with an IBM PC compatible. I have been unable to locate one, and I'm becoming very frustrated.

continued

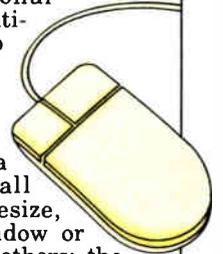
Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. He can be reached c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458, or on BIX as "jerry."

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I have been reading your books and columns with great interest ever since my CP/M days, and I've learned a lot from them.

Edward Caffin
Deland, FL

I recommend that you contact the Bureau of Electronic Publishing (P.O. Box 43131, Upper Montclair, NJ 07043, (201) 746-3031). It carries a large selection of CD-ROM disks, drives, and accessories for PC compatibles and Macs.

—Jerry

Computer Envy

Dear Jerry,

Your article entitled "Mixed Blessings" in the Macintosh Special Edition (June 1989) contained a number of excellent points on how to solve any problems that one might encounter on the Macintosh. The main reason that I'm writing is to tell you how incredibly jealous I am of you.

Being the humble owner of a Mac SE, I can only dream of owning a system even remotely similar to the one you describe in your article. And I quote: "thoroughly loaded... two hard disk drives, one the 330-megabyte Priam MacDisk; 5 megabytes of memory; a LaserWriter IINT; an AppleScan scanner; an Apple CD-ROM drive; an AppleFax board; and a 5¼-inch PC drive..."

Please don't take this as an insult, but I find it more than a bit unfair that you have all those fancy doohickeys and I don't!

Having bought my Mac SE and Image-writer printer when the Mac SE was second-best, when SE was an abbreviation for Special Edition, I have gotten many an hour of performance out of it. I have added a modest array of accessories to it: an extremely noisy, external 20-mega-

byte hard disk drive, an upgrade to 2.5 megabytes of RAM, and a USRobotics 2400-bps modem.

Until recently, I have been completely content with my Mac SE's performance. But with all the hype and publicity surrounding the new series of Macintosh computers, I have come to realize that my SE is no longer second-best. My mind has been wandering to the new Mac IIcx, which I am just dying to buy; however, I'm not sure that I can afford to go out and buy it.

Thomas Maniatis
Quebec, Canada

I run into a lot of people who think that the situation is unfair. All I can say is that I put a good bit of work into getting here. It's always a dilemma: If you have to buy everything, then you have nothing to write about. Not even BYTE could afford to buy one of everything. But if you don't buy the equipment, how can you do long-term use evaluations? You're stuck doing reviews. If you let companies give you hardware, are you not being bribed?

I solve this dilemma by not accepting anything for short terms; trying to discourage people from sending me anything that I don't have some prospect of actually using; buying and paying for enough equipment that if every bit of the fancy stuff vanished tomorrow, I could still manage to write my novels and pay my taxes; and never accepting ownership of anything that is sent to me. All this stuff either is worn out, goes back, or is (with the owner's permission, of course) given to a worthy cause.

There's also a space problem: I had to rebuild the house in order to have a place to put all the equipment, and even that's getting crowded.

As to the Mac IIcx, it all depends on what you want to do with it; two of my

sons get along fine with Mac Pluses, both of which I paid full price for.

—Jerry

Spike Insurance

Dear Jerry,

I plan to retell the tale of "The Great Power Spike" (August 1989) to my students this semester—students of insurance! This example should prove sufficiently bizarre to retain my students' attention while allowing me to illustrate a) the role of legal liability and the need for large limits, b) the need to carefully examine which perils have been insured against in a policy, c) the business pursuits exclusion (which I suspect you may have encountered by now if you've submitted a claim to your own insurer), and d) how risk management can apply to individuals as well as big corporations.

Good luck! I couldn't suppress the feeling that you still faced a lot of hassles to straighten out the mess that someone else created.

Norma L. Nielson
Associate Professor of Insurance
Oregon State University
Corvallis, OR

Actually, it wasn't as much of a mess as you might think. We've replaced all the power strips. Repairs to the VCR cost about \$25. The TV monitor has never worked properly since, and it will have to be replaced. The Priam MacDisk still resides in an old WORM (write once, read many times) housing; for reasons I can't fathom, we're having trouble getting Priam to get us a new power supply. The disk drive works splendidly, though.

I didn't bother with insurance claims. Most of the damage was to equipment that I don't own; the VCR and TV were mine, but that didn't come to enough to make it worth filing anything. —Jerry ■

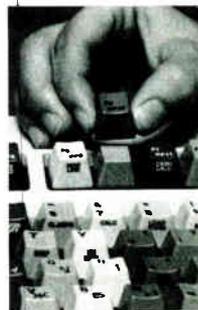
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One customer recently wrote: *"The quality of your work is exemplary and frankly has made a lot of others jealous because they bought systems which were comparable in quality but with a stiff price difference"*—George Syty.

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Gateway 2000's service policies are the best in the industry. We stand behind all of our systems with a **30 Day Money Back Guarantee** and a **1 Year Warranty**. We also offer **Lifetime Toll-Free Technical Support**, and **Free Federal Express Shipping** of replacement parts. If our technicians can't solve your problems over the phone or Fed-X you a solution we can dispatch a technician to most locations to provide **Free On Site Service**. Our policies are great, but it's our people that really set us apart from the competition. Look at what our customers write:

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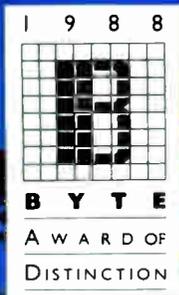
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NEC Claims First Color LCD Laptop

The ProSpeed CSX is an 18½-pound portable 80386SX-based computer with a detachable color LCD screen for displaying EGA-compatible graphics. It measures 15 by 14½ by 4 inches and has a full-size 89-key keyboard.

The screen measures 8⅞ by 5½ inches and supports 640- by 400-pixel graphics. It can display up to 16 colors at one time from a palette of 64. You can attach an external monitor to the built-in CRT port for full VGA display, including 256 colors at 320 by 200 pixels or 16 colors at 640 by 480 pixels.

Driven by a 16-MHz 80386SX chip, the computer uses an 8-MHz AT-type bus and supports an optional math coprocessor. The standard memory configuration is 2 megabytes, expandable to 4 megabytes through a memory card that uses one of two available expansion slots (the other is intended for an optional 2400-bps modem).

The ProSpeed CSX comes standard with a 1.44-megabyte 3½-inch floppy disk drive and serial, parallel, CRT, and external 5¼-inch floppy disk drive ports. The 70-W power supply can run at either 115 V or 230 V.

Price: With 42-megabyte hard disk drive, \$8499; with 100-megabyte hard disk drive, \$9499.

Contact: NEC Home Electronics (U.S.A.), Inc., 1255 Michael Dr., Wood Dale, IL 60191, (312) 860-9500.

Inquiry 1154.



Color reaches the portable computer with NEC's ProSpeed CSX.

Four SX Desktops Fill the Bill

CompuAdd, Hyundai, Acer, and AST Research have recently introduced 80386SX systems. All four have 16-MHz clock speeds, one floppy disk drive, 1 megabyte of standard RAM, and room for expansion. But the systems differ in price, graphics capabilities, and CPU upgradability.

The CompuAdd and Hyundai systems have practically the same basic and expansion characteristics. The CompuAdd 316s can be expanded to 4 megabytes on the motherboard and supports an 80387SX math coprocessor. Standard equipment includes choice of a 1.2-megabyte 5¼-inch or 1.44-mega-

byte 3½-inch floppy disk drive. The power supply is 145 W, and you get a 101-key keyboard. Hyundai's 80386SX system, expandable to 8 megabytes on the motherboard, has a 135-W power supply and is available only with a 5¼-inch floppy disk drive.

Price: CompuAdd 316s, \$1495.

Contact: CompuAdd Corp., 12303 Technology Blvd., Austin, TX 78727, (512) 250-1489.

Inquiry 1157.

Price: Hyundai Super-386s, \$1895; with 40-megabyte hard disk drive, \$2645; with 100-megabyte hard disk drive, \$3395.

Contact: Hyundai Electronics America, 166 Baypointe Pkwy., San Jose, CA 95134, (408) 473-9200.

Inquiry 1158.

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The Acer 1100/SX comes standard with what the other manufacturers call options. It comes bundled with a VGA controller, a 5¼-inch floppy disk drive, a PS/2-compatible mouse, and Windows/386 and EMS 4.0 Memory is expandable to 8 megabytes.

Price: \$2195.

Contact: Acer America Corp., 401 Charcot Ave., San Jose, CA 95131, (800) 538-1542; in California, (800) 782-1155 or (408) 922-0333.

Inquiry 1159.

If you want expansion, you might try the AST Premium 386SX/16 system, which features three proprietary add-in slots for upgrading RAM to 36 megabytes and the CPU to a 25- or 33-MHz 80386 or a 25-MHz 80486.

The heart of the system is an AT-length add-in card that houses the 16-MHz 80386SX and 1 megabyte of RAM (expandable to 4 megabytes).

Two other proprietary slots are available to house 16 megabytes of RAM each, which leaves three 16-bit AT slots and one 8-bit slot for other add-ins. The BIOS is a proprietary AST design that works with any of the CPU modules.

You upgrade the basic system by replacing the AT-length 80386SX card with one of the upgrade boards, with 80386 or 80486 chips.

Price: 386SX/16, \$2695; with 40-megabyte hard disk drive, \$3595; 25-MHz system board, \$3295; 33-MHz system board, \$4495; 80486 board (including RAM), \$6395.

Contact: AST Research, Inc., 2121 Alton Ave., Irvine, CA 92714, (714) 863-1333.

Inquiry 1160.

continued

IBM LaserPrinter Does 10 ppm, Emulates HP

IBM's LaserPrinter, which emulates the HP PCL language, operates at 10 pages per minute, generates 300 dpi, and comes with 10 resident fonts. IBM promises a PostScript emulator for early this year.

The new printer will operate with "most" software that supports the IBM Proprinter, Proprinter XL, and Quietwriter, as well as the IBM 7372 and Hewlett-Packard 7475A plotters, the company says.

For more typefaces and international characters, there are 47 optional credit-card-size font cards.

The LaserPrinter comes with 512K bytes of memory. Additional memory upgrades are available in 1, 2, or 3.5 megabytes. The printer has both parallel and RS-232C serial interfaces.

Price: \$2595; print cartridges, \$199; 1, 2, and 3.5 megabytes of RAM, \$499, \$899, and \$1599, respectively. **Contact:** IBM Corp., 740 New Circle Rd., Lexington, KY 40511, (606) 232-3934. **Inquiry 1162.**

DAT Drives Store Gigabytes in Palm-Size Cartridges

A digital audio tape storage drive from Tallgrass works on XTs, ATs, and PS/2s as well as on the Macintosh. A competing DAT peripheral from Archive runs on XTs and ATs and is optimized for either SCSI-I or the differential (SCSI-II) interface.

Both drives use the HP/Sony Digital Data Storage (DDS) format to store up to 1.3 gigabytes on cassette-size cartridges and are available



IBM's LaserPrinter features 10 ppm, 300 dpi, and HP PCL emulation; PostScript is promised.

in half-height 5 1/4-inch internal and small-footprint external versions. Both also feature average access times of 20 seconds with 60-foot DAT tapes. And, as defined by the standard, the data transfer rate is 183K bytes per second.

Tallgrass Technologies' FileSecure 1300 has a data compression option that boosts storage capacity to 2 gigabytes. Other features include selective file backup and restore, unattended backup scheduling, and network support.

Price: \$4395. **Contact:** Tallgrass Technologies, 11100 West 82nd St., Overland Park, KS 66214, (913) 492-6002. **Inquiry 1163.**

Archive's Python-series DAT products are based on four direct-drive motors that eliminate belts and mechanical mode changes, the company says. The Python series also has a built-in serial port for diagnostics. **Price:** \$5000 to \$6000. **Contact:** Archive Corp., DAT Products Division, 1650 Sunflower Ave., Costa Mesa, CA 92626, (714) 966-4772. **Inquiry 1164.**

LED Printer Features 15-MIPS Processor

The LPX 2020 is a 20-page-per-minute LED printer with HP PCL emulation and up to 300-dpi resolution. An optional networking card lets you serially network up to eight users, and an optional PostScript card includes a National Semiconductor math coprocessor and 35 PostScript fonts.

The key to this printer's performance is the 32GX32, National Semiconductor's 32-bit embedded processor that's rated at 15 MIPS. Standard equipment includes 2 megabytes of RAM (upgradable to 8), 34 resident fonts, two trays adjustable for one ream of legal- or letter-size paper, and face-down printing for automatic collation.

You have a choice of parallel, serial, RS-422, or SCSI ports. AppleTalk is supported on the PostScript emulation card and can be connected via the RS-422 port. **Price:** \$7495; networking card, \$749; PostScript, \$1395. **Contact:** Alps America, 3553 North First St., San Jose, CA 95134, (800) 825-2577 or (408) 432-6000. **Inquiry 1165.**

PC Hard Disk Drive Storage Leaps Above a Gigabyte

The Imprimis Elite line consists of two 5 1/4-inch hard disk drives with capacities of 1.2 and 1.5 gigabytes. Both have a claimed average access time of 12 ms. Maxtor's five-drive Panther line ranges in capacity from 0.8 to 1.7 gigabytes, and the company claims an average access time as short as 10 ms.

The technologies behind the drives, however, aren't the same. Imprimis spins the disk platters at 5400 rpm, versus the standard rate of 3600 rpm. Maxtor solely uses "proprietary read-channel" technology.

The Imprimis Elite series is available in three interfaces: standard Storage Module Drive (SMD) and Intelligent Peripheral Interface-2 (IPI-2), both with a maximum capacity of 1.2 gigabytes and a maximum data transfer rate of 24 Mbps, and SCSI-2, with a maximum capacity of 1.5 gigabytes.

Price: \$4000 to \$5000. **Contact:** Imprimis Technology, Inc., 12501 Whitewater Dr., Minnetonka, MN 55343, (800) 828-8001. **Inquiry 1166.**

Maxtor's drives are available in the Panther 1 and Panther 2 series. Panther 1 drives are available in ESDI, SMD, and IPI-2 (with a maximum data transfer rate of 24 Mbps), with capacities of 0.8, 1.2, and 1.3 gigabytes. The SCSI-2 Panther 2 series (32 Mbps) is available in capacities of 0.8, 1.22, and 1.7 gigabytes.

Contact: Maxtor Corp., 211 River Oaks Pkwy., San Jose, CA 95134, (408) 432-1700. **Inquiry 1167.**

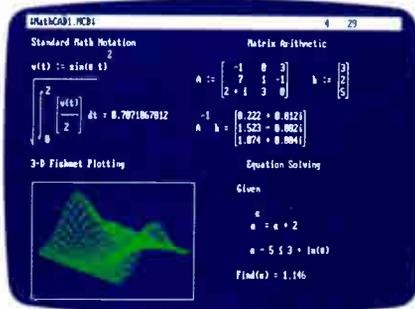
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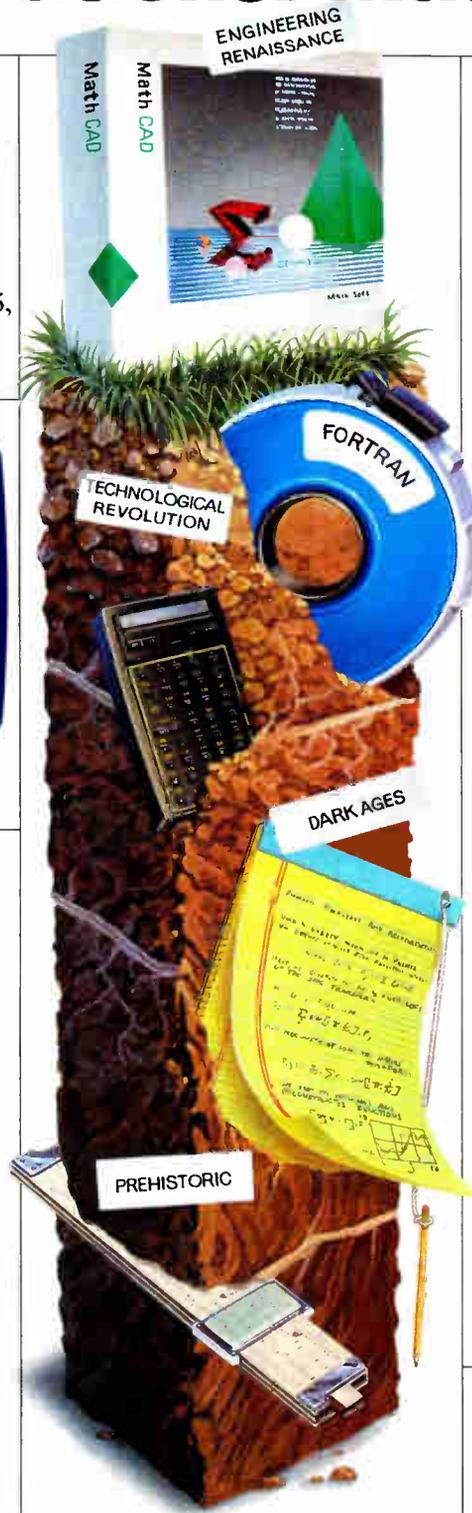


MathCAD 2.5 includes 3-D plotting, HPGL sketch import, and PostScript output.

MathCAD is far and away the best-selling math package in the world. Because it lets you perform engineering and scientific calculations in a way that's faster, more natural and less error-prone than the way you're doing them now—whether you're using a scratchpad, calculator, spreadsheet or program that you wrote yourself.

And now we've made the best even better. MathCAD 2.5 is a dramatically improved version that includes three-dimensional plotting, enhanced numerical analysis, and the ability to import HPGL files from most popular CAD programs, including AutoCAD.® And now you can print on PostScript® compatible printers.

And like before, MathCAD's live document interface™ lets you enter



equations anywhere on the screen, add text to support your work, and graph the results. Then print your analysis in presentation-quality documents.

It has over 120 commonly used functions built right in, for handling equations and formulas, as well as exponentials, differentials, cubic splines, FFTs and matrices.

No matter what kind of math you do, MathCAD 2.5 has a solution for you. In fact, it's used by over 60,000 engineers and scientists, including electrical, industrial, and mechanical engineers, physicists, biologists, and economists.

But don't take our word for it; just ask the experts. PC Magazine recently described MathCAD as "everything you have ever dreamed of in a mathematical toolbox."

And for Macintosh® users, we present MathCAD 2.0, rewritten to take full advantage of the Macintosh interface. Entering operators and Greek letters into equations is pure simplicity!

Look for MathCAD 2.5 at your local software dealer, or give us a call. For more information, a free demo disk, or upgrade information, dial 1-800-MATHCAD (in MA, 617-577-1017).

Available for IBM® compatibles and Macintosh computers.

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March 14, 1989 issue.
Best of '88
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PCterminal/286

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PCterminal/286



SAMSUNG

386AE FILE SERVER

How to plan your LAN.

You'll need a pencil.

That's to write down the telephone number on the next page. Which will connect you with Samsung's nationwide network of resellers. And the Samsung/Novell co-labeled line of LAN hardware.

It's pretty much that simple.

With one call you can plan on substantial savings over the big name computers which, despite high clock rates and even higher price tags, are not really optimized for networking.

And you can plan on 100 percent compatibility with all versions of Novell's NetWare,* because Samsung's LAN hardware was co-designed by Novell. Just like the label says.

THE TESTING WENT IN BEFORE THE LABEL WENT ON.

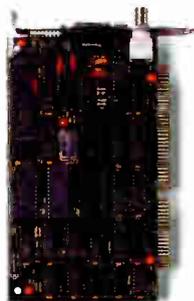
Both the Samsung 386AE and PCterminal/286 have

been tested exhaustively and certified by Novell for compatibility with all popular networking hardware and software products. As a matter of fact, Samsung's 386AE is one of 3 file servers certified by Novell to run NetWare 386.

For example, engineers at Novell successfully tested the PCterminal/286 LAN Workstation in no less than 1200 different network configurations... with 50 units running at once! That's a claim no other computer manufacturer can make.

NETWORKING VS. NOTWORKING.

What's the difference? Take our 386AE Fileserver, for instance. It includes Novell's Advanced BIOS, and eight expansion slots to accommodate multiple network interface cards and disk controllers. Plus an oversize power supply capable of driving dual high capacity hard disks and tape



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SAMSUNG/NOVELL

PCterminal/286

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PCterminal/286

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SAMSUNG/NOVELL

PCterminal/286



SAMSUNG/NOVELL

PCterminal/286

SAMSUNG/NOVELL
SERVER

back-up system. Plus 4 megabytes of main memory for disk caching.

Then there's Samsung's PCterminal/286 Diskless Workstation which includes a built-in Ethernet interface and Novell's Remote Boot EPROM.

And not to be overlooked is our 16-bit SE2100 Ethernet Interface Card which provides up to twice the throughput for the price of an 8-bit card.

THE SAMSUNG COMMITMENT.

With 4 million monitors and half a million PC and LAN computers sold in 1988 alone, it's clear that Samsung has made a serious commitment to the marketplace. In all, Samsung offers no less than nine different PC and LAN computer models with seventeen color and monochrome monitors! And, as a 31-billion dollar international corporation, Samsung has the resources to provide continuous support for its customers.

So why not begin your network planning today? For the name of the Samsung reseller nearest you, write:

SAMSUNG, 3655 North First Street, San Jose, CA 95134, or call **1-800-446-0262**.



SAMSUNG

Circle 275 on Reader Service Card (DEALERS: 276)

World Radio History

MicroRAM Feeds Hungry Micro Channel Systems

With memory-hungry systems becoming the norm rather than the exception, Tecmar has introduced the MicroRAM 386 for IBM Micro Channel and Olivetti P800 computers.

This expansion card lets you add up to 32 megabytes of memory using 4-megabyte single in-line memory modules, and it allows you to mix and match SIMMs of 4 megabytes, 1 megabyte, or 256K bytes on the same board. Tecmar says that typical configurations include 2 megabytes of memory using 256K-byte SIMMs, 5 megabytes using 256K-byte and 1-megabyte SIMMs, 8 megabytes using 1-megabyte SIMMs, and 20 megabytes using 1- and 4-megabyte SIMMs.

The MicroRAM 386 doesn't need a boot disk because OS/2, Novell, and Xenix automatically recognize it. Each MicroRAM 386 supports matched memory cycles with 85- or 100-ns SIMMs, zero wait states with 100-ns SIMMs, and one wait state with 120-ns SIMMs. And the

MicroRAM can be configured to start on any 128K-byte address boundary in the 0- to 256-megabyte address range, so you can configure a single PS/2 or Olivetti with up to eight MicroRAM boards.

Price: Unpopulated, \$549; with 2 megabytes, \$1220; with 4 megabytes, \$1865.

Contact: Tecmar, Inc., 6225 Cochran Rd., Solon, OH 44139, (800) 624-8560 or (216) 349-1009.

Inquiry 1172.

Account for Your Phone Time with the Auditor

The Auditor is an XT- or AT-compatible card that helps keep track of your phone use, whether your computer is on or off. It can monitor up to eight phone lines—and all the telephones on those lines—to provide you with information about incoming and outgoing calls, whether you've got Touch-Tone or rotary service.

On-board memory of 32K bytes saves 1200 call records, or you can add another 32K bytes to save up to 2400 call records. You can then save the information to your drives,

where a software package helps you sort by telephone number or by accounts you've set up in advance. An optional toll restriction function prohibits unauthorized use of the phone.

The Auditor works when the computer is off with a wall-mounted transformer and a rechargeable nickel-cadmium battery for backup.

Price: One line, \$369; each additional line, \$90.

Contact: AccuTel, Inc., 345 South McDowell Blvd., Suite 512, Petaluma, CA 94954, (707) 778-7182.

Inquiry 1174.

Two VGAs for Less

The SuperVGA by Boca Research is an inexpensive 16-bit, 800- by 600-pixel graphics driver for the IBM AT. It automatically switches among VGA, CGA, MDA, and Hercules graphics via an on-board autoswitch.

Up to 16 colors from a palette of 264,144 are supported by Windows, OS/2 Presentation Manager, GEM, Ventura Publisher, and AutoCAD. A 320- by 200-pixel graphics mode supports up to 256 simultaneous colors.

Price: \$275.

Contact: Boca Research, Inc., 6401 Congress Ave., Boca Raton, FL 33487, (407) 997-6227.

Inquiry 1169.

The Prism Basic VGA, by Advanced Technology Information Systems, displays 800 by 600 pixels in a 16-color mode. Drivers are included for AutoCAD, Lotus 1-2-3, Windows 286/386, Ventura Publisher, and PageMaker.

Like the Boca board, the Prism is backward compatible. But the Prism Basic VGA is an 8-bit board that supports 640- by 400-pixel graphics in a 256-color mode.

Price: \$199.

Contact: Advanced Technology Information Systems, 5309 Randall Place, Fremont, CA 94538, (415) 490-9360.

Inquiry 1170.

WordSync Better Data Transfers to Amigas

The WordSync is a hard disk drive interface that doubles data transfers to 30-, 45-, or 80-megabyte SupraDrive hard disk drives on Amiga 2000s, the manufacturer claims. SupraDrives have average seek times of 40, 28, and 11 ms.

WordSync is faster because custom hardware circuitry synchronizes data transfers and because it transfers 2 bytes of data on each transfer cycle. The card itself is a one-slot half-card design with a SCSI expansion port.

Price: With 30 megabytes, \$649; with 45 megabytes, \$749; with 80 megabytes, \$1299.

Contact: Supra Corp., 1133 Commercial Way, Albany, OR 97321, (503) 967-9075.

Inquiry 1173.

continued

Ricoh Announces Its Experts

The Resident Expert (REX) board is the first XT- and AT-compatible add-in board for a personal computer with an expert system incorporated on silicon, according to its designers, Ricoh and International Chip. Previous expert systems have been software simulations.

The bottom line is speed: Ricoh claims that its coprocessor board can accomplish expert-system applications in seconds, whereas they used to take minutes.

The REX coprocessor board is coupled with Rule Compiler software, which gives you a set of prompts for developing custom expert systems. Ricoh claims that the software is also the first expert-system development tool that doesn't require a specially trained expert-system engineer for developing custom applications.

The Rule Compiler software stores knowledge as a series of "If x, then y" statements, or rules. The REX chip directly processes the

rules instead of relying on the computer's CPU to convert them into a numerical format and then process them. The REX board has on-board memory that can store up to 10,000 customized rules. And Ricoh says that the REX chip will process up to 1.7 million rules per second.

Price: \$1500.

Contact: Ricoh Corp., 5 Dedrick Place, West Caldwell, NJ 07006, (201) 882-2000.

Inquiry 1171.

If You Want To Talk Fast DBMS Call 1-800-db-RAIMA And Start Screaming

You'll be screaming, all right. db_VISTA III from Raima combines the flexibility of a relational DBMS and the lightning speed of the network database model.

C db_VISTA III is written for C Programmers. Source code available.

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Relational Query & Report Writer	✓
db_REVISE 1.0 Database Restructure Program:	
Total database redesign/restructuring	✓
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Miniature Thermal Printer Makes Labels

Seiko's SmartLabel Printer is a miniature printer that attaches to your IBM PC's serial port or to your Macintosh's printer or modem port. The Rolodex-size printer uses heat-transfer printing technology and requires thermal paper, which you must purchase from Seiko.

Each SmartLabel Printer comes with software, a cable, and a set of labels, which are available from the company in two-roll packs. Each roll contains 130 self-adhesive labels.

The software, which includes its own database, text editor, and bar code generator, is designed for DOS- and Macintosh-based computers. It also lets you use a mouse and a "capture screen text" mode for quick printing. Printing time is 15 seconds per label. **Price:** \$249.95; labels, \$12.95 per pack. **Contact:** Seiko Instruments U.S.A., Inc., PC Products Division, 1144 Ringwood Court, San Jose, CA 95131, (408) 922-5900. **Inquiry 1177.**

Northgate Modifies Keyboard Layout

The OmniKey/Plus is a luxury replacement keyboard for touch-typists that, the company says, is compatible with most common personal computers, including the IBM PC and PS/2s, the Tandy 1000, the AT&T PC 6300 and PC 6300 Plus, and Macintoshes.

Alps electromechanical key switches provide audible full-keystroke action and tactile feedback. Features include separate cursor-control and numeric keypads. The cursor-control keypad has arrow



Seiko's Rolodex-size SmartLabel Printer.

keys in a diamond pattern instead of IBM's inverted T, which helps prevent you from hitting the Num Lock key or holding down the Shift key, Northgate says. The numeric keypad layout has math operators bordering the numeric keys; large Insert, Delete, and Enter keys; and three LED indicators above the pad for Caps Lock, Num Lock, and Scroll Lock.

Twelve programmable function keys are located on the left side of the keyboard, as function keys were on original PC keyboards. There's also a writing strip above the keyboard that you can use to write down mnemonics for your function keys.

Price: \$119. **Contact:** Northgate Computer Systems, Inc., 13895 Industrial Park Blvd., Suite 110, Plymouth, MN 55441, (800) 526-2446 or (612) 476-4400. **Inquiry 1175.**

EPROM Eraser Averages 10 Minutes for 32 Devices

The Wise EPROM Eraser/Programmer reduces erase cycle time to an average of 10 minutes for up to 32 devices simultaneously, Logical Devices claims.

The Wise system eliminates the need for a separate gang programmer and eraser lamp. It includes an RS-232C port and ProLink for menu-driven EPROM erasure.

EPROMs are first erased by exposure to an ultraviolet light source. With a proprietary algorithm, you determine a safe erasure time. While the ultraviolet system is operating, the unit will continuously read the data in each of the 32 chips.

Price: \$8995. **Contact:** Logical Devices, Inc., 1201 Northwest 65th Place, Ft. Lauderdale, FL 33309, (305) 974-0967. **Inquiry 1178.**

Record Screens of Information on Audiocassettes

If you've ever felt the need to take snapshots of DOS-based computer screen images for training or for talks, you might consider Instant Replay.

It's a breadbox-size instrument that records computer screen images on standard audiocassettes, the same kind you use in your home or car. You can also record your voice to accompany the "screen shots." The device connects to your computer via the RS-232C port and can record ASCII text in real time, says Integrated Applications.

Helping you record the information is a TSR program with an overhead of 40K bytes of system memory. **Price:** \$2395.

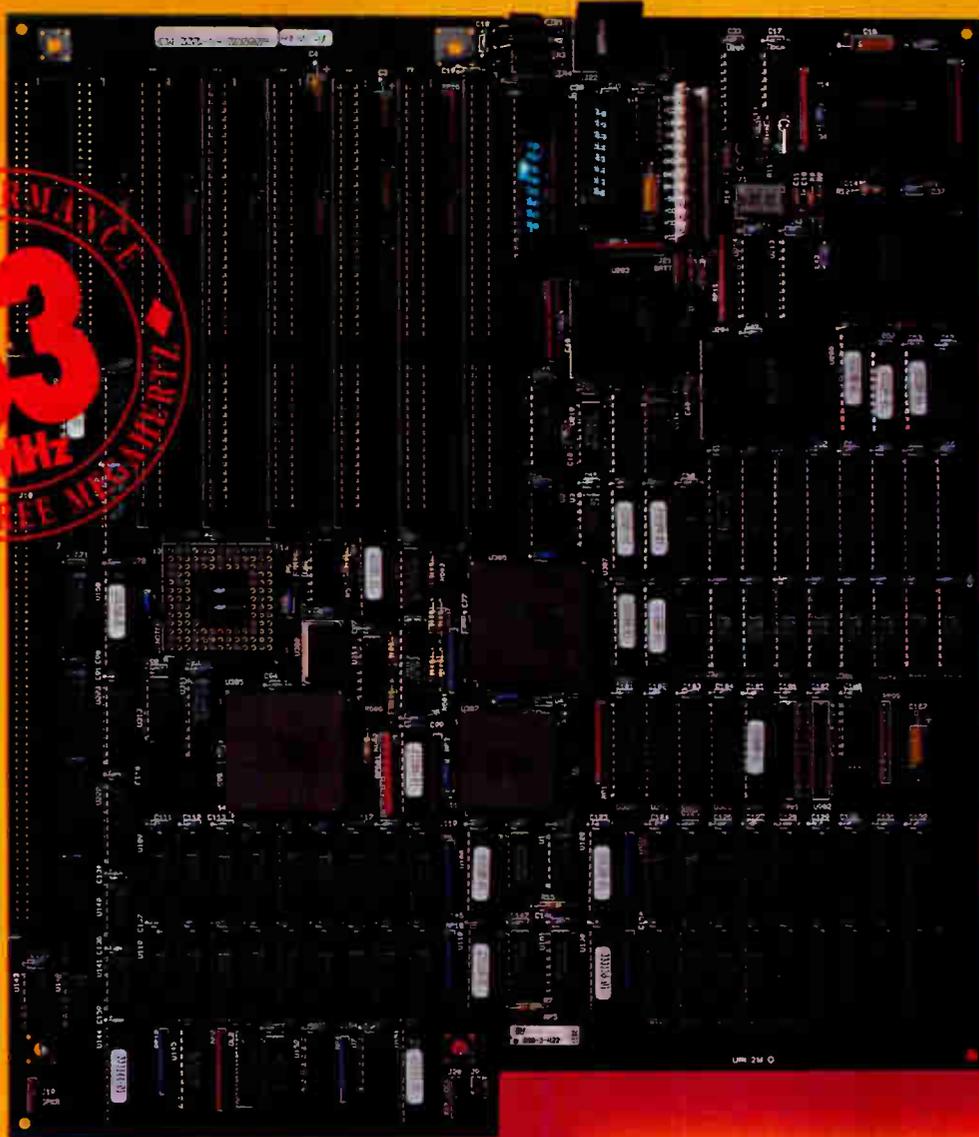
Contact: Integrated Applications, Inc., 8801 East Pleasant Valley Rd., Cleveland, OH 44131, (800) 637-7890 or (216) 328-0090. **Inquiry 1179.**

AT Batteries That Won't Let You Down

Last.bat is a rechargeable IBM AT nickel-cadmium battery with a lifetime guarantee. The 5-ounce battery recharges itself whenever the computer is switched on. It works with all AT-compatible computers (except for some pre-May 1988 Compaq 386 models), and versions are available for Tandy and Everex computers.

Price: \$49.95; with adapter, \$59.95. **Contact:** Accumation, Inc., 8817 Southwest 129 Terrace, Miami, FL 33176, (305) 238-1034. **Inquiry 1180.**

continued



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If your computer feels slow, we know where it hertz. For a fast cure, get our new 386 MotherBoard/33MHz. We've built in 4 Megabytes of high speed RAM, 64K of RAM cache, and both 387 Weitek math coprocessor sockets. This board makes your 386 computer the fastest PC available!

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- PC/AT compatible I/O system for support of OS/2 and UNIX.

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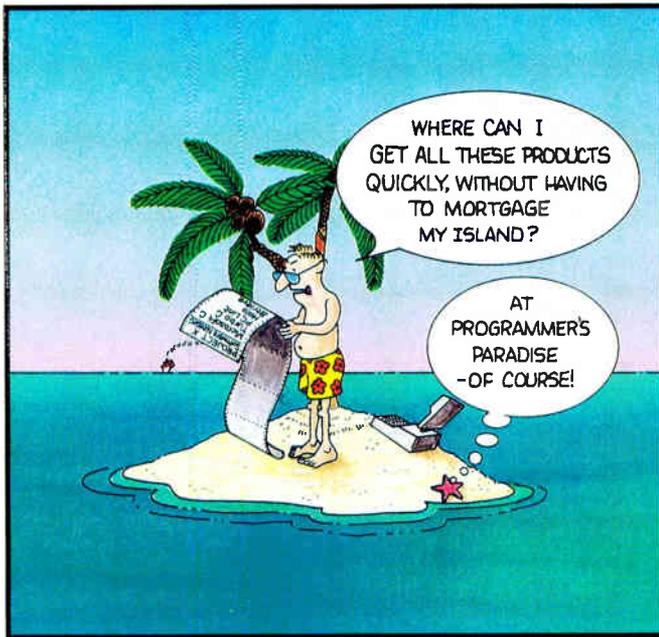
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ProBas Telecomm. Toolkit	75	70
ProBas Toolkit	99	94
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QuickHelp	59	55
QuickMenu	59	55
QuickPak	79	70
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	LIST OURS	
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MS QuickC	99	69
MS QuickC w/ QuickAssembler	199	135
Top Speed C	199	179
DOS Professional	399	359
OS/2 Professional	495	445
Turbo C	150	99
Turbo C Professional	250	169
WATCOM C 7.0	395	319
Zortech C	90	79

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	LIST OURS	
Btrieve	245	185
Btrieve for DOS 3.1 Networks	595	449
CBTREE	159	135
C-Index	99	89
C-ISAM	225	209
Codebase IV	295	219
CQL w/ PASS	395	349
c-tree	395	315
dbc III	250	219
dbc III Plus	500	439
db_FILE Bundle	295	249
Essential B-Tree w/ source	198	149
FairCom Toolbox - Prof. Edition	1095	875
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C-GENERAL LIBRARIES

	LIST OURS	
Code Runner	149	135
C TOOLS PLUS/6.0	149	109
C Utility Library	199	139
Greenleaf Functions	229	159
Greenleaf Superfunctions	299	209
Turbo C TOOLS/2.0	149	109

C SCREENS

	LIST OURS	
C-Worthy w/ forms and source	495	CALL
Facel	99	89
Greenleaf DataWindows	395	309
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Hi-Screen XL Prof. Series	325	275
JAM	595	529
Panel Plus	495	395
Vermont Views	395	CALL
Vitamin C	225	165
VC Screen	149	115

C-UTILITIES/OTHER

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Norton Guides for C	100	65
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SCREENIO		

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w/ Clipper/ FoxBASE module	200	159
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HALO	395	279
HALO/Window Toolkit	595	419
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MetaWindow	325	209
MetaWindow Plus	325	269
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Compiler Pack	99	75
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Microport Sys. V/386 (c omp.)	899	799
PC-MOS 386 3.0 (1-user)	195	179
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VIEW-232 by Blaise

Full-function communications dataline monitor. Bi-directional monitoring up to 19,200 baud. Display data in six different formats, save entire transmission in a buffer, gives dynamic graphic display of how much memory has been used/available as data is being viewed and recorded.

List: \$189 Ours: CALL

RE:SOURCE by Genesoft

Reverse engineering system that produces compact, easily readable pseudo-code from large binary executable files. Re:Source carefully takes the program apart and accurately puts it back together by automatically handling assembler mnemonic synonyms and syntax errors.

List: \$150 Ours: \$129

CASE:W by Caseworks

Windows application development tool that utilizes a high level prototype to design the Windows portion of an application and an Expert System to greatly reduce Windows application development time. Includes a convenient interface to the Windows Software Development Kit.

List: \$795 Ours: \$759

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An Invitation TOO Good To Refuse

You're invited to purchase Vermont Views libraries v1.1 **NOW**, and receive Vermont Views v2.0 with the Designer **FREE** upon its release. This offer is good only until January 31st, 1990. **Don't be left out of the celebration!**

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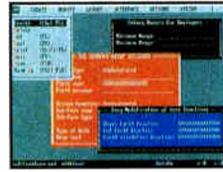
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C-PROGRAMMERS! Would you like to double your productivity and have FUN too? Vermont Creative Software has the answer with the imminent release of the Vermont Views Designer.



This intuitive, menu-driven, screen generator taps the resources of the 650 pre-coded functions of the Vermont Views libraries. Customize data entry forms, choice lists, menus and more. Our customers around the world will be celebrating this powerful enhancement of Vermont Views. See our ad in this magazine for more details on how you can join the party...and try out Vermont Views with the Designer.

List: \$395 Ours: CALL

LATTICE C 6.0

Lattice C is back on top and the benchmarks show it!! Due to a new optimizer and many performance improvements in the library, Lattice C 6.0 for DOS and OS/2 is again outperforming its competitors. And Lattice C now includes a full-screen symbolic debugger, CodeProbe, that will enable you to easily debug family mode programs, Presentation Manager applications, and OS/2 multi-thread applications. And it can be used with a mouse.

List: \$250 Special Price: \$189

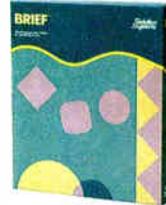


Lattice

BRIEF 3.0 - The Programmer's Edition

Edit Your Programs More Productively Than Ever Before

The program that set the standard for program editing continues to lead the industry. Introducing BRIEF 3.0. New features include: multiple keystroke macros, a new C-like macro language, a source level macro language debugger for both macro languages, "smart" indenting and template editing for



Solution Systems

Ada, C, Cobol, BASIC, FORTRAN, Modula-2, and Pascal, and the ability to "zoom" your current window to full screen size. You'll also get the features over 50,000 current users have come to rely on: unlimited windows, Undo, compile within BRIEF, a LISP-like macro language, and much more.

List: \$199 Ours: CALL

MultiScope™ OS/2 Debugger

MultiScope offers the most advanced features available in any debugging tool. It provides you with 13 different views into your program. It also includes both run-time and post-mortem debugging options to handle any debugging situation: examine your program both during execution and after a protection violation. Explore data structures using MultiScope's graphical data representation window; evaluate expressions (including function calls); debug child processes and dynamic-link libraries; even remote debug through the serial line.

MultiScope includes Presentation Manager and OS/2 text mode interfaces, both compatible with IBM SAA for maximum ease of learning and use.

List: \$299 Ours: \$229



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NewsEdge Signals End of Information Overload

If you lack the time to read all the news that's pertinent to your interests, you could buy NewsEdge and have it sort through electronic news services while you're doing something else.

NewsEdge is a TSR program that carries up to five business news wires simultaneously into your computer and beeps and flashes when an article appears that's of interest to you. NewsEdge software lets you create your own profile of what interests you; it then tries to match key words and phrases with your profile to get you the news you most want to see. Five news services are available: McGraw-Hill News, PR Newswire, Dow Jones News Service, Dow Jones Professional Investor Report, and Reuters Financial News.

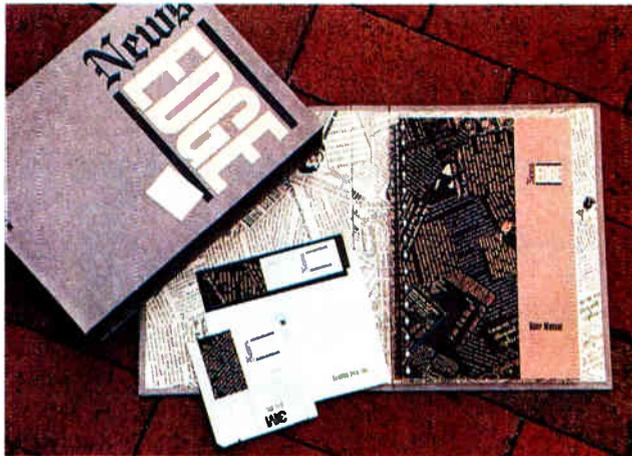
An FM receiver brings the "feeds" to your computer through a serial port. Your computer needs about 640K bytes of RAM for the program and at least a 10-megabyte hard disk drive for storing the stories that interest you. Specifically, about 40K bytes is used for receiving the news and for testing it against your user profile. Another 80K bytes is used to index it on the hard disk drive, also according to your personal profile.

You purchase the system on a one-year leasing basis. The base configuration gives you two of the five news services, and the price includes connect time.

Price: \$7500.

Contact: Desktop Data, Inc., 1601 Trapelo Rd., Waltham, MA 02154, (617) 890-0042.

Inquiry 1056.



NewsEdge edits out all but the news that interests you from up to five news services.

Remote Access and Personal TRS Menus on NetWare

LANSight and LANSelect are NetWare utilities designed to help you get more for your LAN dollars.

LANSight gives a network administrator access to control another workstation on the network. LANSelect provides custom TSR menus within single-user applications. Each utility requires only 5K bytes of RAM on the networked

workstations, yet requires 512K bytes on file servers along with DOS 3.1 or higher and Novell NetWare 2.1 or higher.

LANSight is a remote access software package for LANs and wide-area networks that includes diagnostic and configuration data. It works with NetWare and allows system administrators to access the screen and keyboard. Once linked, the screens of the two PCs mirror each other and the keyboard response on both ends. LANSelect works in most graphics

modes, including Hercules, CGA, EGA, and VGA.

LANSelect is a menu utility that helps you create personalized TSR menus that you can use on workstations across the network. For example, without having to leave WordPerfect, you could hot-key to E-mail or select a printer on the network. Like LANSight, LANSelect is compatible with CGA, EGA, VGA and MCGA graphics. It's also compatible with EMS 3.2 and 4.0 memory.

Price: LANSelect, \$495 per server; LANSight, \$395 per server.

Contact: LAN Systems, Inc., 300 Park Ave. S, New York, NY 10010, (800) 458-5267 or (212) 995-7700.

Inquiry 1058.

Full-Power RS-232C Line Analyzer

The BitView data line monitor from Measurement & Control Systems is a hand-held RS-232C line analyzer for data transfer in several modes: asynchronous, synchronous, bisynchronous, HDLC, SDLC, X.25, NRZI, and NRZ. It has a menu and push-button function control with a small LCD.

Features include monitors for data going in both directions, even simultaneously, from 300 to 38,400 bps. Measurement & Control Systems says that BitView will work best for such applications as continuous monitoring of communications lines in machine rooms, debugging of communications software and hardware, and serial printer setup.

Price: \$595.

Contact: Measurement & Control Systems, Inc., 545 West 11th St., New York, NY 10025, (212) 662-5568.

Inquiry 1057.

IQ Offers Parallel Port LAN Adapters

The pLAN is a laptop-to-LAN interface that lets you use your parallel port as the networking port for Ethernet, ARCnet, or Token Ring networking.

The ARCnet and Ethernet versions, both measuring 6 by 5 by 1½ inches, include Novell NetWare 286 drivers and are compatible with thin or thick coaxial cabling. As an option, the Ethernet box includes Intel's 82560 and 82590 chips for unshielded twisted-pair wiring with 10BASE-T-compatible concentrators. But concentrators from Synoptics and David Systems don't use these

chips, making pLAN incompatible with the most widely used concentrators. The Token Ring box, 8 by 7 by 2 inches, includes a driver for IBM PC Net.

Each model also features automatic device driver configuration and LED diagnostic/status indicators. Cables are sold separately.

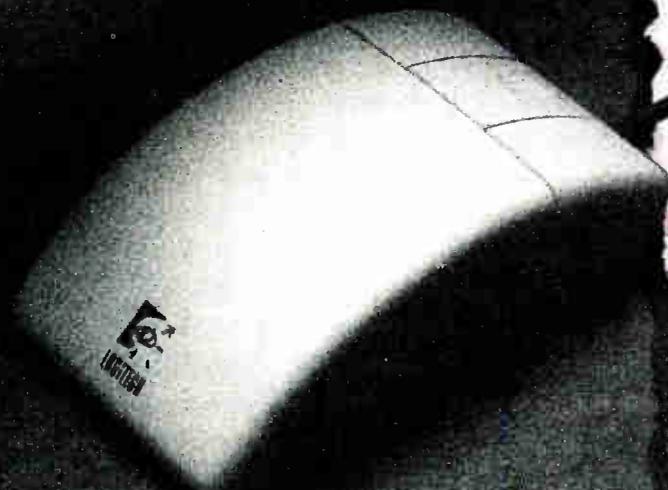
Price: ARCnet box, \$595; Ethernet box, \$695; Token Ring box, \$950.

Contact: IQ Technologies, Inc., 11811 Northeast First St., Suite 201, Bellevue, WA 98005, (800) 227-2817 or (206) 451-0232.

Inquiry 1055.



Why is the world's smartest mouse under \$100?



You're looking at the only mouse in the world with on-the-fly ballistic drivers, adjustable resolution (50 to over 15,000 d.p.i.), 35 free mouse menus, a super-lightweight self-cleaning ball, and a 1,000 mile road test (really).

It's also the world's most comfortable mouse, according to PC Magazine.

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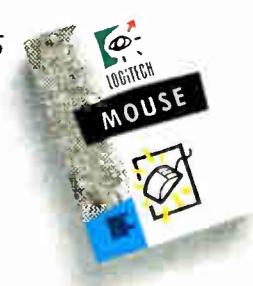
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LOGITECH

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Mix Faxes with Your LAN

Brooktrout's TR112 is an IBM XT- and AT-compatible fax card with two separate transceivers and an optional routing mechanism that works with LANs and a telephone service called Direct Inward Dialing (DID). Technically, each TR112 channel has three functions: a telephone system interface, a fax modem, and a microprocessor and associated circuitry.

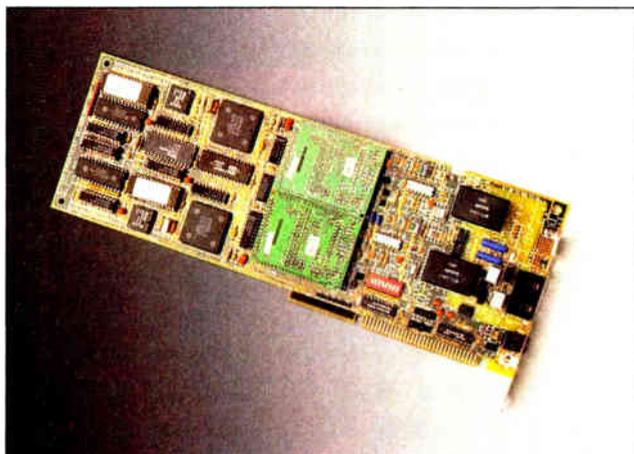
Without DID (the telephone service that allows callers from outside your company to call extensions directly), the TR112 works simply as a two-channel Group 3 fax card that can send and receive faxes simultaneously.

Where this card's features stand out, however, is in an environment with a fax server and DID. Here, the TR112 or multiple TR112s can route mail within the LAN and route faxes from outside the LAN to the appropriate LAN user with his or her DID telephone number.

In addition to the routing capabilities, the TR112 has a voice-response capability. To use it, you would prerecord a message on the fax server's hard disk drive.

Other features include on-board conversion of ASCII to fax format, multiple type fonts, a programmable telephone system interface, and an optional 64K-byte buffer for error-free faxing via the proposed Electronics Industry Association standard. To facilitate applications software development, the TR112 is available with drivers for SCO Xenix 286/386, Unix System V 3.2, Concurrent DOS, MS-DOS, and OS/2.

Price: Single unit, \$1995; with autorouting, \$2495; voice playback, \$150; transmission



Brooktrout's TR112 serves your LAN nodes with DID.

buffer, \$300.

Contact: Brooktrout Technology, Inc., 110 Cedar St., Wellesley Hills, MA 02181, (617) 235-3026; to hear a voice response from a TR112 and to have TR112 automatically fax you literature, dial (617) 235-6193.

Inquiry 1060.

Economy Faxing with Your XT/AT

Despite its long name, the FX-BM89 Plus2 Fax Partner is a simple-to-use background Group 3 fax transceiver board that fits in your IBM XT or AT.

An upgrade from the Plus model, it includes enhanced software for easier operation and has a lower price. When a fax comes in, you're alerted by a screen icon, and the incoming messages are automatically printed on your printer. For sending, the software automatically converts files from word processor formats to fax-file formats. You can also use it in conjunction with a scanner, and there's an automatic cover-page facility.

Price: \$599.

Contact: Panasonic Communications & Systems Co., 2 Panasonic Way, Secaucus, NJ 07094, (800) 742-8086.

Inquiry 1059.

Software-Upgradable V.32 Modem Includes IBM's Native SDLC

The new IBM XT- and AT-compatible V.32 modem card from U.S. Ecycon, the 1032 Plus, uses digital signal processor technology that lets software control modulation on both send and receive lines. That means that the software driver can be tweaked to fit the V.22 (1200 bps) to V.32 (9600 bps) standards, and upgrades to MNP 5 and V.42-bis can be software (rather than hardware) upgrades, the company claims.

But what really sets the 1032 Plus apart from its peers, U.S. Ecycon says, is its native IBM synchronous data link control, which ensures that software such as 3270 and 5270 emulators, PC Support, Office, and the new OfficeVision will run transparently.

Price: \$1495.

Contact: U.S. Ecycon, 1849 Knoll Dr., Suite B, Ventura, CA 93003, (805) 650-8474.

Inquiry 1064.

EtherNext Wires LANs with Twisted-Pair

NetWorth's EtherNext is an Ethernet concentrator for linking as many as 12 PCs or PS/2s with unshielded twisted-pair cabling. It is designed around the evolving iOBASE-T standard.

NetWorth sells 8-bit XT and 16-bit AT and MCA cards, as well as coaxial-compatible transceivers for linking a PC to the concentrator over thick or thin coaxial or even optical fiber cabling. The 8-bit cards have 8K-byte buffers; 16-bit cards have 16K-byte buffers. NetWare software drivers are included.

Price: 8-bit, \$495; 16-bit, \$595; MCA (16-bit), \$695; transceivers, \$249; concentrator, \$2495.

Contact: NetWorth, Inc., 8101 Ridgepoint Dr., Suite 107, Irving, TX 75063, (800) 544-5255 or (214) 869-1331.

Inquiry 1062.

Novell Claims Better Throughput

The NE/2-32 is a 32-bit Ethernet adapter designed to ease the I/O bottleneck. It's designed to work best with MCA and NetWare 386 and to take advantage of the Intel 80386 chip's String Move instruction. This instruction triggers the movement of a sequence of 32-bit words per clock cycle, rather than one 32-bit word, between the host's main memory and the card's memory. Novell claims a 50 percent improvement with one NE/2-32 in the server.

Price: \$995.

Contact: Novell, Inc., 122 East 1700 South, Provo, UT 84606, (800) 453-1267 or (801) 379-5900.

Inquiry 1063.



INSTANT WORKSTATION. JUST ADD OPEN DESKTOP.

Take a look at the vast majority of graphical workstations developed over the past decade and you'll see something they all have in common:

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World Radio History

There's gold Now, Quarterdeck's new

Memory is gold.

And like gold, some of it is hidden away inside your computer. For years, we've been working toward putting it all under your control. And now we can.

Now you can make today's more powerful programs run without giving up network and mouse drivers and TSRs.

Introducing Manifest—the Quarterdeck memory analyzer

Many PC users know there are nuggets of memory sitting unused in most PCs. But those little pieces of memory can add up to 130K!

That's why Quarterdeck Office Systems, publisher of DESQview, developed a new utility that helps you find and use this memory. It's called Manifest. And it does for memory what PC Tools does for disks. For under \$60.

Quarterdeck's seven years of memory expertise made Manifest

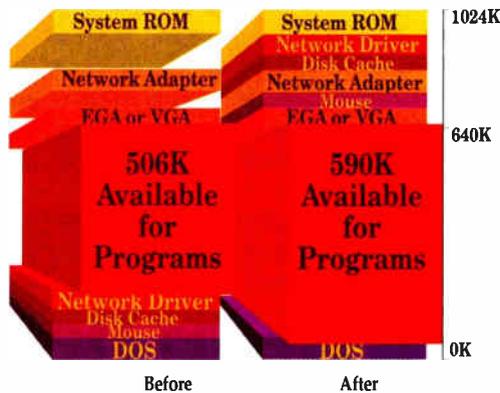
Manifest guides you deep inside your PC.

It locates unused (or underused) memory and suggests where you could load networks, buffers, mouse drivers, TSRs and other utilities to increase performance. It even analyzes what type and amount of RAM you have available, and which portions of your memory are faster.

Administering a number of PCs? Manifest's diagnostic and reporting capabilities reduce technical support time. It not only identifies problems but helps to solve them.



Manifest shows you what's 'under the hood' of your PC.



Your current memory is full of holes. Our tools can fill blocks of unused addresses between 640K and 1024K to free up memory your programs can use.

Manifest shows you the contents of AUTOEXEC.BAT and CONFIG.SYS files. That can be a big help when diagnosing problems. Manifest tells you all about your hardware, too—from your cpu type to what boards you have installed. Manifest even tests memory speed.

And it runs benchmark tests on expanded memory boards so you can make informed buying decisions.

You won't need a PhD to understand what you're doing. Manifest has an interactive 'manual' that tells you how to use the program and what benefits you'll get.

And unlike a lot of hot new software, Manifest works on virtually any PC: 8088, 8086, 80286 or 80386. It's a productivity breakthrough from the memory experts at Quarterdeck.

Introducing QRAM—the Quarterdeck memory optimizer

End RAM cram in your 8088, 8086 or 80286 PC once and for all. QRAM (pronounced cram), is a package of utilities that gives you unprecedented control over memory, letting you set up your memory the way it will work best for you.

If you have EMS 4.0 or EEMS boards, QRAM can find unused addresses and 'map' memory to those addresses. Then it looks at your AUTOEXEC.BAT and CONFIG.SYS files and figures out what TSRs, network and mouse drivers and DOS resources can be loaded high and where.

And, like all Quarterdeck memory products, QRAM is compatible with the Microsoft XMS specification used by Windows 286, V. 2.x.

If your PC has 'shadow RAM,' there's even more gold in your PC. QRAM finds the unused



QRAM optimizes your memory performance by moving utilities and drivers out of the area between 0K 640K—freeing it up for your programs to use.

parts and puts them under your control.

And if you have an EGA or VGA-equipped PC and don't need graphics at the moment, QRAM will make an additional 96K 'nugget' of memory available! When you need graphics again, QRAM will switch you back to graphics mode! Think how helpful that will be for those big dBASE files.

QRAM can't work miracles, but if there's memory available anywhere, QRAM lets you use it to increase your PCs speed and performance.

QRAM is available bundled with Manifest for just a few dollars more than Manifest alone.

Manifest and QRAM—two more examples of Quarterdeck's commitment to mining the most productivity out of the PC and software you own today.

in your PC. Tools can mine it for you.

Introducing QEMM 50/60 Version 5.0

QEMM (Quarterdeck Expanded Memory Manager) 50/60 is the gold standard in memory management for the IBM PS/2™ series 50 and 60. It works with IBM's Memory Expansion Option, Expanded Memory Adapter/A and compatible memory boards.

It supports all three specifications for expanded memory: EMS 4.0, EMS 3.2 and EEMS memory so you can run all expanded memory programs.

And it also works with Microsoft's XMS specification, in case you want to use Windows.

QEMM lets you use memory locations between 640K and 1024K to run TSRs, mouse and network drivers, DOS resources and MCA adaptors. That means you can gain up to 130K of memory space below 640K for your programs.

Best of all, QEMM is designed to be easy to use—even for those new to the PC. Just install it and type 'optimize,' and it looks at your AUTOEXEC.BAT and CONFIG.SYS files and loads whatever it can in high memory. Automatically.

QEMM 50/60 is priced economically. It's the biggest boost you can give your PS/2 for under \$100.



QEMM and DESQview let you multitask and window with the programs you know and use today.

Introducing QEMM 386 Version 5.0

QEMM 386 can expand the memory of all 386-based computers, including PCs with 80386 upgrade boards. It makes your memory compatible with EMS 4.0, EMS 3.2 and EEMS memory without having to add special hardware. It's compatible with protected-mode programs (like 1-2-3 Release 3, IBM Interleaf and Paradox 386) using DOS extenders compatible with the Quarterdeck/Pharlap VCPI spec.

QEMM also works with Microsoft's XMS spec to extend memory for Windows users.

QEMM gives you maximum control over your memory between 640K-1024K. It can find unused memory nuggets as small as 4K and use them to free up room for programs to use.

QEMM 386 even monitors how your programs use memory while they're running. Then it shows you where there's additional memory you can use. It even measures which parts of your memory are fastest and 'decides' how to use them for better performance. In action, it's easy and fun—almost like having an *artificial intelligence* program to help tune up your PC.

All these capabilities add up to greater performance at a very low cost. And QEMM lets you go for the gold without having to become an expert on the PC memory puzzle.

Like all Quarterdeck products, it works with your current PC and favorite software.

A few words about DESQview

What's the smartest thing to do with all that additional memory? Run DESQview and multitask your favorite programs in windows. Use a mouse or keyboard and you can run graphic and text-based programs side-by-side. All without having to invest in a bigger hard disk or more memory.

From Manifest to QRAM, QEMM and DESQview, Quarterdeck helps you mine the most from the software and PC you have today.



DESQview's recent awards.

System Requirements

Manifest: 8088, 8086, 80286 80386 and i486 PCs & PS/2s

GRAM: 8088, 8086, 80286 PCs. Use of high memory is only available when PC has EMS 4 or EEMS expanded memory or Chips & Technologies shadow RAM.

QEMM 50/60: 80286-based PS/2s and compatibles with IBM PS/2 80286 Memory Expansion Option, IBM PS/2 80286 Expanded Memory Adapter/A or compatible.

QEMM-386: 80386-based PCs and PS/2s and PCs with 80386 add-in boards.

Trademarks: IBM, PS/2: IBM Corporation; PC Tools: Central Point Software; 80386, i486: Intel Corporation, Chips and Technologies: Chips and Technologies

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	QEMM 50/60 5.0 (with Manifest*)			\$99.95	
	QEMM 386 5.0 (with Manifest*)			\$99.95	

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California Residents add 6.5%

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Circle 267 on Reader Service Card

World Radio History

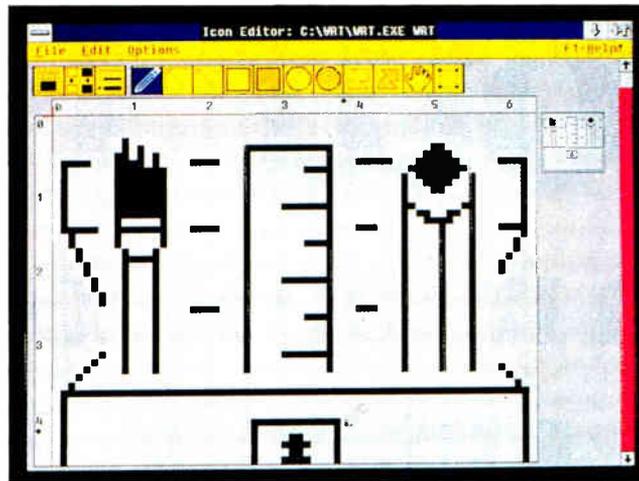
Resource Toolkit for Windows

The Whitewater Resource Toolkit includes seven editors for creating, editing, and managing the look and feel of a Microsoft Windows application. You can use it to create, edit, and copy standard resources such as bitmaps, icons, cursors, dialog boxes, menus, accelerator tables, and string tables from within the Windows environment, according to The Whitewater Group.

With the kit, you can edit or move resources directly from and into .EXE and .RES files. The string table editor lets you translate applications into foreign languages without having access to the application's source code, the company reports.

The toolkit is written in Actor, the company's object-oriented development language, and doesn't require the Software Development Kit or the Resource Compiler. The toolkit supports the Actor and C languages. It runs on the IBM PC AT with Windows 2.1 or higher, 1 megabyte of RAM, and a hard disk drive. **Price:** \$195.

Contact: The Whitewater Group, 600 Davis St., Evanston, IL 60201, (800) 869-1144 or (312) 328-9386. **Inquiry 1131.**



The Whitewater Resource Toolkit's Icon Editor, one of seven types of resources available under Windows, lets you create new icons or modify existing ones.

Object-Oriented Databases

Two companies have recently introduced or upgraded object-oriented database products that can bind with C++ to make that language's objects persistent. *Persistence* means that transient in-memory objects map automatically (and isomorphically) to disk storage. This frees the C++ programmer from the chore of having to interface complex object-oriented programming (OOP) data structures to traditional flat or relational databases.

Servio Logic's GemStone provides C++, Smalltalk, and Nexpert Object

bindings. The GemStone/C++ interface includes a class library, derived from the Smalltalk class library developed at Xerox Palo Alto Research Center, that provides a useful application framework. You can also use GemStone as a stand-alone DBMS. Its native language, called Opal, is an object-oriented data definition language and data manipulation language.

The GemStone "object server" runs on Sun 3 and Sun 4 workstations. These same workstations can double as clients; PCs and Macs running C++, Smalltalk, or Nexpert Object applications can also use the GemStone server. **Price:** \$22,000 for four-user license on Sun 3; \$32,000 on Sun 4.

Contact: Servio Logic Development Corp., 15220 Northwest Greenbrier Pkwy., Suite 100, Beaverton, OR 97006, (503) 629-8383. **Inquiry 1133.**

Ontologic's Ontos, available for Sun, Apollo, and OS/2 workstations, also works with C++; Ontologic recently announced that it too would support Neuron Data's hybrid expert system shell, Nexpert Object. Ontologic reports that the one-to-one mapping of in-memory structures to disk outperforms relational databases, for applications that use complex OOP data-modeling techniques.

Ontos also provides a version of C++, called Persistent C++, that comes with a class library that defines persistent classes such as sets, lists, dictionaries, and arrays. Classes that you derive from these inherit their persistence. A tool called Classify reads C++ class definitions and generates an object-oriented database schema; another, called CPlus, runs the C++ compiler and adds the glue that binds the application to the database. Other tools include a database browser and editor, a profiler, a database reorganizer, and administrative utilities.

Ontos runs on Sun, Apollo, and OS/2 platforms and supports SQL. The company says that it is developing a version for DEC platforms. **Price:** \$15,000; Persistent C++, \$9900; Class Library, \$695.

Contact: Ontologic, Inc., Three Burlington Woods, Burlington, MA 01803, (617) 272-7110. **Inquiry 1134.**

continued

Create PostScript Programs for the NeXT Computer

Displaytalk is an integrated environment for Display PostScript programming on the NeXT Computer. Programmers can inspect the inner workings of a PostScript Wrap or program. Novices can use it to interact with the PostScript server, as the program provides immediate feedback on the proper use and the re-

sulting action of each command.

Displaytalk provides real-time display of all language stacks and variables; a source-level debugger with tracing, stepping, and break-points; on-screen preview of PostScript drawings; and a browser that lets you access all dictionaries. The company says that you can

use Displaytalk to debug PostScript files that won't run elsewhere.

Displaytalk runs on the NeXT Computer and comes on a single optical disk. **Price:** \$995.

Contact: Emerald City Software, 1040 Marsh Rd., Suite 110, Menlo Park, CA 94025, (415) 324-8080. **Inquiry 1132.**



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QNX programmers have a decided advantage.

You see, people who use QNX enjoy the freedom that comes only with a flexible, modular OS. They appreciate the elegance of a **message-passing architecture**. And they marvel at the fact that QNX runs so lean—under 150K—yet out-performs any other PC operating system.

QNX users never worry about whether their applications will make it at runtime, because they know QNX has proven itself again and again in the real world.

It's no wonder that QNX users have achieved so much since the product was first released for the PC in 1982: over 80,000 systems installed in 47 countries world-wide, in all kinds of applications—from making cars to selling books to handling online credit card transactions.

One reviewer dubbed QNX "The multi-everything OS." Now, you might expect

multiuser and multitasking, but realtime? And integrated networking? And true distributed processing? Best of all, these terms take on a new meaning with QNX.

Multiuser, for instance, means up to 32 terminals per micro. **Multitasking** cashes out as 150 tasks per machine.

Realtime means not only priority-driven, preemptive task scheduling, but also speed: at 6,896 task switches/sec on a 16MHz 286, QNX is at least a full order of magnitude faster than a typical UNIX system. **Integrated networking** means you won't need yet another layer of software to set up a LAN, and you can use *any mix* of Intel-based micros—from vintage '81 PCs to PS/2s.

Distributed processing with QNX sounds too good to be true. But it is: *Any task can access any resource*—programs, files, devices, even CPUs—without going through the bottleneck of a central file server.

Besides the satisfaction that QNX developers get from using a fast, powerful, and flexible OS, did we mention that they also enjoy *free technical support*?

If you're wondering why you don't already know all about this great OS, you could try asking the over-achievers who are smugly guarding the secret of their success.

Better yet, give us a call. We'll tell you everything you need to know to become an over-achiever yourself.



For more information or a free demo disk, please phone (613) 591-0931.

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World Radio History

Circle 266 on Reader-Service Card

Write Your Own 1-2-3 Functions

Baler Software is adding two new versions to its line of Baler compilers that let you transform Lotus 1-2-3 worksheets into custom tamperproof programs.

The Baler XE spreadsheet compiler lets advanced spreadsheet builders write additions in BASIC or C to the library of built-in customization features.

Baler 5.0 supports file linking, allowing baled programs to access data from other worksheets. The company says that it has enhanced or added 21 slash commands and six new macro commands to Baler 5.0. A new search-and-replace feature lets you find specific numbers and text in cells. Both Balers support Lotus 1-2-3 release 2.2 and 3.0.

Price: \$495; Baler XE, \$695.

Contact: Baler Software Corp., 2300 North Barrington

The screenshot shows a spreadsheet window titled "Financial Statements Program". A menu is open over the "Insert" cell, listing options: Insert, Delete, Column, Erase, Titles, Windows, and Esc=Cancel. The spreadsheet data is as follows:

	1990	1989	
Income	\$1,526,456	\$1,354,797	12.7%
Interest & other income	\$77,878	\$185,666	-26.3%
	\$1,790,000	\$1,460,463	16.4%
Cost of goods sold	\$950,606	\$921,388	3.2%
Marketing	\$67,157	\$63,300	6.1%
Interest	\$46,118	\$50,609	-8.9%
Taxes on income	\$89,672	\$73,601	21.8%
	\$1,153,553	\$1,108,898	4.0%
Net Income	\$546,447	\$351,565	55.4%

At the bottom of the window, a status bar shows keyboard shortcuts: F1=HELP F2=EDIT F3=LIST F4=MENU F5=GO TO F6=SAVEWORK F9=DRILLDOWN.

With Baler's customization tools (Baler 5.0 shown here), you can improve a worksheet's appearance by adding pull-down menus, color, and custom help.

Rd., Hoffman Estates, IL 60195, (312) 490-5325.

Inquiry 1120.

King Jaguar 2.0, Sheng Labs' spreadsheet compiler, also supports Lotus file linking in version 2.2. Like Baler 5.0, the program supports user-defined functions written in C and assembly and provides routines to print graphs and create pop-up menus and alert messages.

According to Sheng Labs, what sets King Jaguar apart from other compilers is its ability to compile macro commands. Version 2.0 includes several tools to help you compile macro commands: automatic syntax checking, a macro and formula auditor, and MacroView, a debugger that lets you watch macros execute step by step.

King Jaguar 2.0 works with Lotus 1-2-3 release 2.01

and 2.2.

Price: \$595.

Contact: Sheng Labs, Inc., 4470 Southwest Hall St., Suite 282, Beaverton, OR 97005, (800) 548-1270 or (503) 646-3691.

Inquiry 1121.

SAS Jumps In with Statistics for the Macintosh

SAS Institute has combined its background in statistics with the graphing capabilities of the Macintosh to develop a statistical analysis program that lets you open several data tables at once and cut and paste among them. With JMP (pronounced "jump") you can link raw data with plots and graphs that are hot-linked so that changes are updated continually in all related windows. JMP lets you visualize raw data and how it changes as you analyze it, SAS reports.

JMP can also manipulate data graphically. For example, you can use the mouse to reduce and expand the widths of the bars in a histogram and quickly see the changes in the graph.

JMP supports the methods, such as one-way ANOVA, regression, and curve fits, that you expect in a statistical analysis program. If you're unsure of which method to use, JMP can recommend one.

JMP supports other mini-computer and mainframe SAS software via raw data transfer or transport files. It runs on the Mac Plus or higher.

Price: \$695; student version (500-cell maximum), \$89.

Contact: SAS Institute, Inc., SAS Circle, Box 8000, Cary, NC 27512, (919) 467-8000.

Inquiry 1122.

continued

Programs Create Organizational Charts

Unison World's Chain of Command allows you to match names with faces: The program's support of PCX images lets you place clip art or a scanned image next to a person's name. It can also automatically scale and lay out a chart to fit a page.

You can work in text or graphics mode, allowing for easy updating of a chart, and you can print in four font faces with 13 styles in sizes from 1 to 200 points.

The program runs on the IBM PC with 640K bytes of RAM, a hard disk drive, and a mouse.

Price: \$149.95.

Contact: Unison World, a division of Kyocera Uni-

son, Inc., 1321 Harbor Bay Pkwy., Alameda, CA 94501, (800) 444-7553 or (415) 748-6670.

Inquiry 1124.

Company Ladder's split-screen interface prevents you from getting lost in a complex chart, allowing you to quickly locate specific employee positions and update them.

The program can automatically draw boxes and connect them with lines. The text and numbers that appear in the boxes are also positioned automatically, according to PowerUp! Software.

With an IBM PC and your laser printer, you can create

more readable charts using built-in fonts and assigning different type styles for each field in a chart. Charts can be positioned horizontally or vertically on your page. You can choose from seven chart styles and six box styles, or you can mix styles.

Each box in an organizational chart can hold up to 255 characters with 26 fields per box. Each field can have its own printing options.

Company Ladder runs on the IBM PC with 256K bytes of RAM.

Price: \$79.95.

Contact: Power Up! Software Corp., 2929 Campus Dr., San Mateo, CA 94403, (415) 345-5900.

Inquiry 1125.

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two PCs running Ashton-Tate SQL Server.

Doesn't work with either Lotus 1-2-3 or dBASE
just yet.

Supports only Focus.

Supports only C.

Ashton-Tate SQL Server's published benchmarks
show it to be slower.

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The features you'll use most often are available at a touch. Seven resident fonts to vary the look of your documents. Formatting for different document sizes.

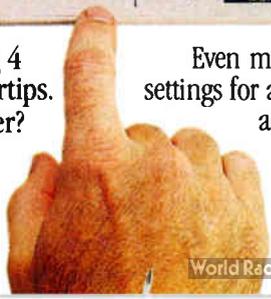
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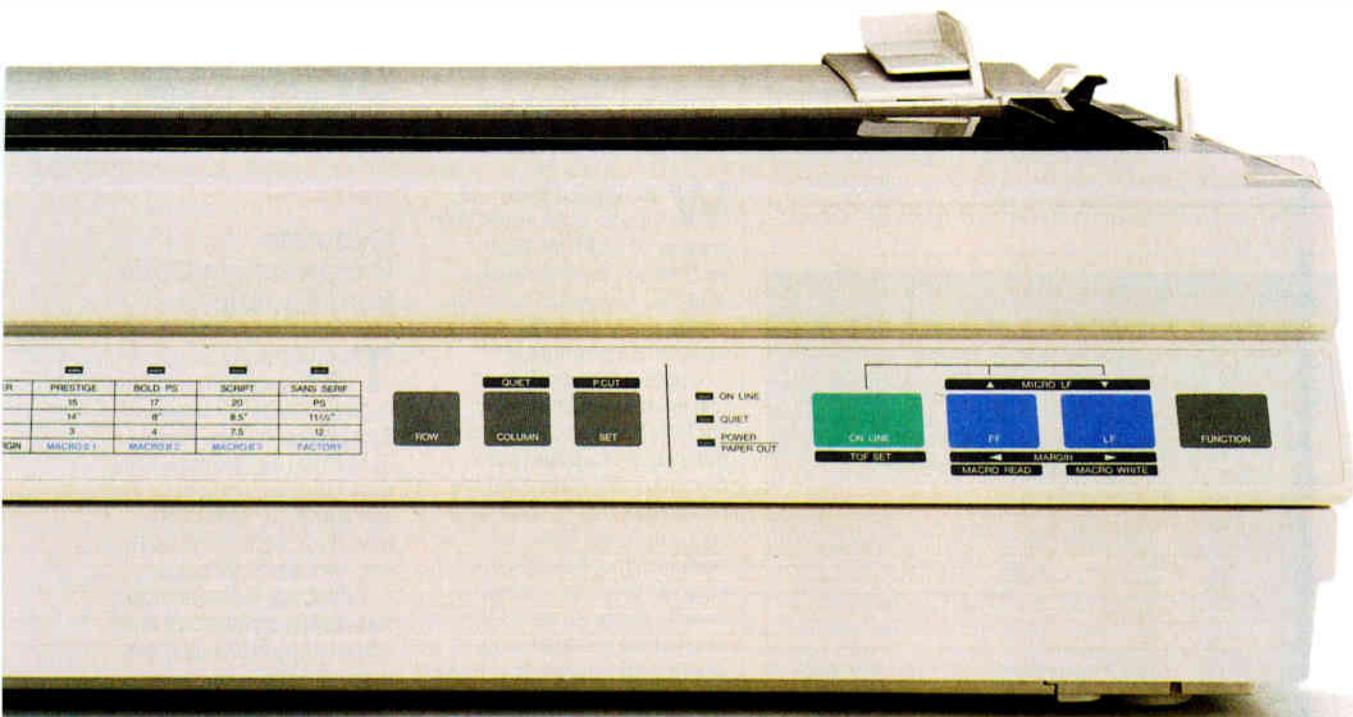
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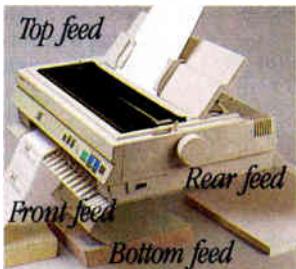


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DESIGN PHILOSOPHY

- The Teletek X-Bandit was specifically designed to utilize the advanced features of the Lotus/Intel/Microsoft EMS 4.0 Specification. Further, the X-Bandit's Segmented Memory Mapping capability allows the user to extend DOS size beyond the 640K barrier. It is available in both 8 and 16 bit versions for use in the IBM XT, AT, and compatible.

MEMORY

- Segmented Memory Mapping allows the user to fill out unused memory segments between 640K and 1024K. By "claiming" unused portions of memory in 16K increments, the user effectively increases TPA size. LAN or custom software modules, for example, can be loaded into these high memory areas thus relieving the lower 640K of TPA for other application programs.
- Split Memory Addressing allows the user to fill out conventional memory to 640K.
- Extended Memory Addressing is available for the PC/AT version.
- 2 Mb capacity in a single slot. Up to 8 Mb/system.
- Parity checking.

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- Easy menu-driven auto configuration software.
- Device driver includes print spooler and RAM drive.
- Supports multitasking with the appropriate shell-resident software package.

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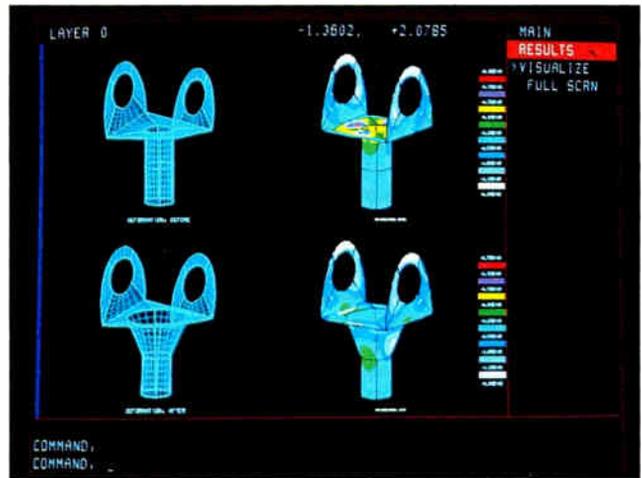
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With Applied Structure, an add-in for AutoCAD version 10 and IBM CAD, you can automate the design, analysis, and optimization of products and components in an integrated environment.

Applied Structure is not just another finite-element analysis program, Rasna reports. It uses a proprietary Geometric Element Analysis technology that the company says eliminates finite-element meshing but provides equal or better evaluation accuracy. Using Rasna's Geometric Element Modeling, Applied Structure can define a model with fewer and larger elements, making for simpler modeling for analysis. An automatic adaptivity feature solves to a level of accuracy that the user specifies. Two other features let you evaluate numerous options for design parameters.

Applied Structure runs on 80386-based IBM PCs with at least 40-megabyte hard disk drives and 640K bytes of RAM or on Sun 3 and Sun 4 workstations.

Price: \$9000.
Contact: Rasna Corp., 2590

North First St., Suite 200,
San Jose, CA 95131, (408)
922-6833.
Inquiry 1139.

Generate Programming Code from Equations

Taking the process of finding the best equation to fit hundreds of real-world data points one step further, TableCode can generate code for a given equation in C, Pascal, BASIC, FORTRAN, Modula-2, dBASE, and Clipper, says AINS Software.

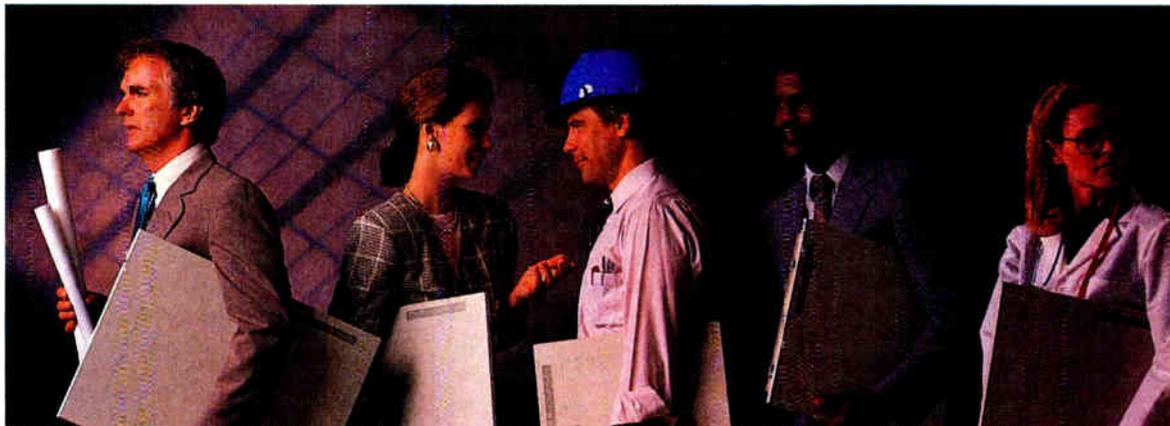
TableCode uses automated statistical methods to fit data into 211 potential equations in one step. You can view which curve fits best with residual tables and plots of the points versus the fitted curve. TableCode will also list all equations that successfully fit the data and rank them according to several criteria. TableCode's twin-window calling program lets you test the equation code.

The program runs on the IBM PC XT with 640K bytes of RAM.

Price: \$149.
Contact: AINS Software, P.O. Box 32277, Phoenix, AZ 85064, (602) 266-1925.
Inquiry 1142.

continued

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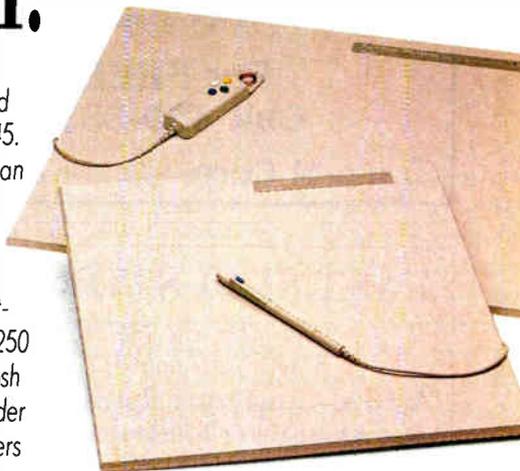
The PC version includes interface cables for the IBM® PC, AT, PS/2 and compatibles. A utilities diskette with test and reset software, an Autodesk® Device Interface™ driver, Universal Mouse Emulator™ and a Microsoft® Windows driver. And an offer for

a free tablet template (US and Canada only) worth over \$245.

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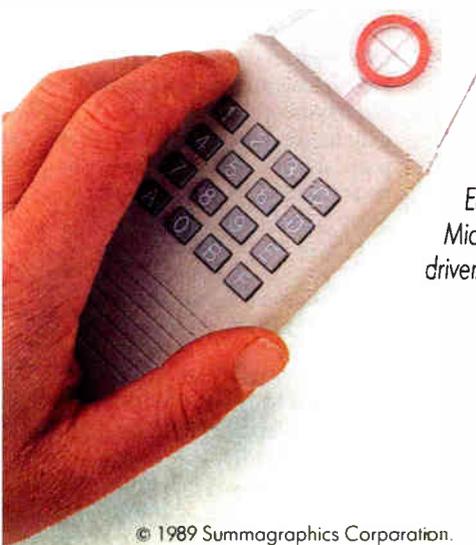
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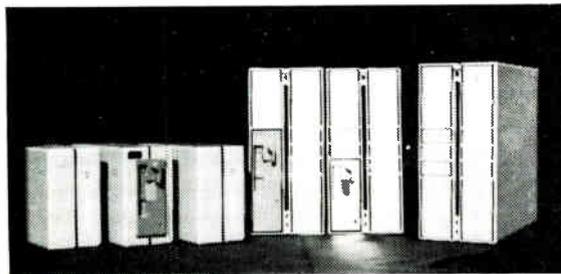
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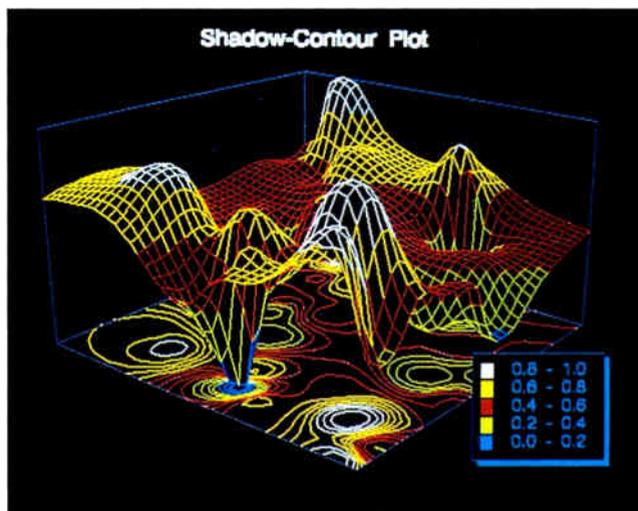
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WHAT'S NEW

SCIENCE AND ENGINEERING



Graftool 2.1 displaying a shadow contour.

Multicolored Curves Added to Graftool

Graftool, the 3-D graphics program that lets you generate and analyze hundreds of variants of scientific and engineering graphs, now supports multicolored curves and surfaces with a Z-value color map, allowing you to use color to indicate value ranges. Graftool 2.1 supports Greek and mathematical symbols, 3-D to 2-D projections, and PostScript, the manufacturer reports.

Graftool's data cursor identifies critical values, such as maxima or minima, by showing you the exact coordinates of any point on a graph. The cursor can mark any portion of a graph for on-screen analysis and data processing. You can plot, graph, superimpose, or place the analysis next to the initial graph. All graphs can be scaled, rotated, and moved in three dimensions. The program's vector-based graphics permit an unlimited number of curves per graph (and graphs per screen).

Graftool 2.1 supports 12 graph types, including x,y plots, parametric graphs, and 3-D trajectory plots. The program runs on the IBM PC. **Price:** \$495.

Contact: 3-D Visions Corp., 412 South Pacific Coast Hwy., Suite 201, Redondo Beach, CA 90277, (800) 729-4723 or (213) 540-8818.

Inquiry 1141.

Schematic Design for Under \$300

With CF640's overlay memory management scheme, you can work with designs of up to 10,000 elements within 640K bytes of RAM. The program's incremental netlist extractor lets you load part of a design into memory, and you can split your screen into four windows.

CF640 includes a program that automatically assigns reference designators and pin numbers to physical packages. Other features are Xilinx and Abel interfaces; symbol libraries; a symbol creation editor; a library of more than 5500 parts; a PADS-PCB back annotator; Spice interface tools; a Susie digital interface; and interfaces to other printed circuit board CAD systems.

CF640 runs on the IBM PC AT or higher.

Price: \$295.

Contact: Phase Three Logic, Inc., 1600 Northwest 167th Place, Beaverton, OR 97006, (503) 645-0313.

Inquiry 1140.

continued



MODEL	DESCRIPTION	RESOLUTION			RS-170, RS-330
		Spatial	Gray Levels	Number	
DT2862-60Hz ^a	Arithmetic Frame Grabber	512 x 512	256	8 ¹	
DT2862-50Hz ^a	Frame Grabber & Frame Processor	512 x 512	256	8 ¹	
DT2862-60Hz ^a w/ DT2858 ^b	Frame Grabber & Frame Processor	512 x 512	256	8 ¹	
DT2862-50Hz ^a w/ DT2858 ^b	Frame Grabber & Frame Processor	512 x 512	256	8 ¹	
DT2861-60Hz ^a	Arithmetic Frame Grabber	512x512	256	8 ¹	
DT2861-50Hz ^a	Frame Grabber & Frame Processor	512x512	256	8 ¹	
DT2861-60Hz ^a w/ DT2858 ^b	Frame Grabber & Frame Processor	512x512	256	8 ¹	
DT2861-50Hz ^a w/ DT2858 ^b	Frame Grabber & Frame Processor	512x512	256	8 ¹	
DT2851-60Hz ^a	High Resolution Frame Grabber	512 x 512	256	8 ¹	

Program	Real-Time Frame Aver. Math & Logic	Hardy Windows
	8-bit	✓
	8-bit or 16-bit ²	✓
	8-bit or 16-bit ²	✓
	8-bit	✓
	8-bit or 16-bit ²	✓
	8-bit or 16-bit ²	✓
	4-bit	✓
	4-bit or 16-bit ²	✓
	4-bit or 16-bit ²	✓
	4-bit	✓
	4-bit	✓

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MODEL	DESCRIPTION	Resolution	Gray Levels	Number
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DT2853-50Hz ^a	Frame Grabber	512 x 512	256	8 ¹
DT2853-SQ-60Hz ^a	Low Cost, Square Pixel Frame Grabber	512 x 512 Square Pixel Option	256	8 ¹
DT2853-SQ-50Hz ^a	Frame Grabber	512 x 512 Square Pixel Option	256	8 ¹
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CPU	8086, 8088 80286, 80386	8086, 8088 80286, 80386	8086, 8088 80286, 80386	8086, 8088 80286, 80386
DISK STORAGE	360/720KB	360/720KB	360/720KB	360/720KB
NETWORKING	NO	NO	YES	YES
FIELDS PER RECORD	99	199	299	499
NUMBER OF RECORDS	UNLIMITED	UNLIMITED	UNLIMITED	UNLIMITED
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You can step a film forward or backward for editing and insert or delete frames. Sections of film can be repositioned, moved, merged, or deleted.

The program provides its own drawing facilities and text fonts. All objects are stored in a single library file, including the film itself. Impel can handle film editing and splicing, simultaneous moving of different pictures, and wipe/dissolve special effects. A film compiler can increase the speed of your finished films.

Impel works on the IBM PC with 640K bytes of RAM, DOS 2.0 or higher (Eastridge recommends 3.0 or higher), CGA, EGA, VGA, or MCGA graphics cards, and a Micro-

soft or IBM PS/2 mouse.
Price: \$295.

Contact: Eastridge Technology, 37 Murray St., New York, NY 10007, (212) 267-7980.

Inquiry 1145.

Real-time Operating Systems for the Mac and 80386 PCs

Two companies recently introduced real-time operating systems based on OS-9.

Microware's OS-9000, a real-time operating system for Intel and Motorola chips, is upwardly compatible with OS-9, a real-time, modular, multitasking operating system for Motorola's 680x0 family. Initially, OS-9000 will support Intel's 80386, and early this year, Motorola's 88000 RISC and Intel's 80486 processors. Later this year, the company plans to support ISDN and a variety of VMEbus multiprocessor architectures.

Microware says that OS-9000, with its scalable, modular architecture, can be used for developing everything from stand-alone, "ROMable" kernels to a complete multiuser developing system. OS-9000 supports RAVE, Microware's

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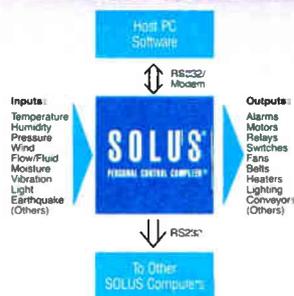
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real-time audio/video environment.

OS-9000 directly supports resident processors, allowing you to edit, compile, and debug your code directly on the targeted hardware. It also supports Unix and DOS cross-development, letting you develop on a host, cross-compile, and download the code to the target platform. Microware also plans to offer LAN and backplane-based communication options.

Industrial OS-9000 will include the real-time kernel with interprocess communication and console I/O managers. The professional version will include the industrial version with 70 utility commands, C compiler, and disk and tape support.

Price: \$995.

Contact: Microware Systems Corp., 1900 Northwest 114th St., Des Moines, IA 50322, (515) 224-1929.

Inquiry 1146.

Ultrasience's OS-9 for the Mac is a full implementation of Microware's OS-9 version 2.3. With Ultrasience's OS-9, you can put a multitasking, multiuser operating system on your Macintosh by connecting dumb terminals to the Mac via modem and printer ports, without modifying your machine.

The Ultrasience OS-9 lets you run standard Mac software and OS-9 applications.

If you're thinking of buying a LAN, you might want to consider OS-9 as an alternative, provided every user doesn't require a graphics monitor. In its first implementation, OS-9 appears as a folder that you click to do real-time multitasking.

You can't yet hot-key to the Mac while OS-9 runs in the background, although the company says that a version scheduled to ship this year will permit that.

OS-9 on the Mac supports C, BASIC, Forth, FORTRAN,

Modula-2, MUMPS, and Pascal, in addition to all the Mac ToolBox calls and AppleTalk, providing full compatibility with third-party Mac devices as well as color and black-and-white Quick-Draw commands.

OS-9 for the Mac requires just 150K bytes of memory. Price: Mac Plus or SE version, \$780; Mac II, \$900; Mac IIx or SE/30, \$960.

Contact: Ultrasience, a division of Gibb Laboratories, Inc., 1824 Wilmette Ave., Wilmette, IL 60091, (312) 256-0080.

Inquiry 1147.

DA for the Mac Hyphenates in 15 Languages

If you're putting together a document or newsletter on the Mac in a language other than English, you know what a pain hyphenation is. For example, Germanic languages often join several words together, at which point a word processor gives up, requiring you to manually insert carriage returns and hyphens.

A desk accessory called Dashes DA makes hyphenation in most European languages reliable for the first time by using a compounding algorithm for most Germanic languages. The DA eliminates the need for expensive customized word processors or desktop publishing programs and is 99 percent accurate in each supported language, according to the developer. It works with any word processor with discretionary hyphenation capabilities.

Dashes DA works on the Mac Plus or higher.

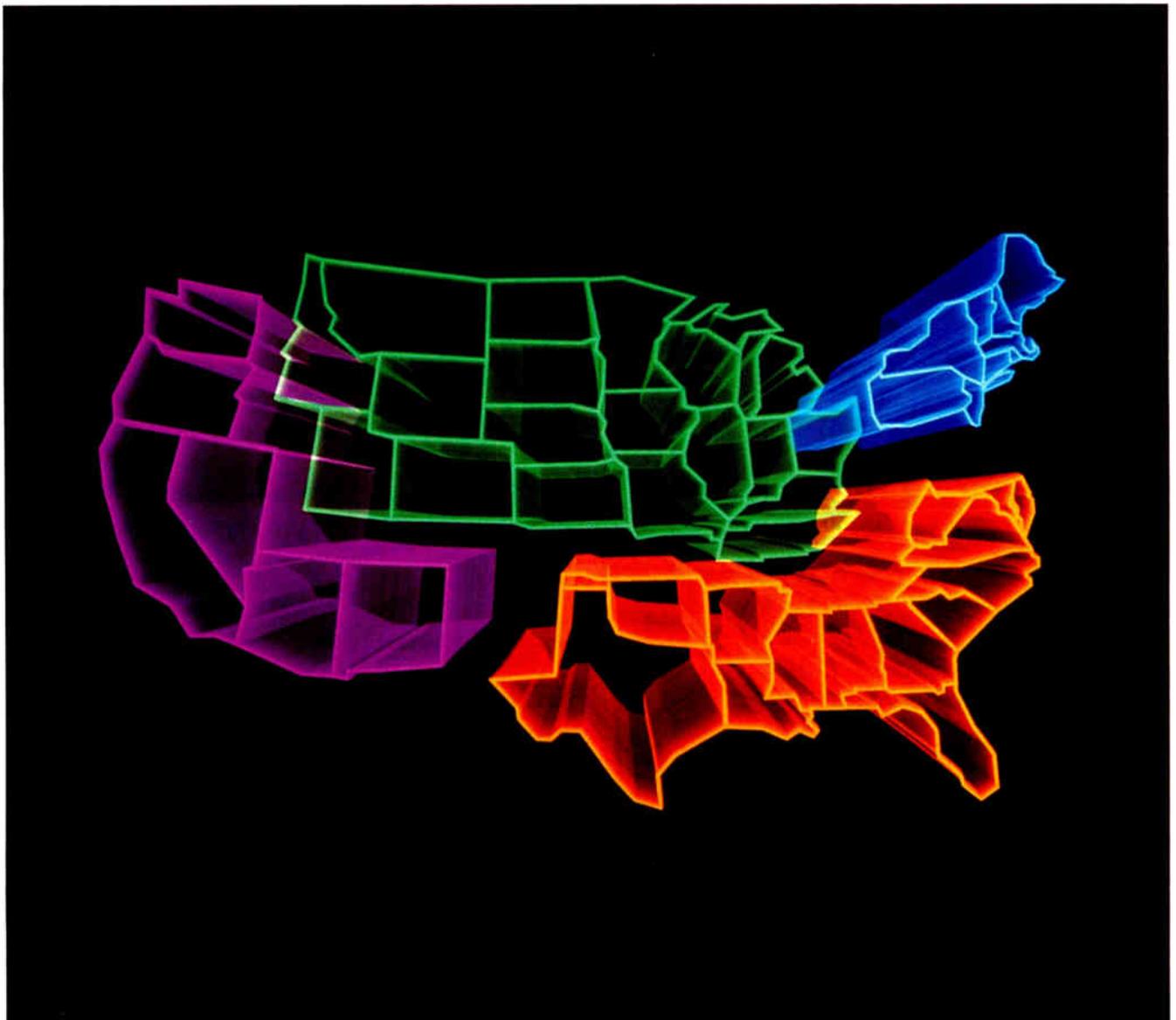
Price: \$95 each language. Contact: Circle Noetic Services, 5 Pine Knoll Dr., Mont Vernon, NH 03057, (603) 672-6151.

Inquiry 1149.

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WHAT'S NEW

METRO NEW YORK • NEW ENGLAND

Commodore's President Speaks to BCS Amiga Group

Hot off the heels of launching a \$15 million national advertising campaign that positions the Amiga as the computer for the creative mind, Commodore president Harold Copperman outlined his plans to move Commodore into the same league as Apple and IBM.

Speaking to the Boston Computer Society's Amiga group on a cold and wet October night, Copperman proposed a five-point plan for bringing back the bloom to the Commodore name.

Copperman, 42, and most recently vice president and general manager of Apple's

eastern operations, played four different TV spots centered around Stevie, who uses his Amiga for music, statistics, science, and video/multi-media. He also released details of a print campaign that will run in *Time*, *Newsweek*, and *Life*.

Copperman said much work needs to be done before the Amiga breaks out of its multimedia niche and into the mainstream of computerdom. Copperman's five-point plan (not necessarily in order of importance, he said) is as follows: enhance Commodore's image, strengthen distribution, focus on the Amiga, go after new markets, and focus on customer satisfaction.

Copperman acknowledged there's still much work ahead, especially in the area of supporting software developers,

improving the Amiga's video, and software quality. "We've got some really good code, but we have to make it safer," he said. He also said, "There are lots of frustrations to fix. Just loading onto a hard disk . . . is not a trivial task." Commodore is currently establishing a developer's advisory board and may release developer's tools to help developers comply to the Amiga standard.

Copperman will use the Amiga as a wedge to open the door of business and government by focusing on the Amiga's strengths: interactive training and desktop video. Copperman acknowledged that IBM and Apple are even now competing with Commodore in the graphics arena, of which the Amiga was once king of the hill. Cop-

perman said Commodore will add more color to, enhance the speed of, and increase the resolution of the Amiga.

Copperman also said Commodore has a great opportunity in the education market as Apple tries to push its users onto the Macintosh platform. This will cause teachers to lift their heads and examine what else is out there. He said many will be dissatisfied with black-and-white performance and having to pay a five-figure price for color.

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CEO Canion Hints at Compaq's Plans

Compaq president and CEO Rod Canion, in announcing his company's plans for a family of Extended Industry Standard Architecture-bus products, asserted that EISA will be primarily a high-end platform for micro-processor-based servers and workstations. Bearing in mind Compaq's Midas touch in every product category it has so far attacked, the picture Canion painted of the future may cause a few sleepless nights at DEC, Sun, and IBM.

Speaking to the New York PC users group, Canion demonstrated the company's LTE notebook computers and highlighted Compaq's moves into

the high-performance desktop and the "no-compromise" laptop sectors of the market. Canion couldn't resist taking a few swipes at IBM and the Micro Channel Architecture (MCA). He pointed out that Compaq had already enhanced the AT bus and maintained backward compatibility with the introduction of the Flex architecture and memory.

"In the last two years, MCA has competed not with EISA but with an improved AT bus," he said. "Even so, we do well in comparisons." The real competition will be with "Micro Channel II or whatever is next," he said, because "what we introduce will go beyond what exists in any MCA system now."

The opening of the EISA era is a major turning point for Compaq. Canion said that

both IBM and Compaq had foreseen "minicomputer-class applications" for PCs in the future, and both recognized the need for a faster bus to support greater I/O bandwidth. With EISA, he said, "Compaq is moving out of the traditional PC arena." That will include not just new hardware but also software programs, distribution, and support that is more typical of minicomputers, he said.

Canion was candid in saying that he doesn't see a role for low-end EISA systems in the near future. (After all, the Intel EISA chip set now supports only 80386 and 80486 CPUs.) And he doesn't believe low-end applications need EISA. (An interesting observation, in light of IBM's controversial MCA-bus 80286-based Model 50.)

"Even complex applications are OK in the Flex architecture, and the 80286 and 80386 don't really stretch the I/O bus," he said. "But when you get into SQL and client/server computing, you need more bus bandwidth. That's where you'll see EISA from Compaq and others."

Asked whether the availability of bus-mastering boards would determine the commercial success of EISA, Canion responded that Compaq's initial product offering would include some such boards but, "it's not a numbers game." The bus wars are not a battle to the finish, he said, because both 32-bit architectures will gain adherents.

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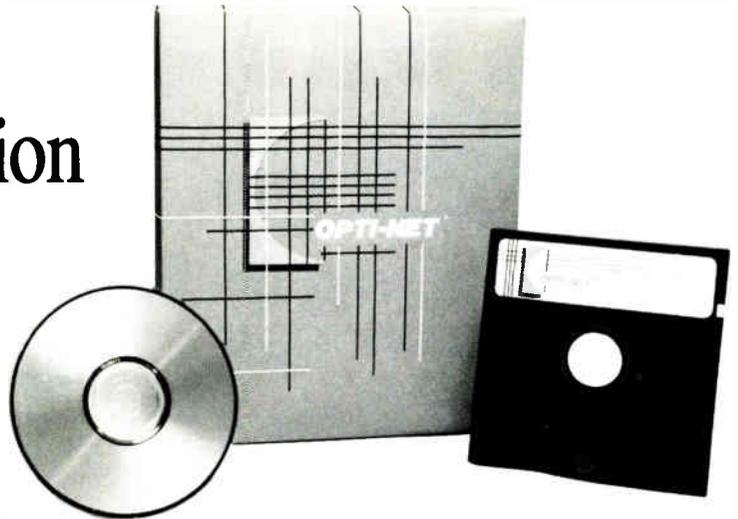
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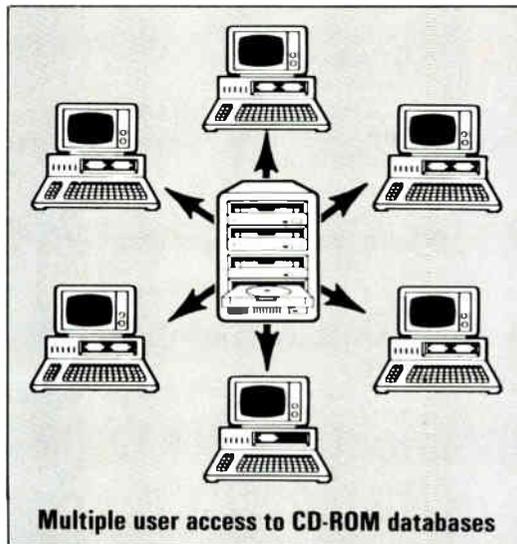
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DTP Program Lets You See Before You Get

Silicon Beach Software takes WYSIWYG technology one step further with Personal Press, a desktop publishing program that you can use to preview a document's appearance without opening up a graphics or text file.

Personal Press uses a technology called *proxies*, used with the program's dialog boxes. With a proxy, you can select a predefined template, place text and graphics (you can even crop the graphical image before you place it), and view the entire page layout as a thumbnail without opening the document. You can see what will happen before you hit the OK button, the company reports.

The program includes a workbook for storing text and graphics, a posted-notes facility, and a navigator. With posted notes, you can attach working notes, editing comments, and checklists to a document. The navigator feature lets you navigate through the linked text blocks.

Personal Press can import and display 8-bit PICT, TIFF, and Encapsulated PostScript graphics. You can define and name eight spot colors and print them as separations. With Silicon Beach Software's Advanced Halftoning and conventional PostScript halftoning options, you can print grayscale images.

Also included is a word processor with hyphenation, a thesaurus, search-and-replace capabilities, and a spelling checker. Personal Press runs on a Mac Plus with 1 megabyte of RAM. For color, you'll need a Mac II or higher with 2 megabytes of RAM. **Price: \$299.**



With Personal Press, you can leave reminder notes to others who work on the same document.

Contact: Silicon Beach Software, Inc., 9770 Carroll Center Rd., Suite J, San Diego, CA 92126, (619) 695-6956. **Inquiry 990.**

Analyze General Linear Models on the Mac

A program for analyzing general linear models lets you perform post-hoc tests, specify contrasts, tabulate and plot means, and view residuals in the friendly confines of the Macintosh user interface. Developer Abacus says that the program, SuperANOVA, is comparable to SAS Institute's GLM mainframe program, yet is easier to use and understand.

SuperANOVA (for analysis of variance) can handle analyses of variance, covariance, multiple variance, and multiple covariance, plus simple, multiple, and polynomial regression on experimental data.

The program comes in two versions: one for the Mac Plus and SE, and an optimized version for the Mac II family. **Price: \$495 each.** **Contact:** Abacus Concepts, Inc., 1984 Bonita Ave., Berkeley, CA 94704, (415) 540-1949. **Inquiry 988.**

Statistical and Data Management Under OS/2

MicrOsiris, a statistical package for survey analysis using moderate to large data sets, accepts over 1000 permanent variables and as many cases as you can get on your disk, according to its developer, Neal Van Eck. The program is based on Osiris IV, a mainframe program developed and in use at the University of Michigan.

MicrOsiris has an interactive statistical decision tree, to help you choose the appropriate statistical techniques, and a help facility. The program can handle weighted data and includes a program to check and validate wild codes. MicrOsiris can also aggregate data to a new level of analysis, the company reports.

MicrOsiris runs on the IBM AT or higher with OS/2 1.1 with Presentation Manager. **Price: \$225.** **Contact:** Van Eck Computer Consulting, P.O. Box 419, Selinsgrove, PA 17870, (717) 374-5239. **Inquiry 991.**

OS/2-Compatible Unit-Conversion Program

S.I. Plus, a unit-conversion program previously available only as a TSR program, is now compatible with OS/2, Geocomp reports. The program is a straight port of the previous DOS version and doesn't run in the DOS-mode session.

You can use the program to perform over 70,000 conversions in 80 different classes of units, the company reports. Classes of units include force, force per length, mass density, noise level, capacity, torque, momentum, area, volume, temperature, and many others.

S.I. Plus runs on the IBM AT with OS/2 1.0 or higher. **Price: \$79.** **Contact:** Geocomp Corp., 66 Commonwealth Ave., Concord, MA 01742, (508) 369-8304. **Inquiry 1003.**

Analyze Mortgages for Home or Banking

The Mortgage Analyzer 3.0, a professional version, lets you analyze a loan with nine built-in models for evaluating adjustable rate mortgages and performing what-if analyses. The program can compute equivalent annual percentage rate and total mortgage costs and calculate biweekly and monthly payments.

The Mortgage Analyzer runs on the IBM PC with 256K bytes of RAM. **Price: \$300;** personal version, \$59.95. **Contact:** FM Resources Ltd., P.O. Box 1700, Herndon, VA 22070, (703) 481-5640. **Inquiry 993.**

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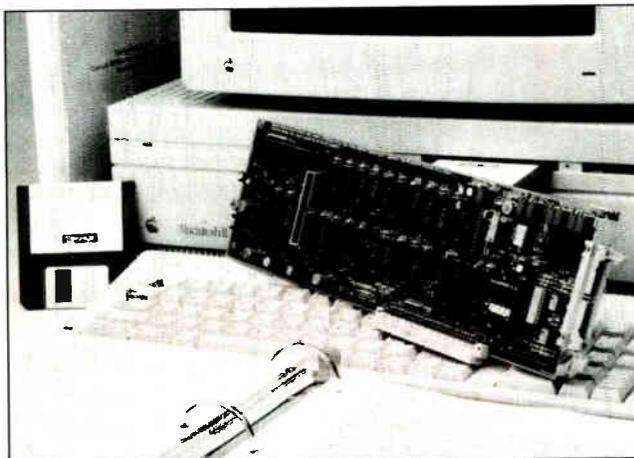
Analog I/O Board for the Mac II

The MacAdios II Jr, a NuBus-compatible data acquisition board for the Mac II or higher, includes a 12-bit A/D converter and 16 single-ended or eight differential analog input channels. The A/D converter is accurate to within 0.02 percent with a conversion time of 12.5 microseconds, MetraByte reports. A DC/DC converter changes the 12 volts provided by the NuBus to the 15 V required by the card.

Other features of the board include eight digital input and eight digital output channels, two analog output channels, three counter/timer channels, and three A/D trigger modes. The card includes driver software and a set of 13 I/O routines, callable from seven high-level programming languages, that will handle most data acquisition applications, the company reports. Optional analog and digital I/O units expand the Mac's capability. **Price:** \$999; analog expansion interface, \$200; digital expansion interface, \$150. **Contact:** MetraByte Corp., 440 Miles Standish Blvd., Taunton, MA 02780, (508) 880-3000. **Inquiry 986.**

Spectral Simulation on the Mac

NMR[™] (pronounced NMR prime prime) is a nuclear magnetic resonance spectral simulation program for the Macintosh. With NMR[™], you can define nuclear abundance ratios, spectrometer frequency, resonating nucleus, line widths, spectral width, tick mark spacing,



The MacAdios II Jr lets the Macintosh II run laboratory-measurement and process-monitoring applications.

and coupling constants.

After you've defined the spectrum and run the simulation, you can use NMR[™] to learn more about the spectrum (e.g., what caused a certain peak in the reading). The program can simulate scalar and dipolar coupling, and you can print on-screen spectra to the Apple Imagewriter or LaserWriter. You can also save spectra as PICT files.

NMR[™] runs on the Mac 512KE or higher (a coprocessor is optional). A version that requires a 68881 or 68882 math coprocessor is available for the Mac II or higher. The 512KE version can simulate up to six nuclear spins. You'll need at least 2 megabytes of RAM for up to eight nuclear spins. **Price:** 512KE version, \$275; coprocessor-specific version, \$375.

Contact: Calleo Scientific Software Publishers, 1300 Miramont Dr., Fort Collins, CO 80524, (303) 493-8573. **Inquiry 994.**

Statistical Graphing Package for the Daily Grind

Stats is a program for managers and executives who need to maintain and compare dozens of statistical graphs on a regular basis. It

is not another presentation graphics program or spreadsheet with graphics capability, KnowWare reports.

Stats can generate graphs using the same data for different time periods, including biweekly, monthly, and quarterly. It doesn't require you to manually reenter the data or reorganize it. You can combine individual statistics into a group total or group average graph. The program also supports unit of measure conversion for international organizations.

Stats runs on the IBM PC with 640K bytes of RAM and a hard disk drive.

Price: \$575. **Contact:** KnowWare, P.O. Box 17788, Boulder, CO 80308, (303) 444-7224. **Inquiry 1002.**

Graphics Improved, WYSIWYG Editing Added to XyWrite

XyWrite IV, the newest version of XyQuest's word processor, lets you view the page layout of your document and edit in WYSIWYG mode, the company reports. The company has added font definition and type size commands to make it easier to specify fonts within a document.

XyQuest says it improved the graphics to let you import graphical images and see them on the screen.

XyQuest added A La Carte menus to the program in 1988 to supplement the command-line interface. In the new version, XyQuest makes them true pull-down menus. You can toggle between the command-line and menu interfaces.

XyWrite IV runs on the IBM PC with 384K bytes of RAM and a hard disk drive. For WYSIWYG display, the company recommends EGA or higher.

Price: \$495. **Contact:** XyQuest, Inc., 44 Manning Rd., Billerica, MA 01821, (508) 671-0888. **Inquiry 987.**

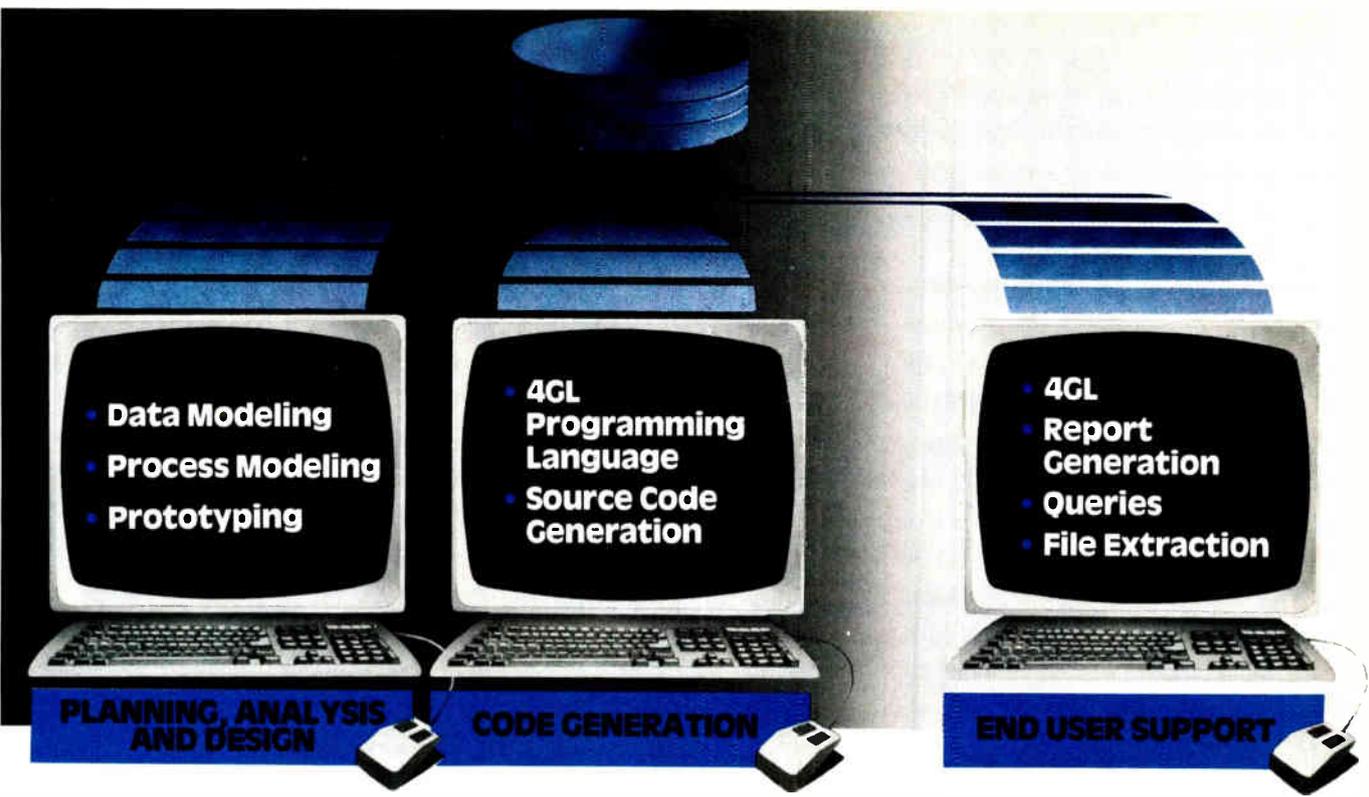
Calculate Thermodynamic Properties

Techware Engineering Applications has introduced @Steam, a program with 19 @ functions for Lotus 1-2-3 that calculate the thermodynamic properties of steam or water.

The procedures used by the functions are valid in the saturated, superheated, and compressed liquid regions and at supercritical pressures, the company reports.

For the input of temperature and quality, for example, functions can return enthalpy, entropy, and specific volume. The @Steam add-in adds about 54K bytes of RAM to the memory requirements for Lotus 1-2-3 releases 2, 2.01, and 2.2 running on the IBM PC.

Price: \$399. **Contact:** Techware Engineering Applications, Inc., P.O. Box 16, Emerson, NJ 07630, (201) 262-7410. **Inquiry 992.**



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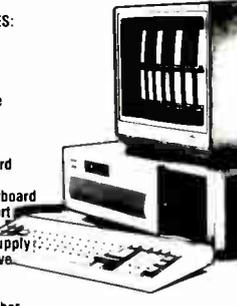
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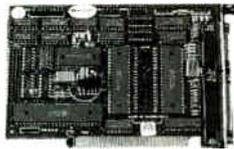
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- MAGITRONIC**
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MAGITRONIC TECHNOLOGY INC.



A Modular and Expandable 33-MHz Machine

The CompuStar II, which is Wells American's IBM PC compatible that lets you choose the CPU, video, and number of expansion slots that are best for you, is now available in a 33-MHz 80386 version.

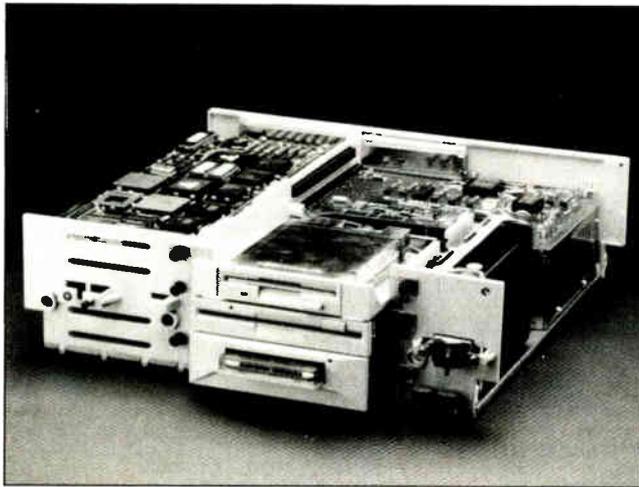
You can also configure the CompuStar II as an 80286, 80386SX, or 80386 with varying MHz ratings. That's because all the machine's processor-related circuitry comes in separate plug-in modules that are interchangeable. If you do an upgrade, the amount that you pay Wells American is only the difference between the two processors.

But the processor isn't the only thing that's modular about this machine: Video circuitry is on a separate plug-in card, and you can increase the number of bus expansion slots by sliding off the top and snapping in a bus expansion chassis. You can also install up to four 3½- or 5¼-inch floppy disk drives. The front panel includes a recessed reset switch, lock/unlock key, and power switch. The I/O module has one parallel port and two serial ports, a disk drive controller, the hard disk drive interface, and bus expansion circuitry. You choose between a hard- or soft-tactile keyboard.

Price: 33-MHz 80386 machine with a 42-megabyte hard disk drive, 1 megabyte of RAM, a floppy disk drive, and a Super VGA monitor, \$6155.

Contact: Wells American Corp., 3243 Sunset Blvd., West Columbia, SC 29169, (803) 796-7800.

Inquiry 995.



Using an optional bus expansion chassis, you can add five bus expansion slots to the CompuStar II, for a total of 11 slots.

Watch What You Eat

The American Heart Association's Cholesterol Education Program is an interactive program for physicians, medical students, pharmacologists, nurses, and other professionals who want to learn more about the preventive management of blood cholesterol levels.

The program provides data from clinical studies examining the link between high blood cholesterol levels and coronary heart disease. Full-color graphics describe the process of atherosclerosis, and an animation discusses lipids and lipoproteins.

Interactive exercises include patient case studies, where you're given a fictional patient's history, lab results, and data from a physical exam and asked to prescribe treatment. In a basic tutorial, you're presented with Mr. and Mrs. Jack Sprat and asked to place certain foods on the appropriate plates.

The program includes a comprehensive glossary and bibliography, information on the impact of diet and high saturated fat intake on cholesterol levels, and the mechanism of drug therapy treatment. Material will be

frequently reviewed and updated.

To run the program's sound, animation, color, and interactive capabilities, you'll need a Mac II or higher with an 8-bit color card, 5 megabytes of RAM, and 20 megabytes free on your hard disk drive. A version without sound requires 4 megabytes of RAM. A black-and-white version is also available for the Mac Plus and SE with HyperCard 1.22 or higher.

Price: Free for medical schools and other health care facilities.

Contact: The American Heart Association, National Center, 7320 Greenville Ave., Dallas, TX 75231, (214) 373-6300.

Inquiry 1000.

Professional Nutrition Analysis

Although anyone concerned about monitoring food intake can use Nutri-Calc HD, the program is designed for the professional who needs to assess diets, recipes, and menus for their nutrient content.

Nutri-Calc HD analyzes diets and recipes for 30 essen-

tial nutrients, from cholesterol to sodium. You can set goals for each client and display nutrient totals numerically or in pie or bar charts. The program's database has more than 3400 foods, including fast food, brand-name foods, frozen dinners, and health foods. You can also add or delete entries.

The program's Personal Notes feature lets you save test results, medical status, and recommendations for each person.

Nutri-Calc HD runs on the IBM PC with a hard disk drive, 1.8 megabytes of free memory, and 512K bytes of RAM.

Price: \$225.

Contact: Camde Corp., 4435 South Rural Rd., Suite 331, Tempe, AZ 85282, (602) 821-2310.

Inquiry 1001.

Add 8 Megabytes to Your PS/2

Memoryzation² is an 8-megabyte memory board for IBM's line of 32-bit Micro Channel Architecture computers.

Two boards can support 16 megabytes of high-speed extended memory—all, or a portion, of which you can use with the latest EMS 4.0 software applications, Newer Technology reports.

The board uses 256K-byte or 1-megabyte plug-in single in-line memory modules with nine chips. You can combine the modules in groups of four to update memory from 1 to 8 megabytes.

Memoryzation² fits the IBM PS/2 70, P70, and 80. **Price:** 8 megabytes, \$2615; 4 megabytes, \$1475.

Contact: Newer Technology, 1117 South Rock Rd., Suite 4, Wichita, KS 67207, (800) 678-3726 or (316) 685-4904.

Inquiry 999.

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The Action 1496 modem operates in multiple standard modes—asynchronously from 1200 to 9600 bps, with every CCITT standard in between, and synchronously through leased lines at the V.33 mode, when speed and automatic connection are required.

An automatic callback feature is handy when there's phone line trouble and you need to finish a file transfer.

The modem includes remote configuration and diagnostic features, so you can manage a modem network remotely from a central site over a phone line.

Price: \$1795; rack-mountable model, \$1745.

Contact: Data Race, 12758 Cimarron Path, Suite 108, San Antonio, TX 78249, (512) 692-3909.

Inquiry 982.

Windows-Based CASE Tool

Object Plus generates source code for Ada, C, and C++ using the object-oriented methodology as described by Peter Coad and Edward Yourdon in their book *Object-Oriented Requirements Analysis*. The program includes an element dictionary, an Ada and C code generator, and an object repository that includes all the objects you've identified.

Object Plus includes a reverse engineering facility for importing existing Ada or C objects with their methods and types. The program runs on the IBM PC with 640K bytes of RAM, Windows 2.0 or higher, DOS 3.0 or higher, and a color graphics card.

Price: \$6700.



When your leased line is interrupted, the Action 1496 modem will automatically use its V.32 dial-up protocols and connect you at 9600 bps.

Contact: Easyspec, Inc., 17629 El Camino Real, Suite 202, Houston, TX 77058, (713) 480-3233.

Inquiry 985.

Accounting Software for the Sun386i

For businesses that want to use the Sun386i workstation for something besides engineering and science, Armor Systems recently released 13 integrated accounting applications and a report generator for the Sun386i/150 and Sun386i/250.

Excalibur+ Premier runs under SunOS 4.0 and takes advantage of that operating system's multitasking and networking capabilities. Naturally, you can also take advantage of the Sun386i's ability to run DOS applications simultaneously as sessions in separate windows. However, the accounting applications are straight Unix ports, so they don't take advantage of the window-based graphical interface.

The 13 integrated applications include general ledger, accounts payable and receivable, inventory control, pur-

chase orders, order entry, billing, point of sale, bank reconciliation, job cost, payroll, customer information/database manager, and quick sale.

Price: Bank reconciliation and customer information modules, \$595 each; all other modules, \$995 each; report generator, \$1095.

Contact: Armor Systems, Inc., 324 North Orlando Ave., Maitland, FL 32751, (407) 629-0753.

Inquiry 983.

Put AlphaWorks in Your Pocket

AlphaWorks, a multi-function program with integrated applications, runs on the Poqet PC, Poqet Computer's 1-pound portable computer that runs on two AA-size batteries. AlphaWorks will be available on ROM-executable memory cards, letting you reserve most of the computer's 512K bytes of RAM for data.

AlphaWorks' applications include word processing with a spelling checker and thesaurus, database management, a spreadsheet with graphics, and communications.

Price: \$195.

Contact: Alpha Software Corp., One North Ave., Burlington, MA 01803, (617) 229-2924.

Inquiry 989.

Clipper Add-on Cleans Up Addresses

If you throw a mailing or flier into the wastebasket without looking at it, chances are it's because the address label is rife with abbreviations, missing punctuation, and capital letters—tipping you off that it's junk mail.

A program called DynaKey.LIB can help you clean up those mailing lists while reducing the number of keystrokes necessary to enter data. DynaKey.LIB converts lists from all uppercase to the usual uppercase/lowercase format, translates abbreviations into a more attractive format (e.g., D/M into Dr. and Mrs.), and adds missing punctuation.

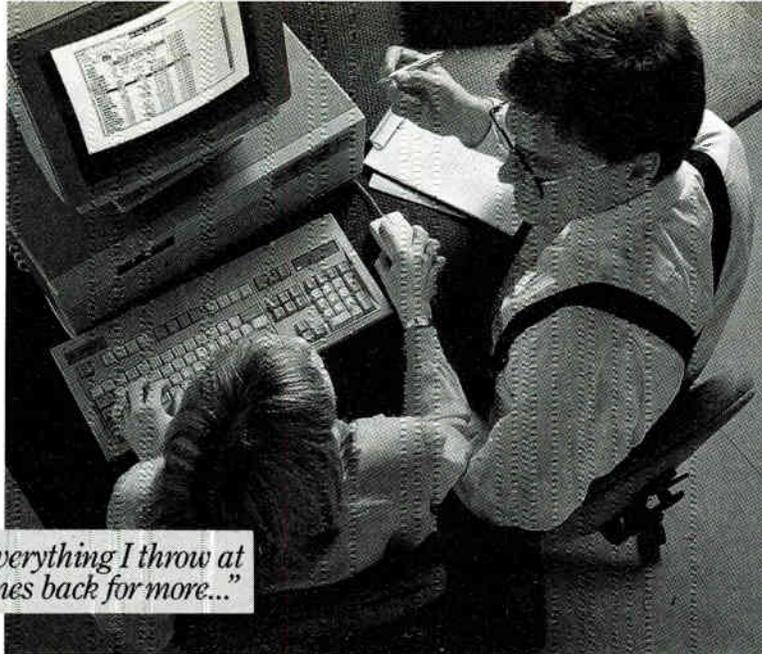
You can use the program in two ways. In a data-entry program written in the Clipper language, DynaKey.LIB helps the person keying in the information by expanding abbreviations, adding missing punctuation, and adding the appropriate casing automatically. Or you can use DynaKey.LIB as a data-cleanup program. It can convert data you've downloaded from a mainframe into presentable names and addresses. You can tailor the casing and expansion characteristics for each field.

DynaKey.LIB runs on the IBM PC with all versions of Clipper, including the forthcoming Clipper 5.0.

Price: \$169.

Contact: Peoplesmith Software, 18 Damon Rd., P.O. Box 384, North Scituate, MA 02060, (800) 777-2460 or (617) 545-7300.

Inquiry 984.



"It takes everything I throw at it and comes back for more..."

YOU'VE BEEN SAYING OUTRAGEOUS THINGS ABOUT OUR 386-33MHZ COMPUTER.

Recently, when customers, potential customers and industry experts called us, they said something strange. They said, "Your PC-Link 386-33MHz computer *works!*" This was hardly cause for celebration. But then we heard that the other 386 machines have bugs. And that they're very expensive. (Now *that's* outrageous.) And that even compared to the Compaq Deskpro 386/33, our computer was the best choice for a 386-33MHz.

Get a Copy of our Report Card In InfoWorld's 386/33 product comparison, we were rated "Excellent" in categories including CPU Speed and Hard Disk Access (sequential and random). "Very Good" described our software compatibility. And we shared the top rating for Value. Call us for a reprint of the InfoWorld report card and judge for yourself.

Ready to Work at \$5995 PC Link features a 33MHz PC/AT compatible—complete with 4MB of RAM and a 159MByte hard drive with 16ms access time and a 10MHz ESDI interface—for \$5995. For those with a large byte appetite, we also offer a 33MHz system with a 16ms 330MByte hard drive for \$6995.*

Compatibility Thanks to its data bus speed of 8.33MHz, the PC Link 386-33MHz is fully compatible with IBM PC/AT expansion connectors. Which means our computer runs expansion cards for the PC/AT such as VGA cards, modems, network cards and the Bernoulli Box. Our compatibility list goes on to include DOS, OS/2, Windows/386, UNIX V, DESQview 386 and

off-the-shelf software. This computer takes everything you throw at it!

Speed

With the Intel 80386 microprocessor running at 33MHz, you can make very, very fast work of spreadsheet, desktop publishing and CAD/CAM applications. (To boost your math intensive applications, get our optional 33MHz 387 math coprocessor or Weitek Abacus chip.) Get your hands on our mighty zero wait state system with 64K Cache RAM—and never look back.

Quality

(Look what *BYTE* Says)

We've assembled an all-star team of Made in U.S.A. components for our 386-33MHz model. It features the acclaimed Hauppauge 386 Motherboard/33MHz (with one 32-bit, six 16-bit and one 8-bit expansion slot) and the Award Software Modular 386 ROM BIOS. *BYTE* Magazine wrote: "PC Link has done a good job balancing the price/performance equation. Nothing spectacular, perhaps, but a solid machine at a reasonable price."

— *Stanford Diehl, BYTE, 1989 IBM Special Edition*

In addition to our new 386-33MHz PC, we offer the 386-16MHz and the 386-20MHz. All three systems have excellent reliability.

33MHz Standard Features:

- Intel 80386-33 microprocessor
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- 159MB 16 ms ESDI Hard Disk
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- Dual diskette and hard disk drive controller
- Enhanced 101 key keyboard
- 1 parallel and 1 serial port
- 220-watt power supply
- MS DOS 3.3 or 4.0

16 and 20 MHz Standard Features:

- Intel 80386-16 microprocessor or 80386-20
- 640K DOS memory
- 320K Extended memory
- 64K Shadow (BIOS) memory
- Award Software connector BIOS
- 4-way interleaved RAM
- 0 wait states
- PC/AT compatible
- One 8/32-bit expansion slot
- Four 8/16-bit expansion slots
- Three 8-bit expansion slots
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PC LINK Warranty

PC Magazine said: "The components are good enough to make you forget about the 1-year parts-and-labor warranty."** Still, it's here if you need it.

Call PC Link for a true 386-33MHz computer that actually works. Ask for a reprint of InfoWorld's 386/33 Report Card. Call: 1-800-221-0343. In New York: (212) 730-8036. For information on our complete product line, request our brochure!

PC LINK

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Stop Wasting RAM!

If you use any of these popular programs, chances are you are, unless you have Innovative Data Concepts' memory-saving utility programs:

The SWAP Utilities™

Each of these eight exciting SWAP programs use less than 8000 bytes of RAM, and provide most of the functionality of the full utility program at a tremendous savings in RAM. The following useful but ram-hungry TSRs can be 'tamed' by IDC's utility programs:

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SWAPSH™ -- PC Tools Deluxe Shell	SWAPDT™ -- PC Tools Deluxe Desktop
SWAPMT™ -- Lotus Metro and Express	SWAPNG™ -- The Norton Guides

Read what people have been saying about The SWAP Utilities:

"Unlike such early TSR managers as Referee, The SWAP Utilities do not need to reserve a large parking lot in DOS, so your applications can use all the RAM that SWAP frees."

Edward Mendelson, PC Magazine First Looks, April 25, 1989

"The Swap Utilities tamp down four large, but highly useful, TSRs down to 8-9K ... attacking the problem of memory overcrowding with a program, rather than more hardware."

Jeff Angus, InfoWorld, May 8, 1989

At a cost of just \$25, these programs are ones you can't afford NOT to have! For more information about The SWAP Utilities, call IDC at 1-215-884-3373, or write:

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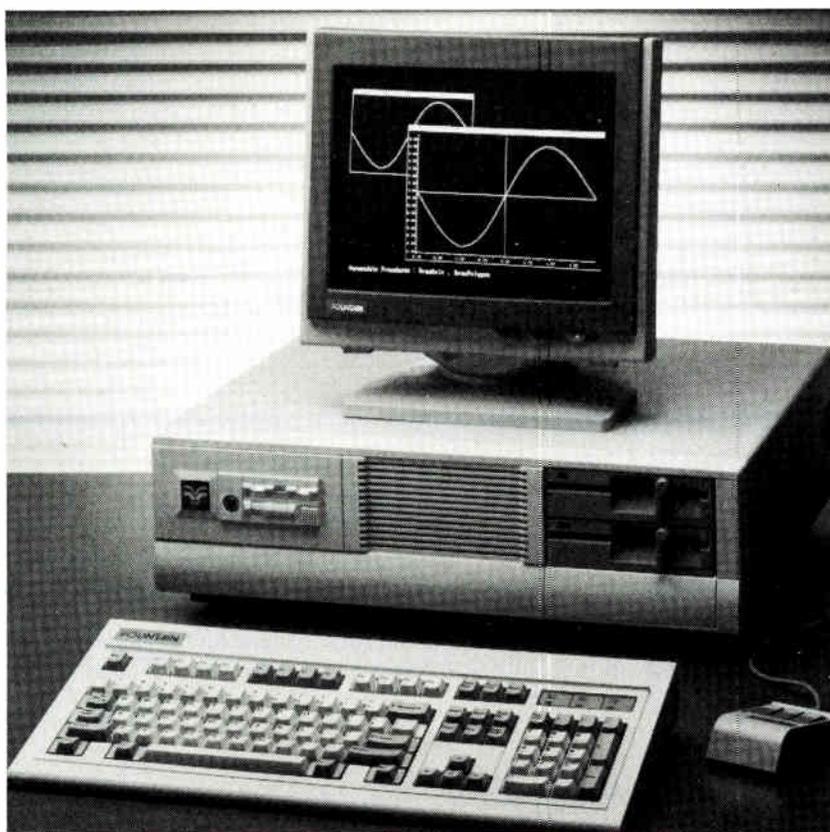
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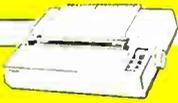
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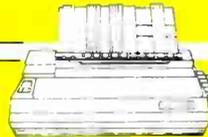


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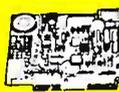
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SHORT TAKES

BYTE editors' hands-on views of new and developing products

Portable Mainframe

LapLink Mac III

Intelligent Graphics
Controller 20

Gray F/X

Fax96



How Portable Can a Portable Mainframe Be?

Pretty portable, as it turns out. A few months ago, Opus Systems introduced the Personal Mainframe, a coprocessor card designed around the Motorola 88000 RISC CPU; the card can plug into a 16-bit slot in any IBM PC AT clone. Now Opus is back, this time with a faster version of the card and much more software to run on it, including Unix, X Window System, Motif, word processors, and spreadsheets. Better still, the company is offering the card installed in a lunchbox-style portable computer, making it the first portable RISC workstation. At 22 pounds, it's certainly portable—and at 21 million instructions per second (MIPS), it can outrun many of its deskbound workstation brethren.

The **Portable Mainframe**, actually made by NEC, is a 16-MHz 80386SX-based lunchbox portable—a conventional AC-only portable system with a 640- by 480-pixel monochrome gas-plasma display, 2 megabytes of RAM, a 40-megabyte hard disk drive, and three expansion slots. In one of those slots is the Opus coprocessor card, which has a Motorola 88000 running at

either 20 or 25 MHz, from 4 to 24 megabytes of RAM, and twin 16K-byte caches for instructions and data.

The 80386SX handles all I/O, including screen updates, keyboard input, printer and serial ports, and disk drives. That leaves the 88000 free to run Unix, and it runs it faster than many other RISC workstations, including SPARC-based Suns and MIPS-based DECstations. It even benchmarks faster than Data General's AViiON, which uses the same RISC CPU, probably because so much of the Portable Mainframe's I/O housekeeping is done by the 80386SX. With a 20-MHz 88000, the Portable Mainframe is rated at 17 VAX MIPS; at 25 MHz, it's rated at 21 MIPS. (For comparison, a 16-MHz 80386 offers about 3 MIPS.)

While it's handling the I/O for the 88000, the 80386SX has lots of spare time for running programs under DOS. You can simultaneously run Unix on the 88000 and DOS on the 80386SX. You can also transfer files between Unix and DOS, hot-key back and forth between them, and even execute commands and programs of one operating system

from the other.

But the Portable Mainframe does have an Achilles' heel: the creaky, old 16-bit AT bus. Because the coprocessor card plugs into an ordinary AT slot, it's easy to add other AT-compatible cards to the system—a big advantage. But the AT bus also slows down I/O throughput. Although the 88000 CPU may be rocketing along at 21 MIPS, the AT bus is limited to a throughput of only around 16 megabytes per second. That's just about enough to constantly update a VGA screen, but it's not nearly enough for the oversize screens favored by most of today's workstation users for engineering simulations. Unless Opus adds a video connector to its coprocessor card, or designs a Micro Channel Architecture or Extended Industry Standard Architecture version of the card, the Portable Mainframe may never be the machine of choice for engineers or scientists who are studying fluid dynamics or structural stress.

On the other hand, it may turn out to be perfect for recalculating spreadsheets, a job that requires pure processor power, not pretty pictures.

Regular DOS spreadsheets like Lotus 1-2-3 will run on the Portable Mainframe, but only at DOS speeds. However, QCalc, a Lotus 1-2-3-compatible Unix spreadsheet program, has an 88000 version that should be available by the time you read this. In addition, Lotus 1-2-3 will be available soon in a Unix port done using XDOS from Hunter Systems.

A Unix version of WordPerfect also runs on the Portable Mainframe, and other 88000-based software is rapidly becoming available, thanks to the 88Open Consortium, a group of 88000-based workstation vendors who have developed a standard software environment so that the same shrink-wrapped software can run on any 88Open-compatible computer.

Does the Portable Mainframe really qualify as a portable mainframe? It may have mainframe MIPS, but it does not have mainframe throughput. On the other hand, it doesn't have a mainframe price, either. And at just under 1 MIPS per pound, it's certainly the most concentrated processing kick available today. With its merger of DOS compatibility and RISC power, the Portable Mainframe may be just what some microcomputer users have been waiting for. □

—Frank Hayes
continued

THE FACTS

Portable Mainframe
\$13,995 (20-MHz
version)

Opus Systems
20863 Stevens Creek,
Building 400
Cupertino, CA 95014
(408) 446-2110
Inquiry 1008.

Move It Anywhere with LapLink Mac III



Until recently, if you wanted to move a plethora of files from one Macintosh to another, your choices were either expensive or complicated beyond belief. Ironically, those in DOSdom were better off: A utility program from Traveling Software, called LapLink, allowed easy batch-file transfers between computers via a serial cable. The company also introduced LapLink Mac, which let you copy files in bulk from an IBM PC to a Mac. This was fine if you were migrating from one machine to another, but what the Mac community sorely needed was Mac-to-Mac file transfer capability. This, unfortunately, was precisely what earlier versions of LapLink Mac lacked.

Leave it to Traveling Software not to overlook this need for too long. **LapLink Mac III** not only delivers the traditional Mac-to-PC batch-file transfers, but it also handles Mac-to-Mac transfers. And you accomplish transfers between Macs in a variety of ways: via a serial cable, the AppleTalk network, or a modem. Passwords are required for transferring files over the network or through a modem, which is an important security feature. If you're try-

ing to put files onto a Mac Portable to do a presentation, you can even use a special optional SCSI cable to perform a high-speed transfer directly to the Portable's hard disk drive. Why no SCSI ID conflict with the Mac Portable's CPU? It turns out that the SCSI ID of the Portable can be modified by software, a feature used by LapLink Mac III.

The package comes with software for both the Mac and the PC. A unique cable solves your serial-port connection hassles: One end of the cable has a male mini-DIN-8 connector (for a Mac); the other end is a three-headed hydra that has a female DB-25 connector (for a PC), a female DB-9 connector (for a PC), and another male mini-DIN-8 connector (for a Mac). Transfers between Macs over this

serial cable can hit a peak of 750,000 bps, well over the rated maximum of 57,000 bps. LapLink Mac III manages this feat with a small accelerator module that plugs into the DB-25 connector. This accelerator uses an oscillator that clocks the data through the serial ports at the higher rate. It's the same technique DaynaTALK and TOPS FlashBox use with their LocalTalk network boosters.

I tried a beta version of LapLink Mac III on a Mac Plus, a Mac II, a Mac IIX, and a Mac IICx. The PC software wasn't very stable, but that's OK. Given Traveling Software's track record with the PC-only version, I'm sure it will be fixed. Instead, I chose to look at how LapLink Mac III handled new ground: moving Mac files about. The Mac interface

is considerably improved over the earlier versions: Instead of a small window with the transfer managed by the PC, you have two windows that present an SFFile-style directory of files on the source and target machines. Make a few mouse-clicks to select files, and you're started. Transfers over the serial cable with the accelerator were fast and smooth using both Finder and Multi-Finder. The transfers over BYTE's LocalTalk network ran more slowly, but some of the delay is due to AppleTalk's protocol overhead.

I left LapLink Mac III running on the Mac II equipped with a Hayes modem at work and dialed into it from home using a Mac Plus and an Apple modem. Using the appropriate password (you can give out several passwords, each one providing different degrees of access), I connected successfully and could view not only the files on the Mac II, but those files on the network servers as well. I was able to send and receive files to the "remote" computer, but the transfer rate is much slower than a conventional XMODEM transfer. Traveling Software promises that the modem and network transfer rates will be faster in the release version.

Best of all, these transfers can be bidirectional—that is, the receiving system can initiate a file transfer as well. I connected two Mac IIs by modem and sent files from each to the other simultaneously. LapLink Mac III handled all transfers (i.e., serial, network, and modem) reliably.

The variety of ways LapLink Mac III moves files about will solve many file transfer headaches. The modem option even lets you send a software update to that poor soul in the field. I'll be direct: This product will answer a lot of problems for Mac users. If you need to move a lot of data about among different Macs or even to PCs, LapLink Mac III provides the means. □

—Tom Thompson
continued

THE FACTS

LapLink Mac III
\$189.95

Requirements:
Mac Plus, SE, SE/30, II family, or Portable running System 5.0 or higher. IBM PC, XT, AT, PS/2, or compatible with 256K bytes of RAM

running MS-DOS 2.11 or higher.

Traveling Software, Inc.
18702 North Creek Pkwy.
Bothell, WA 98011
(206) 483-8088
Inquiry 1009.



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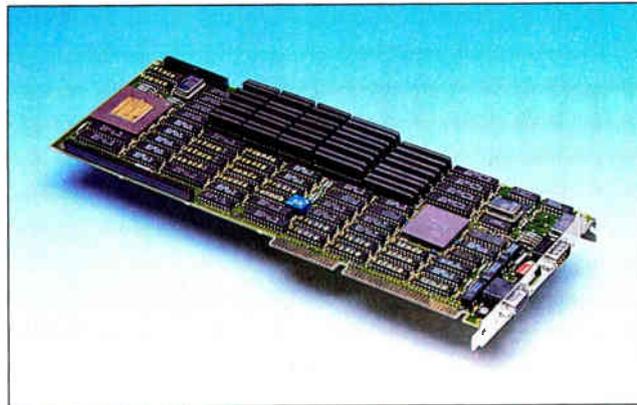
Take the Graphics and Run

In today's world of graphical user interfaces running ever-more-sophisticated graphics-based applications, even the fastest systems get bogged down, because the graphics processing is still handled by the main system processor. But help is on the way in the guise of Hewlett-Packard's **Intelligent Graphics Controller 20 (IGC)**.

This is the first shipping graphics board to use the TMS34020 chip from Texas Instruments. This powerful and sophisticated dedicated graphics processor hums along at a fleet 30 MHz. The IGC handles all the graphics work and does it faster than your system's main processor could.

While the IGC comes with a well-designed installation utility and an excellent manual, installing it isn't for the faint of heart.

Since my monitor wasn't included in the installation utility, I had to go through a custom monitor installation and install drivers and additional software. It all took a while, but the end results are downright amazing.



Using Windows became an entirely new experience. Most noticeable, of course, is the crisp 1280- by 1024-pixel maximum resolution that the IGC gives you. But the proof of the IGC's graphics muscle came when I kept opening new windows that were running different graphics applications. With my VGA, each graphics window that's opened slows down all the other windows.

With the IGC, however, there is no discernible degradation in performance.

As you might expect, the IGC outdoes itself in CAD applications. Using AutoCAD with the well-known drawing of St. Paul's Cathedral, a redraw that took about 2 seconds with my VGA popped onto the screen in about a third of a second with the IGC. And the 2 seconds required to zoom into

the image under VGA was reduced to about half a second. When these common operations happen so quickly, they appear instantaneous.

The IGC has drivers for Windows (286 and 386), AutoCAD, and GEM. But it will work with all applications that conform to TIGA (Texas Instruments Graphics Architecture) and DGIS (Direct Graphics Interface Standard). All major software developers are in the process of incorporating DGIS into their existing and future applications, so it will just be a matter of time before the IGC will work with them all. Right now, it can bring its power to many commonly used applications, including Lotus 1-2-3 and WordPerfect. To get its maximum resolution, you'll need the type of high-end monitor that normally sells in the \$2000 range. You can use the IGC with lower-priced monitors, but the maximum resolution drops to 1024 by 768 pixels.

If you need the IGC's resolution and speed in your day-to-day work, it's an unbeatable bargain. And what's especially significant about the IGC is that it brings to the IBM PC the type of graphics power that's been available only, at a much higher price, on the Macintosh. □

—Stan Miastkowski

THE FACTS

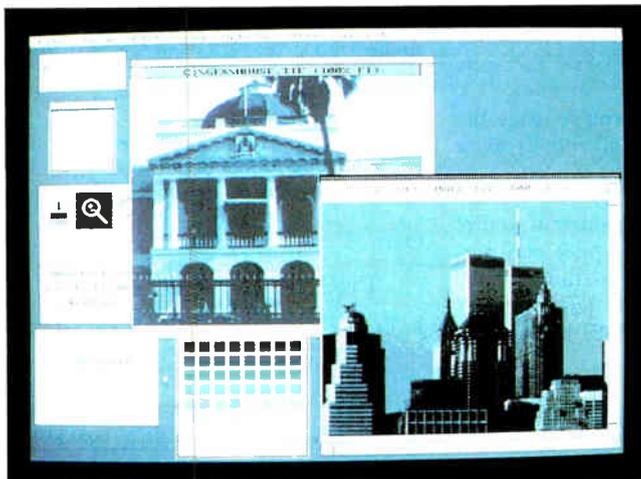
Intelligent Graphics Controller 20
\$2495; 34010-based version, \$1000

Options:
512K-byte video RAM upgrade, \$400; 512K-byte RAM upgrade, \$330.

Requirements:
IBM AT or compatible.

Hewlett-Packard Co.
3404 East Harmony Rd.
Fort Collins, CO 80525
(303) 229-3800
Inquiry 1010.

Gray F/X: Xerox Brings Good Image-Editing Tools to DOS



If you'd asked me a week ago to recommend an image-editing program for a DOS computer, I'd have recommended that you buy a Macintosh. But after working with a new gray-scale raster editor from Xerox Imaging Systems, I'd say soup up that DOS box with some extra memory and get a copy of **Gray F/X**.

Gray F/X is designed to manipulate monochrome images, either imported from another application or scanned in directly. The program has all the basic image-enhancement tools you'll need to do things

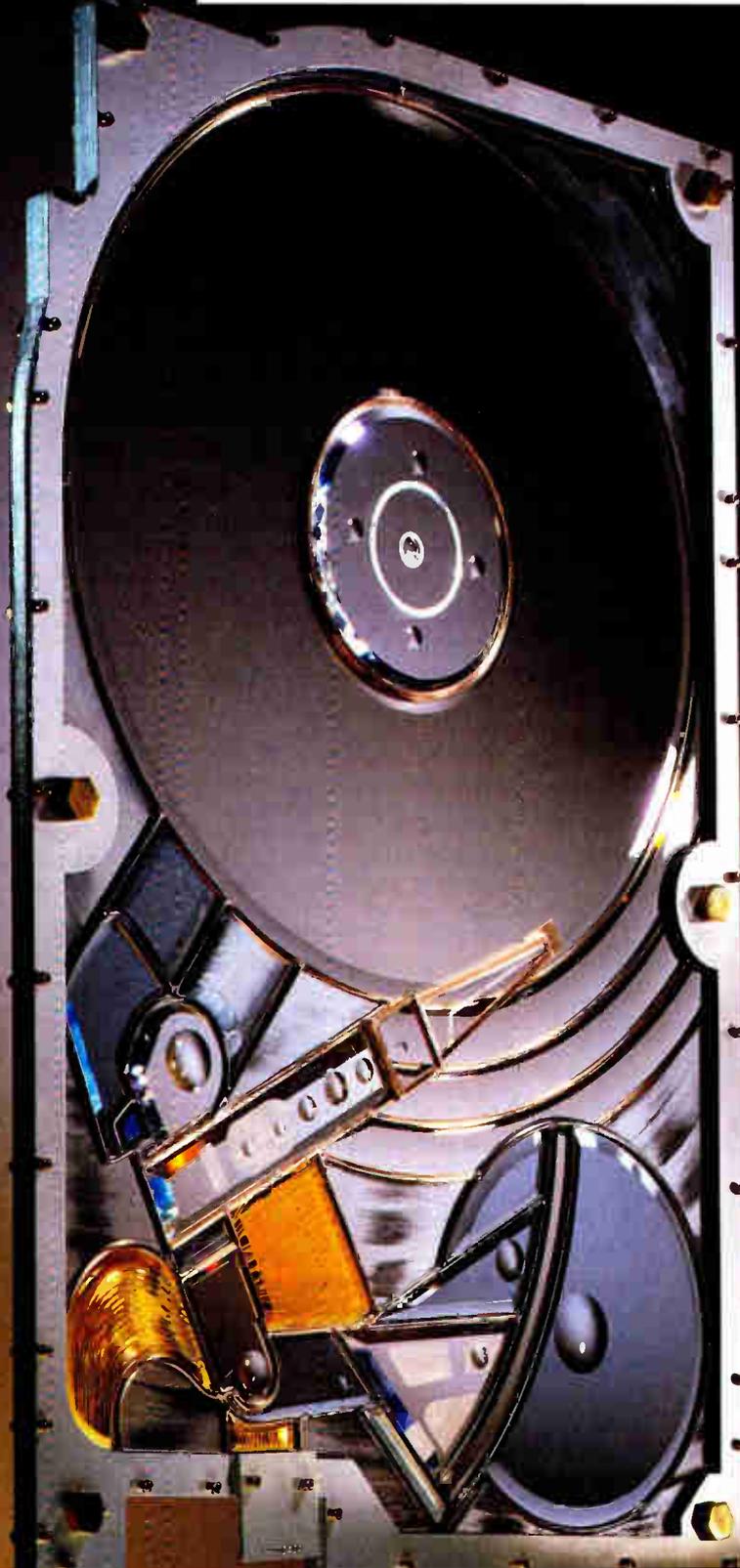
like changing brightness and contrast, sharpening or softening edges, redistributing gray values, copying and pasting parts of a picture, zooming in and out, and doing little tricks like rotating, slanting, and warping part of an image.

The brush tools don't have the capabilities of, say, PC Paintbrush IV, but they're adequate for a program that isn't trying to be a paint program. You can use the brush, which comes in a few different sizes, to touch up an image or to draw something into the picture.

continued

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*Beveled Glass Window by
Thomas Tisch & Andreas Lehmann
Oakland, California*

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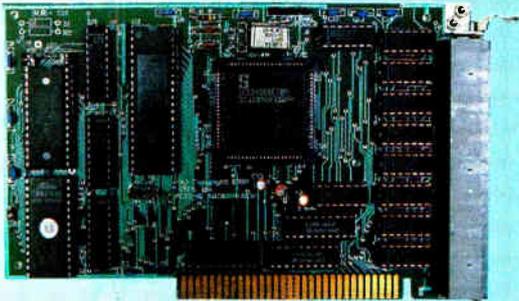
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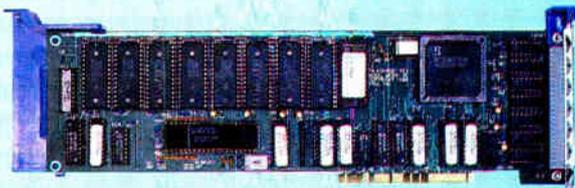
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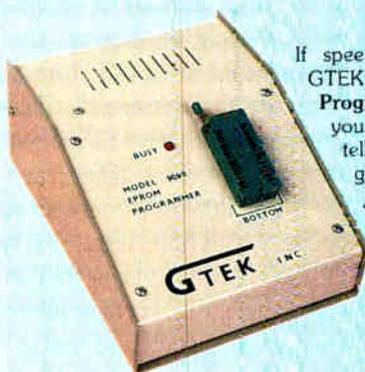


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THE FACTS

Gray F/X
\$495

higher. Expanded or extended memory is recommended.

Requirements:

IBM AT compatible (80286 or 80386) with a hard disk drive (at least 10 megabytes free), a VGA display, and DOS 3.0 or

Xerox Imaging Systems
535 Oakmead Pkwy.
Sunnyvale, CA 94086
(408) 245-7900
Inquiry 1011.

The brush is smart enough to pick up any shade you select and allow you to paint with it.

The program's designers have avoided the trap some developers fall into of loading the interface screen with too many function icons and toolboxes. Gray F/X's workspace is clean and unobtrusive, and it doesn't overwhelm you with boxes and bars that get in the way. The scanning portion of the program is the simplest I've seen yet; it reminded me of the Apple scanner software, which lets you preview the image and adjust the margins before punching it in.

Gray F/X is a program that's frame-oriented; in order to work with a piece of an image, you first have to draw a frame around it (rectangular or free-form). This works easily enough, but I didn't find it to be particularly intuitive. I kept expecting it to work like a Mac program. Once you've framed something, though, you can quickly change the way it looks, or the way everything else around it looks.

Although the program will work with graphics devices capable of 256 shades of gray, it

is limited to 64. For most applications, this probably isn't a big deal. But to some potential users, this could be a factor. Gray F/X will work with most monitors (VGA), scanning devices, and printers that are IBM-compatible. Scanning resolutions are 100, 150, or 300 dots per inch, in half-tone, line art, or 16 out of 64 shades of gray. The program will work with TIFF, IMG (GEM), CUT (Media Cybernetics), PCX (ZSoft), and PostScript files.

I worked with a beta version of Gray F/X, primarily on a BitWise 80386-based system with an inordinate amount of memory (8 megabytes). The program ran like a charm, although some operations taxed the system's RAM. Although Xerox says you can run Gray F/X on an 80286-based system, I'd recommend that only to people with patience and time to kill.

Xerox has a reputation for coming up with great ideas that don't quite make it in the commercial computer market. This package could help the company shake that rap. □

—D. Barker

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Once upon a time, fax machines cost thousands of dollars and required their own corner of the office. Now, with the remarkable Fax96 from Fremont Communica-

tions, you can add fax capability to your IBM PC for less than \$200.

The Fax96 is a half-length plug-in card that will send and receive Group 3 faxes at 9600 bps. With the easy-to-use software that accompanies it, you can send ASCII, TIFF, or PCX files directly from your hard disk to almost any fax machine in the world, and

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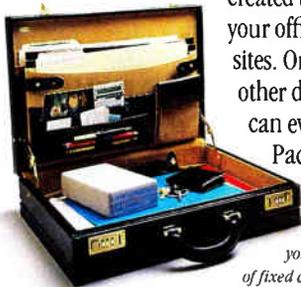


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At last, the Disk Pack gives you everything you've always wished for in a data storage system. The speed and high storage capacity of a hard drive. The ease and convenience of a floppy diskette. And the safety of a tape backup. All wrapped up in a state-of-the-art rugged unit, about the size of a paperback book. Designed to make your life a lot simpler and more secure.

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Just picture this: With the Disk Pack you carry your whole work environment with you, wherever you go. All your files, all your data stay organized and configured just the way you created them. Between your office and remote sites. Or home. Or another department. You can even mail a Disk Pack. It's that rugged.

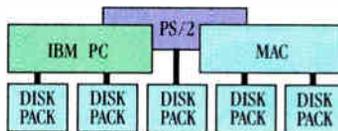


The Disk Pack frees you from the constraints of fixed computers. Your whole work environment fits in the palm of your hand.

Total security for your data

Simply slide out a Disk Pack module and lock away your entire business customer base and payroll figures in a drawer or safe. Same for lawyer,

banker or accountant sensitive data and Uncle Sam confidential information. All fully secured in a snap.



Get full data portability and security on the computer of your choice. Macintosh, PC-Compatible or PS/2.

Blazing speed Rock-solid reliability Limitless expansion

Breakthrough technology makes the Disk Pack four to five times more reliable than other removable products. Access times as low as 13 ms make it one of the fastest hard drives on the market. The Disk Pack doesn't limit you to a single storage capacity either. You can interchange 20-, 40-, 80- or 120-MByte modules in your

system and between systems. Link modules up for a whopping Half-GByte + of on-line data. Store them for unlimited off-line data. And do lightning-fast data backups.

That's not all. The Disk Pack turns a shared computer into your fully personal machine within seconds. It's ideal for space grabbing applications such as color graphics, CAD, or music. One Disk Pack module does the job of 100 diskettes.

Ten times faster. And with a lot less hassle.

And thanks to the Disk Pack's unique architecture, you'll use it equally well on any Mac, Apple, PC-compatible or PS/2 computer. It's that advanced.



The Disk Pack is ideal for data security. Lock it away and forget about accidental or intentional data loss.

For more information call

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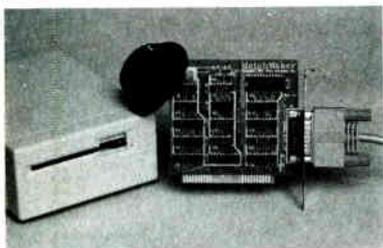
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Read Mac Disks in a PC MatchMaker

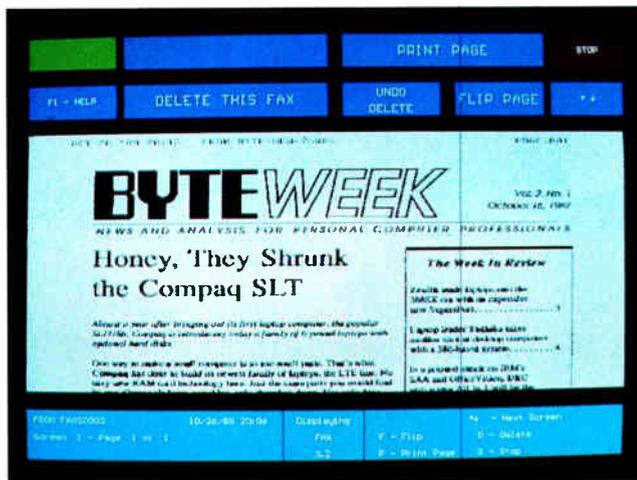
– the best way to share data between a PC and a Mac. The **MatchMaker** card lets you plug a Macintosh floppy drive into a PC.



- Easy-to-install half-size card.
- Use any external Macintosh drive.
- DOS-like command software included.
- 1 year warranty, Made in USA.
- Also available; **MatchPoint-PC** to read/write Apple II disks.

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THE FACTS

Fax96
\$195

Requirements:
80386 system with 384K bytes of RAM, a hard disk drive with 1.5 megabytes of free space, DOS 2.1 or higher, and a graphics display (CGA, EGA, VGA,

or Hercules). A graphics printer is optional.

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receive faxes even when you are running an application.

The low price and small size of the Fax96 are due to a new single-chip fax controller from Yamaha that replaces the Rockwell chip set used by most PC fax boards.

Installing the Fax96 was easy. The manual provides complete, illustrated instructions for setting jumpers to choose the communications port and IRQ level and for installing the fax software. When you want to send a file, you enter fields on a "cover page" pop-up window.

Faxes are received in the background, which means you don't need the Fax96 software loaded. If you're running another application, a little window pops up on the screen, and program execution halts until the fax is received. I tested reception while running a variety of applications (e.g., Lotus 1-2-3 and Windows) and found no interference.

Received faxes are stored on disk and can be called up from

a menu for screen display and output to a variety of printers, including the Hewlett-Packard LaserJet. The Fax96 software maintains a log of sent and received files. Before sending files, the Fax96 software has to convert them to fax format, which takes about 40 seconds per page. Transmission takes between 20 and 50 seconds per page, depending on their complexity.

My only complaint was with the software, which is slow and lacking in flexibility. Fax96 software doesn't include a phone log (nor will it access other phone logs, such as SideKick's), so each transmission requires you to reenter the whole cover page. My beta version had trouble sending PCX files. File handling is clumsy and slightly illogical. And it doesn't include advanced features like fax broadcasting or time-delayed transmission. On the other hand, these are drawbacks I can live with for \$195. ■

—Andrew Reinhardt



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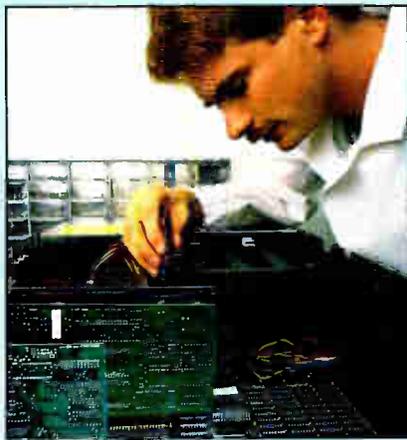
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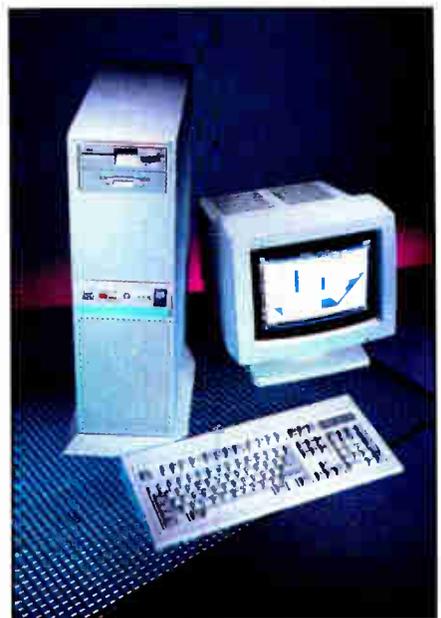
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Speed (MHz)	20/8	16/8	12.5/6.25	10/4.77
BIOS	Phoenix	Phoenix	Phoenix	Phoenix
Norton SI Rating v 4.0	22.0	17.6	12.3	2.1
Standard Memory	1MB	1MB	512K	640K
Shadow BIOS	384K	Yes	Yes	—
Memory Upgrades	2/4/8/16/32MB	2/3/5/6/8/16MB	640K/1/2/3/5MB	—
Coprocessor Support	80287 or 80387	80387SX	80287	8087
Expansion Slots: 32-bit	1	—	—	—
Expansion Slots: 16-bit	4	6	6	—
Expansion Slots: 8-bit	3	2	2	8
Dual HD/FD Controller	Yes	Yes	Yes	w/HD systems
5.25" Floppy Drive	Your Choice	Your Choice	Your Choice	Standard
3.5" Floppy Drive	—	—	—	Optional
Device Bays (Exposed/Internal)	3 Exp./2 Int.	3 Exp./1 Int.	3 Exp./2 Int.	2 Exp./2 Int.
Serial Ports	2	1	1	1
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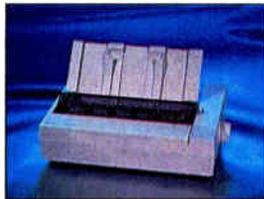


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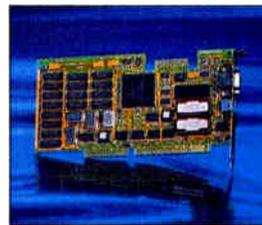
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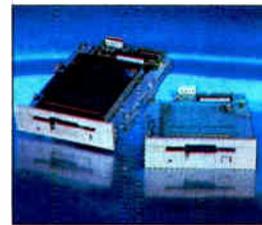
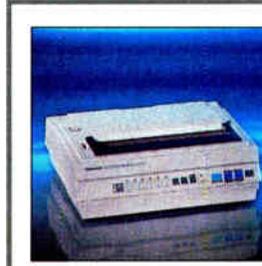
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Apollo Shrinks the Workstation Price Tag

The Apollo 2500 sets
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graphics workstations

Hewlett-Packard/Apollo has changed the definition of an entry-level graphics workstation with the introduction of the low-cost Apollo 2500. A year ago, only the elite used graphics workstations for specialized engineering applications. Then came the "affordable" high-performance workstations, Digital Equipment's DECstation and Sun's SPARCStation, with half the price and twice the performance of previous workstations.

Now, for less than \$4000, the Apollo 2500 offers you three to four times the computing speed of a VAX-11/780 and a graphics resolution that is equivalent to the finest monochrome displays for PCs. You can have two 2500s for the price of one DECstation. When you consider how much it would cost to build an 80386-based AT to the level of the Apollo 2500, you realize that this machine represents a major change in the price/performance ratio.

The Package

For the base price of about \$3900, you get a 20-MHz Motorola 68030 processor with a 20-MHz 68882 math coprocessor; 4 megabytes of RAM; a 15-inch, 1024-

by 800-pixel, 76-Hz monochrome monitor; and an Apollo keyboard with a three-button mouse. (The price of this configuration for educational institutions is \$2500.) The minimum configuration also includes a serial communications port, but no parallel port. You must use a serial or network printer.

This is a diskless network configuration with either Ethernet, the Apollo token ring, or IBM's Token Ring. You can make it into a stand-alone system by adding an internal 200-megabyte 3½-inch SCSI hard disk drive, with the operating system and utilities, for roughly \$3000 more. Other options include a 1280- by 1024-pixel, 70-Hz, noninterlaced monitor, a 660-megabyte hard disk drive, a floppy disk drive, a 2.3-gigabyte 8-millimeter tape drive, and up to 16

megabytes of memory. All options are available only through Apollo. The 2500 has no provisions for additional serial ports or for a parallel printer port.

The Apollo 2500 box is only 15¾ by 22¾ by a slim 5½ inches. It is designed for use either as a base for the display tube or as a tower beside your desk, but it lacks stabilizing feet for the latter orientation. Inside the box, the hardware takes only about half the usable volume. The CPU board is a mere 14½ by 11 inches. The network card is installed in a single horizontal AT-bus slot; however, you can't put any old AT board in the slot and expect it to work. You must write special drivers for the boards to work with the 2500.

Everything but the network controller and power supply is on the motherboard: 1-megabyte single in-line memory modules mount directly into the 16 memory slots; seven somewhat incomprehensible status LEDs and reset and operating-mode buttons are on the front; and the SCSI controller is near the back with a ribbon cable connector for the optional hard disk drive and an external port for connecting external hard disk and tape drives. To the left of the motherboard is a

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The Apollo 2500 provides workstation performance for less than \$4000. Note the unusual keyboard layout designed for use with Apollo's proprietary Domain/OS.

cage for the network card and the optional hard disk drive. On the far right is an 88-watt universal power supply, which doesn't require switching between 50- and 60-Hz power. There are 4 inches of empty space between the power supply and the motherboard.

But wait! Is the Apollo 2500 running Unix? No, it's just a well-crafted illusion. Apollo systems do not run Unix, although Unix programs are easily ported to them. The Apollo 2500 runs Domain/OS, Apollo's proprietary operating system for networked workstations. The Unix apparition results from the port of all the Unix System V.3.1 and BSD 4.2 shells, utilities, and libraries to Domain/OS.

Among the applications that are already available for the 2500 are Teamwork, a large-scale software and systems development environment from Cadre Technologies; Software through Pictures, a computer-aided software engineering system from Interactive Development Environments; InterBase DBMS from Interbase Software; Nexpert, an expert-system environment from Neuron Data; Oracle's DBMS; Frame Maker, a workstation publishing system

from Frame Technology; Interleaf's electronic-publishing system; and Mathematica, a graphical mathematics modeling and research tool from Wolfram Research. The WingZ spreadsheet from Informix, Island Graphics' desktop publishing software, and Mathematica are all bundled with systems for higher education. So you can see that the Apollo 2500 is already in the mainstream of applications.

Your Fingers and Eyes

Working with a 2500 isn't quite like anything else. As with many proprietary systems, the keyboard is peculiar to the operating system and workstation. (An optional Motif-compliant keyboard is available.) The keyboard has 10 general-purpose function keys that reside above the usual QWERTY keys, and a numeric keypad is on the right with five special function keys above it. An 18-key block of window manipulation and editing keys is at the left of the keyboard. Every key performs a default function; many key combinations are also predefined. You can extend or redefine any of the keys to fit your special needs.

Unless you are running OSF/Motif or

another X Window System window manager, the windows (via the Apollo Display Manager) look like nothing you've seen elsewhere. Each window has a title bar at the top, a text box, and a command/shell entry line at the bottom. You needn't use the mouse; instead, you use the special function-key block on the left side of the keyboard.

Because of the tight relationships among the windows, the Display Manager, the Domain/OS, the screen, the keyboard, and the mouse, this window environment is especially responsive, unlike other graphical user interfaces that are built as layers above the operating system. People who take the time to learn the Apollo way usually feel comfortable with, perhaps even attached to, this window environment.

Discovering the 2500 is like walking into an art deco restaurant and finding not only that the decor is clean and bright, but that the menu has everything you want to eat at an affordable price. But art deco is not the current fashion; nor is Domain/OS. ■

Ben Smith is a BYTE technical editor and can be reached on BIX as "bensmith."

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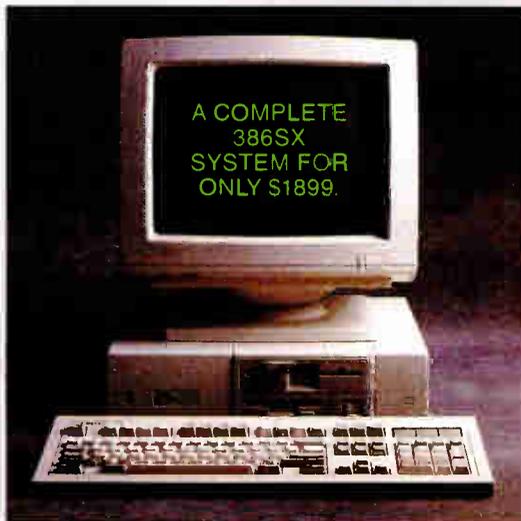
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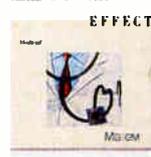
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A MATTER OF STYLE AND GRAMMAR

Jerry contemplates changing to a new word processing program and upgrades Mrs. Pournelle's computer

According to the file-numbering system I use, this is column 100. That doesn't mean I've done only 100 columns, because I've been writing these for more than 8.3 years. I didn't start using the numbering system until I'd been at this for a while, at least a couple of years. Come to that, I've done special issues, book reviews, and show reports, none of which were numbered.

Nowadays, these columns are about 6000 words long. Figuring 6000 words a column and counting only the numbered ones, that's 600,000 words I've done for BYTE. I expect the true count is closer to 800,000 words, a fair-size book. Put another way, though, it's only 4.8 megabytes. That would have been several boxes of 8-inch floppy disks back when I first started, but it's only four 5¼-inch disks in the 1.2-megabyte high-density format, and most of my hard disks have subdirectories fatter than 5 megabytes. Maybe it's not so very much after all. Sure *seems* like more.

Indeed, that's only 4.8 megabytes of characters (assuming 800,000 words averaging five characters and a space per word) in standard ASCII text such as was created by old Zeke, my friend who happened to be a Z80. However, even Zeke running WRITE, the text editor Tony Pietsch wrote for Larry Niven and me after we grew weary of Electric Pencil's shortcomings, would have had to mark the ends of paragraphs with a carriage return. My paragraphs tend to be long; assume 80 words as an average, and you get

another 100,000 characters, so that my entire BYTE oeuvre is 4.9 megabytes in WRITE format.

In fact, though, what I have done is a great deal more than that. I just looked at the file size of last month's column. At 6000 words, it should be 36,000 characters; but Q&A Write stores it in a file that's over 44K bytes.

That's a lot of storage overhead. In the old days of 160K-byte floppy disks, I couldn't have put up with that, not only because the larger file size took up room I didn't have, but also because it would have taken forever to load and save. Like most writers, I was taught that when using a computer for creative writing you must save early and often, because you never know when some software glitch is going to hang the computer. That type of glitch was a major reason we weren't happy with Electric Pencil; one of the features Tony put into WRITE was the capability to recapture your unsaved text from memory, even if you did a hardware reset. Even so, I tend to save my work after each paragraph.

Saving to 160K-byte floppy disks took many seconds. When we first got the machines, that didn't seem important, but as the weeks went on, I developed a tendency to fidget while the machine was saving. Nowadays, the Distributed Processing Technology disk drive controller in my Big Cheetah has an on-board 68000 CPU chip with a megabyte of RAM and more smarts than old Zeke! I can load and save this file so fast I hardly notice there's disk action going on. The DPT controller drives a 330-megabyte Priam hard disk drive; so file size isn't very important, anymore.

Despite that, I might change word processors; which is to say all this has been an elaborate lead-in to yet one more discussion of word processors for writers.

The Writer's Word Processor

The text editor I generally recommend to writers just getting into computers is Sy-

mantec's Q&A Write. I'm using it now. I recommend Q&A Write because it's far and away the easiest to learn of the full-featured word processors; although it doesn't have all the features available in WordPerfect or Microsoft Word, it has more features than most creative writers will ever want or need. Most of Q&A Write's "missing" features have to do with print format, which isn't important to creative writers, anyway, since our output tends either to go out over a modem or to be simple double-spaced typescript of 60-character lines.

When I say Q&A Write is easy to learn, I mean that most writers can just sit down and start using it, even if they've never tried writing with a computer before. Most things in Q&A Write—either the stand-alone product or the almost-identical editor contained in Q&A—work just the way you expect them to. Moreover, if the newcomer to Q&A Write has any experience with WordStar, most of the old commands have been preserved. Control-R scrolls up a page, Control-T deletes the next word, and so forth. It has been my experience that anyone can learn to use Q&A Write in a very short time.

There are other attractions. It's fast. There's a good macro capability. The character set is attractive on EGA and VGA screens. There are on-screen margins, something I didn't like at first; now I can't see how I got along without them. There's a little card-file program that lets me make notes as I go along. It annoys me that there's no ability to sort and print those cards, but since they're in ASCII format, it was no great trick to write a little QuickBASIC program that will do that for me. In other words, I very much like the program, which naturally raises the question, why would I consider abandoning it?

There's only one real reason: the file format. Q&A Write stores files in its own strange format. That format may have

continued

been published, but I've not seen it. In any event, few third-party programs will work on Q&A Write files; and after a while, that gets to be a pain.

Third-Party Stuff

Two of the programs I'd like to be able to use are the grammar and style checkers Grammatik III and RightWriter. I don't really *need* either one of them. Both natter at me about my long sentences, and neither really understands what I'm

doing; but even so, it's sometimes worth the effort to run an essay through the mill just to be certain I'm not losing my touch. Grammatik III did wonders for Mrs. Pournelle's writing over the course of a year—and saved us a lot of fights, too. Writing is a very personal thing, and it's easy to get defensive when a human editor criticizes your stuff. The computer program doesn't mind at all if you think its critique is full of beans, and you don't have to admit to anyone that it

caught a stupid mistake, either.

RightWriter and Grammatik III are very different. Just for the fun of it, I put this essay through each. Both think my sentences are too long. Both chide me for every instance of passive voice. Otherwise, their analyses aren't similar at all.

They both have minor problems. Grammatik III sort of knows it's working with a Q&A Write file; but because of Q&A Write's odd file format, Grammatik III can't let you change the length of a line, meaning you can't edit most problems from within the Grammatik III program itself. Grammatik III doesn't know you can end a sentence with "etc.," so it believes that's part of the next (too long) sentence. It finds unusual capitalization, one of my most common mistakes (I hold the Shift key down too long), but there's no way to put specific weird words in its dictionary. (What you must do is tell it to ignore the word for the rest of the session. If you put a word like CoDominium in the dictionary, it always challenges the odd capitalization. Sigh.) Grammatik III can't learn that DESQ-view and LapLink are *supposed* to be that way.

RightWriter has its share of minor problems. As an example, you must remember the exact filename and path to the file you want it to analyze. There's no on-screen system to work your way to the file. The major problem, though, is that RightWriter just isn't as smart as Grammatik III. Subtle problems are totally beyond its capability. It natters incessantly about trivial difficulties but misses important ones. RightWriter doesn't believe that I should use words like *dissertation* and *readable* and *criticizes* and *collaboration* because they are jargon. I shouldn't use *factors*, *disadvantages*, or *effectiveness* because they are often misused and might be misunderstood. I shouldn't use *funk* or *botched* because they are colloquial.

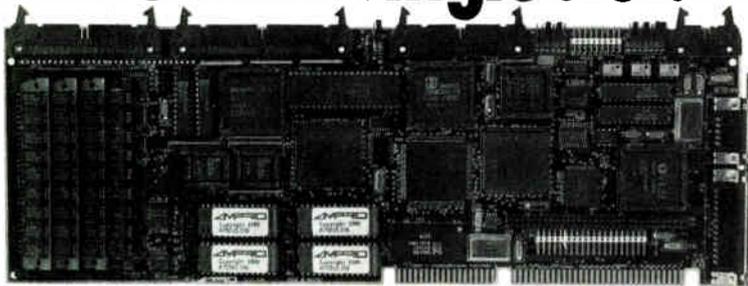
RightWriter doesn't think much of my ability: it finds this essay "weak," and demands that I use shorter sentences, no passive voice, and a much simpler vocabulary. I don't agree.

I suppose RightWriter can help beginning writers get up to speed, but I don't find it much help. I certainly wouldn't change text editors just to use it.

Grammatik III might be worth the change, but since it *almost* works with Q&A Write, I can already use it, and do, although not as often as I would if it better understood the Q&A Write file format. One caution: use your own spelling checker before invoking Grammatik III.

continued

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Roland Larson's Readability is almost important enough to change text editors for. This program does the best job of analyzing readability of any program I've ever used. Unlike most programs that attempt that job, Readability looks at what you're trying to do, and it compares your work with experts doing the same thing. Fair warning: one of the "experts" in popular science exposition is, ahem, me. Readability understands that while averages are important, so is variability; an

essay with nothing but short sentences soon gets boring. However, the program catches expository lumps, in which you have several long sentences full of long words all run together.

I can't recommend this program highly enough, not only to beginning writers, but to experienced writers in a hurry; it will catch things you didn't want to have go out under your name. I use it a lot; and I ought to use it more, and would if I didn't have to go through the ASCII con-

version and back every time.

Readability does have one problem: if there's a header without a period at the end, the program insists that it's part of the next sentence, even if there are two carriage returns and an indentation between it and the beginning of a true paragraph. I don't suppose there's much to be done about it, just as I don't suppose it will ever learn to understand the Q&A Write file format.

I'd like to use the Microsoft Bookshelf CD-ROM as part of my word processing operation. Alas, I can't. I have enough trouble getting Bookshelf to work with DESQview—you can just do that—without trying to induce it to work with an unrecognized word processor. This is a real pity, because Bookshelf crams a lot of information on that CD-ROM, and much of it is stuff I *ought* to have available and would use if it were convenient; and when Bookshelf is working right, it *is* convenient.

There are a lot of useful CD-ROMs, and very few to none of them are aware of Q&A Write's file structure.

There's Jurisoft's CompareRite, which takes two versions of a document and shows their differences; it's extremely useful for collaborations. And then there's GrandView, a nearly essential outline program. It's published by Symantec—but it doesn't recognize Q&A Write files, which must be converted to ASCII just like any other foreigner.

I could go on, but I presume the point is made. Q&A Write, for all its convenience—and it is very convenient—doesn't work well with other text processing programs, and I have no reason to believe that will change. Symantec told me a year ago they'd do something. One proposed solution would be an Atex output option. I was sent an experimental copy of a file conversion system that changed Q&A Write files into something more universal; but since Q&A Write couldn't read the files it had made, that didn't help much, and anyway they never released that conversion. I presume the notion is now dead. Pity.

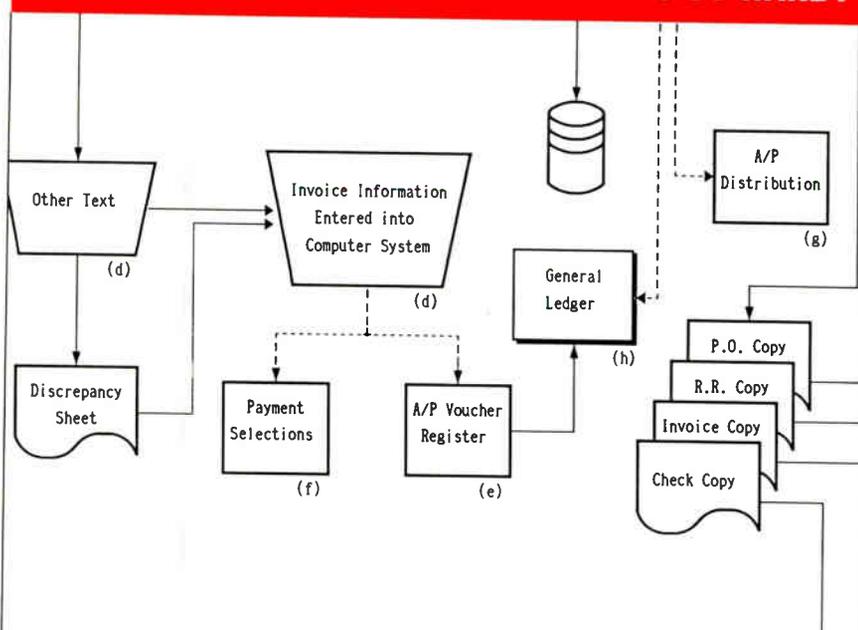
I'm not sure where I go from here. I'm in no tearing hurry to change editors, not with all the work I've got to do. On the other hand, I think it has to be done. There's just too much new stuff being written, and Q&A Write doesn't seem to be keeping up. So where to from here?

There are a lot of options.

One obvious choice is WordStar. I never liked the old WordStar, simply because I am perpetually fiddling with my

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text and I don't want to have to go do Control-B to reformat the paragraph when I'm done. I want the computer to do that for me as I write. The new WordStar 5.5 fixes that traditional problem. It's fast, and heaven knows most outside programs recognize the WordStar format.

There are two main disadvantages. First, WordStar doesn't really like to show you on-screen left margins. That's a minor problem, but I confess I have grown fond of the screen appearance of Q&A Write. Second, WordStar files are not readable with a standard text editor or viewer such as you find in Norton Commander. Although Q&A Write files have a lot of control characters and stuff in them, the text itself is pretty well straight ASCII once you get past the header; and I've got used to being able to peek into those files.

The next candidate is WordPerfect. This is said to be the most popular word processor for the IBM PC. Whether or not that's correct, a lot of people use it, so there will always be third-party support.

Aside: PluPerfect

There are also ways of taming WordPerfect. PluPerfect, from a tiny outfit called IR-Soft, is a TSR program that loads itself, then WordPerfect. You can pass any command line (e.g., WordPerfect filename) through PluPerfect on to WordPerfect. Once you have loaded PluPerfect, pressing the 5 in the number pad (with Num Lock off, of course) or pressing the middle button of a Logitech Mouse will get you a drop-down menu that pretty well controls WordPerfect. I've fooled around with this enough to like it; if I do adopt WordPerfect, I may use PluPerfect with it. There's one problem: PluPerfect does want memory. I was able to get it to run (with WordPerfect) in a DESQview window, but I use an 80386 machine with the QEMM memory manager and thus can have big DESQview windows.

You don't need a mouse to run PluPerfect. I've previously mentioned MousePerfect, a program that adds mouse capability to WordPerfect; alas, I wasn't able to try it with PluPerfect. I doubt they'd work together, since MousePerfect generates mouse menus to run with WordPerfect, but who knows? The PluPerfect menu system is well thought out and fast. It would be nifty to have both PluPerfect and a mouse.

WordPerfect Executive

Another advantage to WordPerfect is the Executive package. This chopped-down

version of WordPerfect is bundled with a suite of other little programs, such as a card file, an appointment scheduler, a phone book, and a small spreadsheet capable of doing expense reports. The whole package can fit on a 3½-inch disk and is designed for use in portable machines. Back when I was using WordPerfect, I found this an excellent complementary package.

Finally, WordPerfect has what can only be called world-class support ser-

A nother
advantage to
WordPerfect is the
Executive package.

vice. I've never heard of anyone telephoning them and not getting courteous and efficient help. That alone is enough to make me want to encourage them.

The downside of WordPerfect isn't so easy to describe. It has to do with philosophy and design: WordPerfect comes out of a different tradition from the one I'm used to. I know that's vague, but it's about the best I can do. There's something about WordPerfect that makes me slightly uncomfortable, and I am just not at all sure what it is. I even have the nagging suspicion that I'm being unfair, and if I spent some time with WordPerfect I'd probably like it. Of course, I did use it for a while before Q&A Write, and I was willing to turn away from it. We'll see.

I see I'm using up more room than I intended for this discussion. I expect you all understand: for me, the word processor is far and away the most important computer program I have or use, and thus the most interesting; but I can't expect everyone to be a fanatic on the subject.

Anyway, I'm in no hurry to change; I like Q&A Write and just wish that I could solve the file format problem. I've even been tempted to analyze what that format is and write my own set of filters and conversion programs. But I probably won't have time to do that.

Next month, I'll look at other candidates, including PC-Write, the industry's most successful shareware program, and My Word!, which is the only major full-feature word processor I know of available with source code. My

Word! is written in Microsoft QuickBASIC and is faster than you would believe. You can also get My Index, complete with source code; the two make a formidable package.

Other possibilities include XyWrite III Plus and its especially jiggered scholarly offshoot, Nota Bene. Nota Bene, incidentally, is the answer to a dissertation writer's dreams; nothing else comes close to it for scholarly work. It's also extremely complicated, but you'd expect that of a program that really knows how to handle bibliographies and footnotes and such.

Finally, there's Microsoft Word, which keeps getting better all the time, and certainly will be supported by Microsoft CD-ROMs.

There may be more, but those are the ones I'm looking at. Sometime this year I'll choose one. Stay tuned.

Org Plus

From where I sit, I can see about 200 items of software and hardware on tables and carts out in the Great Hall, and I suppose a good half of it would be worth mentioning here. Alas, here in the office are another 25 or so items that I *know* ought to go in the column, and realistically I won't get to half that before I run out of space; all of which tells us that the computer industry is healthy despite the government's attempts to kill it with nitwitted cartels and FCC regulations.

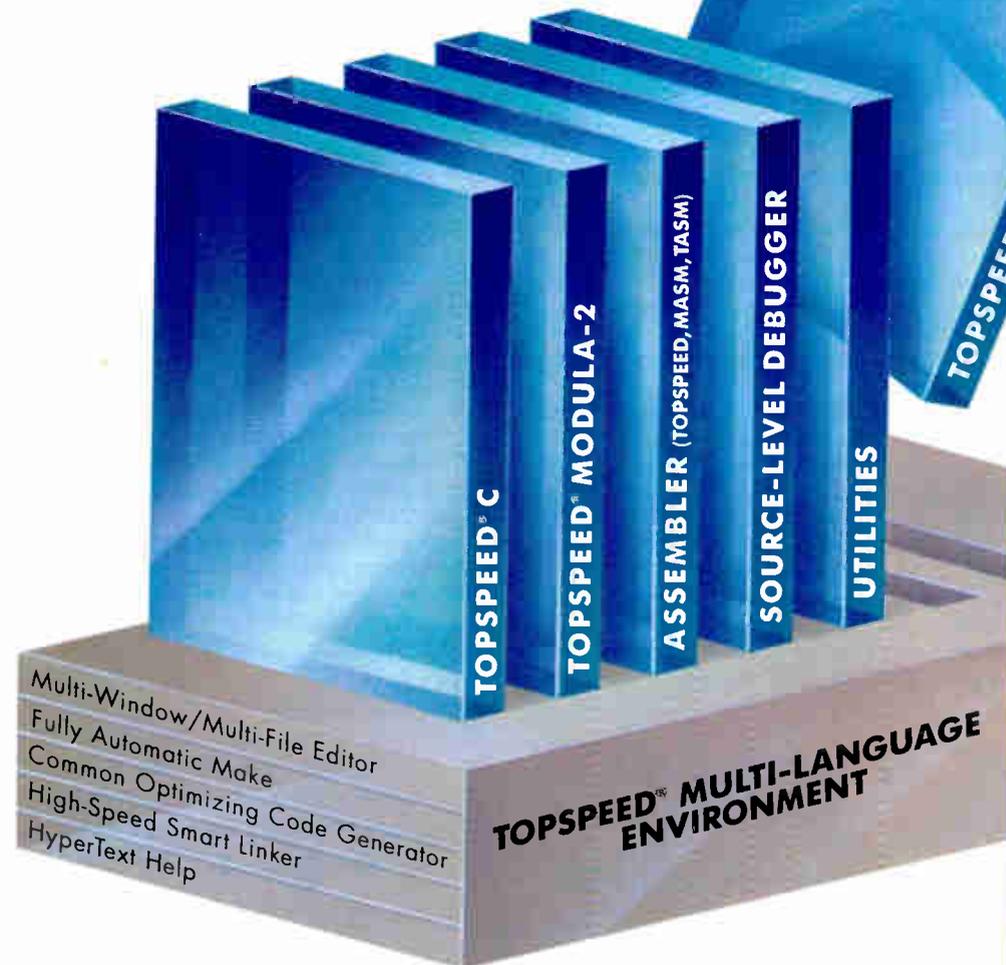
With so much software out there, it's inevitable that more than pure merit determines what's selected for review. With Org Plus it was Brett Walter, formerly the product manager for Q&A Write at Symantec. Brett recently went to work for Banner Blue Software, an outfit I never heard of, and he sent me a copy of Org Plus, a program that draws organizational charts; not something I need very badly. Still, it came from a friend, and as I looked at the package I suddenly realized I do have a use for this.

Although I spend a lot of time playing with computers and then writing about them, I like to think I am still primarily a science fiction writer; and one of my continuing series of science fiction novels concerns the exploits of John Christian Falkenberg and his 42nd Mercenary Legion during the breakup of the CoDominium Government. The CoDominium is a world order set up by the U.S. and the USSR sometime toward the end of this millennium, and I confess that sometimes I have trouble distinguishing between some of the fiction I wrote 20 years ago and today's newspapers; but

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that's another story. What's important here is that although I have extensive notes, including a rough sketch of the 42nd's organizational structure, I never did do a complete organizational chart of Falkenberg's Legion. This looked like a fair test of Org Plus.

You'll see the results in my next Falkenberg novel. I can't compare Org Plus to other organizational charting programs, because this is the only one I've used. I can say that Org Plus is easy to set up, simple to learn, and effective. It has provision for "hidden" notes on people and their job descriptions. There are about seven box styles and an equal number of chart styles. You can build the chart, cut and paste on-screen, and generally muck about with it, after which it will print on many different standard printers or on a plotter.

Org Plus Advanced will print sideways; the basic program will do that only if you have Funk Software's Sideways program as well.

There's also a built-in spreadsheet affair, so that you can make Org Plus total up such things as the number of people in given units and stuff like that. It's not go-

ing to put Lotus 1-2-3 or SuperCalc out of business, but it will manage a reasonable range of statistics and totals.

All told, it helped me, and my next Falkenberg novel will probably reproduce part of the new Org Plus chart of the Legion, circa 2085.

Upgrading

I forget why I went downstairs to play with Mrs. Roberta Pournelle's machine, but it doesn't matter. What did matter was that I noticed she was running MS-DOS 3.21, the version with the defective XCOPY. It has other problems.

"Time to upgrade your system," I said. "Maybe I ought to give you the new Z-386—"

That didn't work. Roberta has become quite fond of her Kaypro 386i, which she has named Dan MacLean in honor of my late mad friend. I think she's convinced that one night she'll fall asleep at the keyboard and wake up with a message from MacLean on-screen. The weird part is I didn't argue with her, because I'm not so sure she's wrong. "OK," says I, "you can keep the Kaypro, but we have to upgrade that DOS version."

Time was that the way to upgrade DOS was simply to boot up with the new DOS on a floppy disk and then do the SYS C: command; but just to be on the safe side, I called my son Alex, who makes a good part of his living recovering data from crashed hard disks.

"Back it up and reformat," Alex said. "Probably a third of the problem disks we get come from botched SYS upgrades. Besides, you haven't backed up Mom's stuff in ages."

"I hate smart alecks," I said, but he was right. It really was time to back up all her files, and once I had that done, we could reformat her hard disk, something that hadn't been done for several years; but then it's a Priam, and you almost never have trouble with those.

First thing was to back up all her files. The obvious way was to dedicate a Maximum Storage WORM (write once, read many times) disk to RJP's files and put them all on that. The only problem was that her machine is downstairs and set up in a way that makes it very difficult to open the case: and there's no WORM drive controller in her machine. I have

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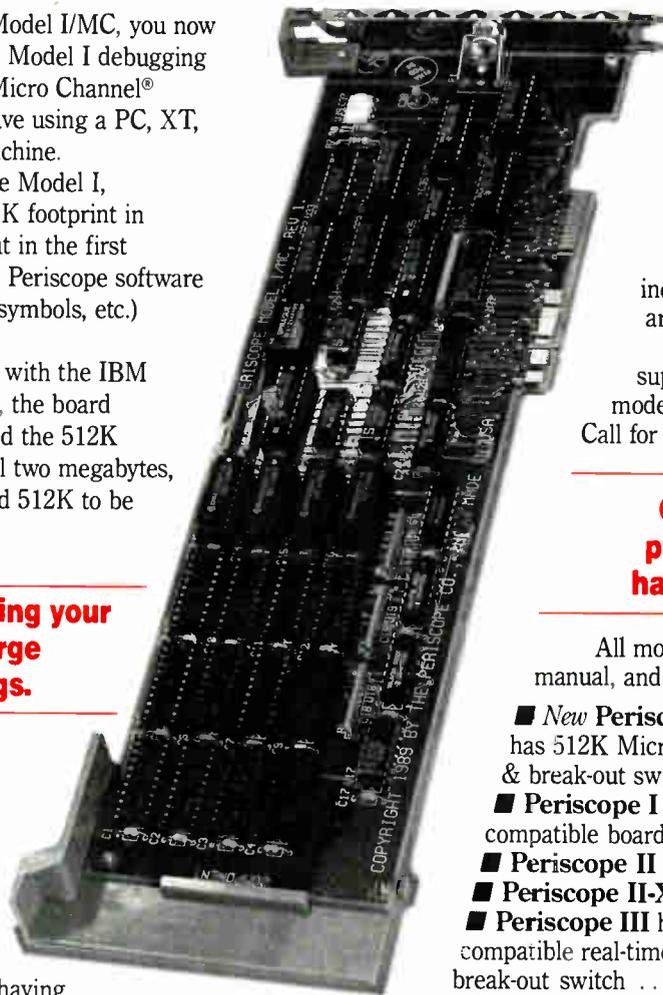
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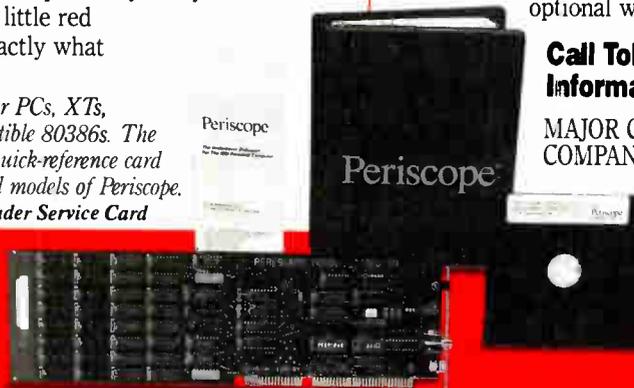
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	WordPerfect 5.0/5.1\$495 WordPerfect Executive 1.0\$249 WordPerfect Corp. 1555 North Technology Way Orem, UT 84057 (801) 225-5000 Inquiry 1028.

two Maximum Storage WORM machines, but they're both up here. They're portable, but you do have to have a controller installed.

Alas, I recently disassembled the only LAN we had running. The machines are way too far apart for the standard LapLink cables. I tried using Traveling Software's LapLink 3 with a DeskLink (telephone-type) cable. That didn't work.

When Traveling Software chairman Mark Eppley heard that, he was nonplussed, because LapLink 2 would work with the telephone cable, and he was sure the capability had been left in LapLink 3; but there was nary a word about it in the help files or documents, and it sure didn't work automatically. Eventually, one of the technical people told him that if you invoke LapLink 3 thus: LL3 /3, where the "/3" means "3-wire," you can use the DeskLink cable system that allows 100 feet of telephone cable between the machines.

Once I knew that bit of arcana, the rest of it was easy. I set up two directories on the WORM (RJPC1 and RJPDI), set LapLink to copy subdirectories, and fired everything from her C and D drives off to the WORM. It took a while, but it all got accomplished during dinner with no problems.

Now the files were backed up, and I could install MS-DOS 3.3 on her machine. I chose 3.3 rather than 4.0 because I find it is good enough, and while I have had no problems with version 4.0, I don't see any real advantages to it, either. Roberta finds that partitioning her hard disk into two logical drives is more convenient than having one big one, which eliminates the main advantage of MS-DOS 4.0. She finds that many of the utilities, such as Norton's Disk Sort, work faster on smaller logical disk drives, and of course all her DESQview accesses were set up to expect C and D drives.

FDISK Is Evil

I booted up with the original IBM DOS 3.3 floppy disk and did `FORMAT C: /s /v`. Of course, it wouldn't do it: in order to format a hard disk drive with DOS 3.3, you must be able to tell DOS the disk's volume name, and I didn't know that. Exit `FORMAT` and go use the Norton Utilities to remove the volume names from both the C and D drives. Now `FORMAT C: /s /v`. Worked fine; but when I tried to format the D logical drive, there was something wrong with the disk partitions.

Foolishly I thought I could fix things with the DOS `FDISK` program. This is

the one that changes your DOS partition tables.

Years ago I worked for Boeing. One of our planes crashed. The investigation showed that an Air Force maintenance crew chief had wired up a control backward: the pilot thumbed for trim up, but he was getting trim down. By the time the pilot discovered this, the plane was in an "unrecoverable attitude"; that is, it's possible to fly the B-52 (and other planes) into a situation that they can't fly out of.

You can do the same thing with FDISK. I'm not quite sure how I did it, but I managed with FDISK to get Roberta's system set up so that more than half the disk space was lost and *unrecoverable with FDISK*. "Don't panic," I thought, and opened a Jolt Cola. Then I called Alex, who confirmed that this isn't all that uncommon. "FDISK is evil," he said. "And there's a version that comes with Compaq computers that's even worse. Makes me money, though."

Enter SpeedStor

Then I did what I should have done in the first place and got out SpeedStor, which has a good low-level format capability. Another possibility would have been Kolod Research's hFormat, which is highly reliable. Kolod sold the program to Paul Mace, and now Mace has sold his disk utility package to Fifth Generation, the outfit that markets the Fastback backup utility. Anyway, I've often used SpeedStor and find it reliable as well.

SpeedStor will let you have disk partitions larger than 32 megabytes, but we didn't need that here. SpeedStor will also let you give the disk a volume label with lowercase letters in it. DOS will report that, but you can't use DOS to change it because DOS won't pass lowercase letters, and thus you can never convince DOS you know the label name; but you have to enter the label name in order to change it. The solution to that is Norton Utilities, which will erase the volume label if you confirm that's what you really want.

OPTune

Next we installed OPTune.

OPTune advertises itself as "the first 'All-in-one' Hard Disk Survival, Repair, and Tune-up Maintenance Utility," and I guess that's right. It combines the capabilities of Gibson's SpinRite, some of Norton Disk Doctor, and the file optimizations of Golden Bow's Vopt. OPTune checks to see that your disk has been formatted with the optimum inter-

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leave factor. If your disk wasn't—some haven't been—the difference in speed can be dramatic. OPTune then examines your disk sectors one at a time. At each sector, it picks up any data and holds it in memory, reformats the sector, and puts the data back again. It can also test the sector with varying degrees of thoroughness; some tests are done quickly, but some run all night.

OPTune will also repack the files on your hard disk, much as Vopt does. It seems to take longer than Vopt but claims to be more thorough. The differences aren't noticeable to me, and since I have Vopt anyway, I continue to use it.

As a test, I deliberately unmarked a couple of bad sectors and let OPTune look for them. For whatever it's worth, it found them with no trouble. Any more rigorous test will have to be done by someone better equipped than I am.

In summary, OPTune is a decent disk utility that combines many functions previously found only in different programs. It works with DOS 4.0; some disk optimizer utilities won't. However, OPTune will *not* work on my big Priam hard disk drive with the DPT controller.

It does run all right with the 150-mega-byte logical drive on my Zenith 386/25 running DOS 3.3 Plus and the Zenith cache system. If you're going to buy only one disk utility, this is probably the one to get.

Finishing the Job

Once the disk was tuned up, it was time to bring Roberta's files back. We didn't want them all, but I didn't want to sit there and move files a directory at a time, either. Fortunately, there was plenty of space on the new Z-386/25's hard disk. The result was a weird lash-up. First, we connected the Z-386/15 to the Z-386/25, parallel port to parallel port, and ran LapLink 3 in Turbo mode. That really screams. It very quickly moved all the files from the WORM drive on the Z-386/15 to subdirectories C1 and D1 (Roberta's C and D drives) on the Z-386/25. I then used Norton Commander to go through those files and delete all we didn't want and connected Roberta's Kaypro to the Z-386/25 with LapLink 3 (with the /3 option) working through the telephone cable. LapLink 3 will normally send itself, but it won't do it over a

telephone cable; you must transfer it with a floppy disk.

Once that was done, though, the rest was automatic. I went downstairs and watched *Snoops*, the new Friday night mystery TV show. I don't normally watch such things, but they filmed part of one episode at Chaos Manor, which was enough to get me interested. Anyway, by the time the show was over, the files had been transferred.

LapLink Mac

I find Traveling Software's LapLink 3 indispensable, but the company didn't stop there. Now there's LapLink Mac. This not only lets you connect your Mac to your PC and move files back and forth, it also lets you connect two Macs together. LapLink Mac includes a gizmo that, when plugged into the LapLink Mac cable, accelerates the file transfer; with it, you can move files about five times faster than AppleTalk will do it. Of course, you need at least three Macs, with one used as a file server, to connect Macs with AppleTalk at all.

LapLink Mac lets you link Macs with

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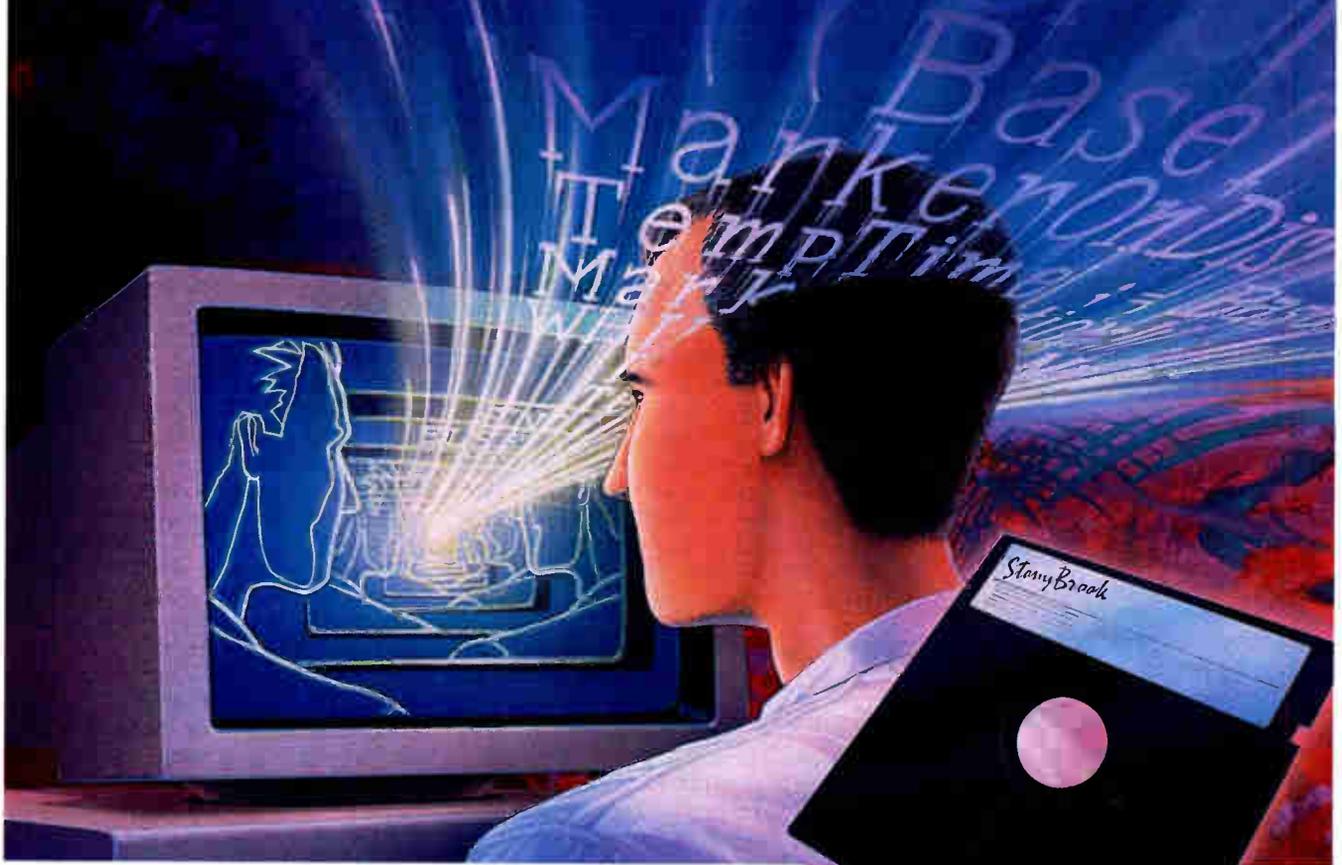


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CHAOS MANOR

telephone cable, so they can be 100 feet or so apart. It works quite well, and they've done a very Mac-like job with the user interface. However, it is only a file transfer system, not a full network.

If you have several Macs and you need to connect them very often, you'd do better to get real networking software. I'm no expert on this, but people I consider to be experts tell me the best of the easy-to-use Mac networks is probably Farallon Computing's Timbuktu, which lets Mac users share resources and operate each other's computer systems. Note that you need a copy of Timbuktu for every Mac workstation in the system. Timbuktu works with any AppleTalk network, including PhoneTalk and EtherTalk. It's more powerful than I need. LapLink Mac takes care of what little file transfer we do electronically—usually it's simpler just to save on a disk and carry that up to the Mac IIx and its printer—and it's convenient to be able to move text files from PCs to Macs with the same program.

Mice and Unmice

There's no room to do justice to two important new developments in mice. The first is Logitech's new trackball, which they call TrackMan. I have often said I would prefer a trackball to a mouse; but up to now, every time I got a trackball, I hated it. This one is different.

With TrackMan, you manipulate the ball with your thumb, while the fingers rest naturally on three mouse buttons. Everything is very comfortable, and you get really precise control. It takes a minute to get skilled at click-and-drag operations, but not much more time than that, and everything else seems natural the first time you try it. There will be a lot more on TrackMan in issues to come.

The other development is Microsoft's new mouse package. This gives such precise control over the mouse that after using the new Microsoft mouse for a couple of days, I found I was very unhappy with the Macintosh IIx mouse control. There is also a wonderful paint program that has a way to save images that can later be glued into QuickBASIC programs. I intend to use that in a new revision of Mrs. Pournelle's Reading Program, and I may just write a war game that has been kicking around in the back of my head for several years.

Winding Down

As usual, there's an overflow of worthy stuff piled on my ready table. In hardware, there's Zenith's nifty new Mini-sPort laptop, which may, just may, wean

me away from carrying the 16-pound SuperPort; I certainly like it better than I do the NEC UltraLite. The real question is, can I carry enough of the stuff I work with on trips? Then there's Atari's Portfolio, a full DOS computer you can actually put in your pocket. Darndest thing I ever saw.

Finally, we have Seiko Instruments' Smart Label Printer, which I nominate as the most useful gadget of 1989: it takes addresses off your screen (as for example in a letter) and prints mailing labels from them. Cheap, effective, useful, and I sure wish I'd thought of it.

There's also the standard ton of software worth mentioning. I've got a new color Mac version of Maxis's Sim City. There's also an IBM version with a truly horrible copy-protection scheme. This would be a lot better game and simulation if the program authors didn't spend so much time trying to control what the user does with it.

There's also a new version of Nemesis, the Go Master. Nemesis and its rival Cosmos keep fighting it out as to which program is the strongest go player; alas, both programs play better than I do, although I'm foolish enough to think that if I practice enough that could change. I like the Nemesis user interface a lot.

The program of the month is Stella, a system dynamics simulation program for the Mac (you really want a Mac IIx or IIcx if your simulation is at all complex). I could spend weeks playing with this if I had the time. Every Mac needs one.

The book of the month is *The Western Way of War: Infantry Battle in Classical Greece* by Victor Davis Hanson, with an introduction by John Keegan (Knopf, 1989), which is a fascinating analysis of Greek hoplite warfare: just what would make the free citizens of Greek city-states stand there in phalanx and fight it out on level ground? Hanson tells us, and I'm glad I didn't have to do it.

Next month the portables, more on mice, and maybe I can get ahead of this pile of stuff, but I probably can't. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerrypp."



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What are your options for small-systems Unix and Unix editing programs?

In the first installment of this column, I asked readers to suggest topics they wanted me to cover. I've been very impressed at the diversity of responses and experience of the BYTE readership, and I'm happy to see that so many people are taking Unix seriously (not to mention reading this column).

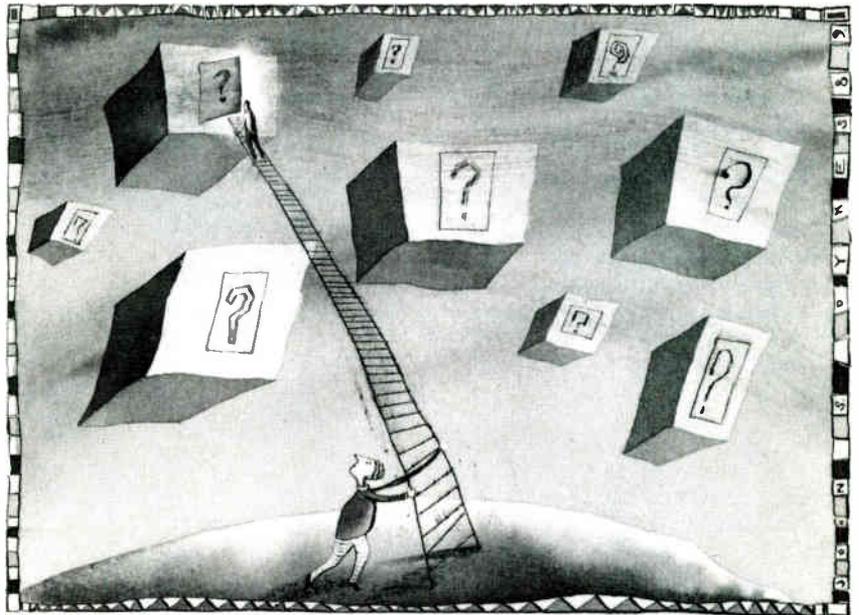
Many of the topics and questions you've sent in are complex enough that they will require entire articles to cover. Some are interesting, yet less comprehensive. Rather than disappoint anyone, I figured that every few issues, I would cover a number of these shorter topics in one column. So that's what I'm doing this month.

Which Unix for You?

By far, the most popular question I'm being asked goes something like this: "I have an 80386-based personal computer at home, and now I want to put Unix on it. What is the best and least-expensive version I can get?"

Now there's a loaded question if I ever heard one. If only the best in every field were also the least expensive! Rather than make some sort of all-encompassing judgment from on high, I prefer to give you information that will help you make a decision for yourself.

I will, however, begin with a pronouncement or two about hardware. If you are thinking about buying an 80386-based computer specifically to run Unix, investigate very carefully before getting one based on the 80386SX chip. The 80386SX, a 16-bit version of the original 80386 (now called the 80386DX), is a great platform for a computer that's



meant to run an operating system such as MS-DOS. The 80386SX, using 16-bit memory, has led to the introduction of extremely cost-effective computers, but I don't believe it is suitable for running Unix.

The reason? All you have to do is read some accounts of people who have true 80386DX-based 32-bit systems and who have added low-cost 16-bit memory and are experiencing serious throughput problems as a result. Imagine running an entire system on 16-bit memory.

You might also heed the warnings of The Santa Cruz Operation (SCO), which warns about system "panics" (unrecoverable crashes) under Unix and Xenix due to low-quality memory chips, especially with certain static RAM chips. The company also strongly recommends not using 16-bit memory, especially if the chips are slower than 90 nanoseconds, for the reasons I've detailed above, plus some DMA problems that are related to this.

Now About That Software

The least expensive way to get started in Unix is not to buy Unix at all, but instead get a Unix look-alike: an operating system that has been modeled on Unix and is compatible in many respects. The best kind would, of course, be one that actually included the source code, so you could study the principles involved. If it cost less than \$100, this would be great, right?

No, I'm not ready for the butterfly nets. The book *Operating Systems: Design and Implementation* by Andrew S. Tanenbaum (Prentice-Hall, 1987) contains the basic source code—with complete and detailed explanation—of Minix, which is a complete Unix version 7 near-compatible operating system that will run on the IBM PC. You can also order the complete source code and ready-to-run binaries from Prentice-Hall for less than \$100 (various packages are available, depending on your exact machine

continued

ITEMS DISCUSSED

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For owners of 80386-based systems, there are many more choices. Most of these are based on the current AT&T System V release 3.2 port of Unix for the 80386, with various amounts and types of added value, depending on the orientation of the vendor. SCO Xenix is the exception here: While compatible with most 80386 Unix applications software and most source code, it has a different development history, and its own cadre of admirers.

One reader took me to task for mentioning SCO Xenix so frequently, saying that Interactive Systems' 386/ix has a better DOS interface. In fact, SCO's DOS interface is VP/ix, which is licensed from Interactive!

I have run a number of Unix versions on my own 80386 machine as part of published reviews and have found SCO Xenix—especially the later versions, such as 2.3.3—to be extremely fast and stable. It is different from other systems, including the new SCO Unix/386, because it doesn't have the vast amounts of code necessary to support the official AT&T Unix port.

SCO also supports a wide variety of hardware on both its Xenix and Unix systems, including mice, many serial and video boards, and streaming tape drives, as well as ST506, run-length-limited, SCSI, and ESDI hard disk drives, with device drivers that are included as part of the basic package. I recommend that anyone who is looking for an 80386 Unix software platform with great memory efficiency and speed—and who doesn't need precise Unix 3.2 compatibility—should look into SCO Xenix.

If you need real Unix 3.2, the most inexpensive one I've been able to find is from Esix Systems (a subsidiary of Everex, which manufactures 80386 computers). Esix System V/386 includes an unlimited-user license for the run-time system, the software development package, the X Window System (with libraries), Streams, and Remote File System (RFS) with Ethernet support.

Interactive Systems was one of the companies that helped develop Unix 3.2 for the 80386; the company sells it as 386/ix. As the developer of the VP/ix DOS interface (which lets you run DOS programs as a task under Unix), Interactive Systems sells this product to end users as well as to SCO. It also has products ranging from the Ten-Plus user interface to Network File System (NFS), TCP/IP, and the X Window System, which is why it has a very complex price list. But its most popular configurations

continued

[XT or AT] and memory configuration). While Minix is not a substitute for Unix in a business environment, it is a great base for learning. There is enough public domain source code that will run on Unix version 7 to keep you happily porting for years, plus an entire support group on Usenet and discussions on BIX.

Strangely enough, Prentice-Hall publishes another book with the source code for a Unix-like system. This one is *Operating System Design: The Xinu Approach* by Douglas Comer (1984), and it describes a fully networking system that was originally designed to run on a PDP-11 minicomputer. Xinu has subsequently been ported to other machines, including the Macintosh, and it also enjoys its own group on Usenet.

Going Commercial

For those who are ready for the real thing, there are several alternatives. The first one is to buy a Unix-based computer

and use the version of Unix that the vendor provides. This method is common in the business world. It ensures that at least *someone* has tested the hardware and software together. Plus you have a single vendor to complain to if something goes wrong.

Suppose you have a personal computer already and you are interested in getting Unix à la carte. If you're running an IBM AT, there is only one major vendor supporting that market these days: SCO. SCO Xenix is available as a run-time system alone or with the complete software development system or text-processing system at an additional cost. Many people are not aware that SCO sells a two-user license at a reduced cost, for both its 80286 and 80386 versions. This is a possible alternative for a person working at home alone; the second user can use uucp or some other remote log-in. There are many applications packages available to run under SCO Xenix.

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SCO now has its own Unix 3.2 as well, and by the time you read this, it will have released the new Open Desktop product. Open Desktop is based on Unix 3.2, and it includes Xsight (Locus's X Window System product), Open Software Foundation's Motif graphical user interface, NFS and TCP/IP, Relational Technology's Ingres DBMS, and the Merge/386 DOS interface from Locus. The total package is priced aggressively, which is just as well: You'll need the money for more system RAM!

Which Editor for You?

Next to operating systems, the easiest way to start a religious war among computer users is to talk about which text editor is the best. I don't want to start a controversy or anything, but EMACS is probably the most powerful and comprehensive environment available for work on character-based terminals. On the other hand, I use vi exclusively, because I work with many different Unix systems, and I can always be assured of finding vi no matter where I go (I used to use ed for the same reason). It's also much smaller and starts up fast; this is important for someone who does a lot of writing.

The only reason I mention this is because the *second* most popular question readers have asked is, "How can I find out more about using vi?" Older Unix manuals, especially Berkeley-derived ones, sometimes have the original tutorial on using vi by Bill Joy, which is good material to look at. The book *A Guide to vi: Visual Editing on the Unix System* by Dan Sonnenschein (Prentice-Hall, 1987) is a more easily available source and is more appropriate for those who aren't into reading manuals.

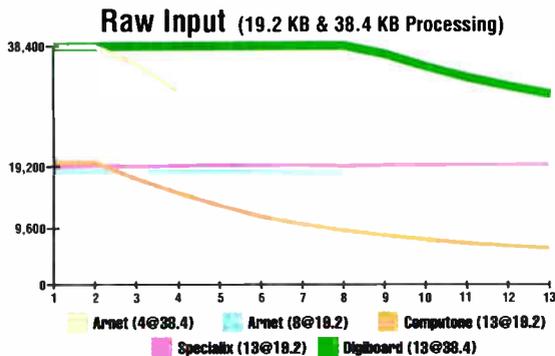
I just hope nobody complains that I'm mentioning Prentice-Hall all the time now. It does publish many good Unix books—but not *all* the good ones, by any means.

That's it for the current most-asked questions. Next month I will begin to address some of the deeper, more technical problems. ■

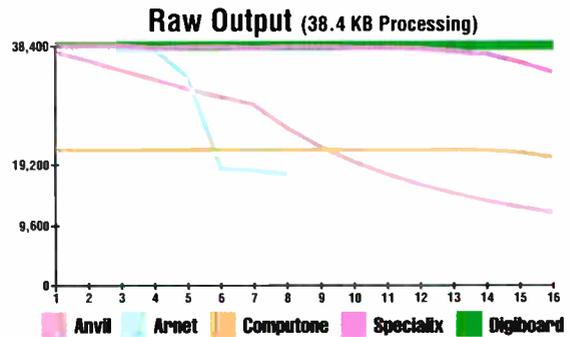
David Fiedler is publisher of the Unix Video Quarterly and the journal Root, as well as coauthor of the book Unix System Administration. He can be reached on BIX as "fiedler."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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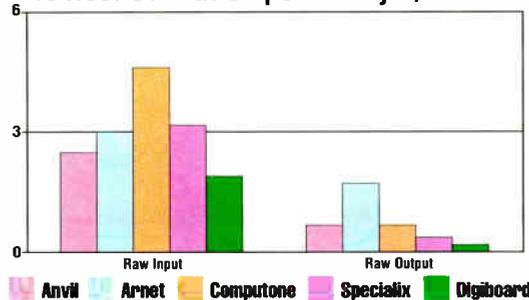


Raw Input: Primarily data received via host-to-host communications. The higher the better.

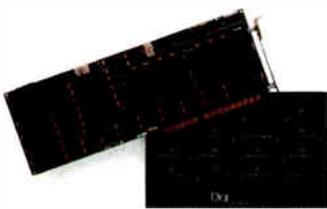


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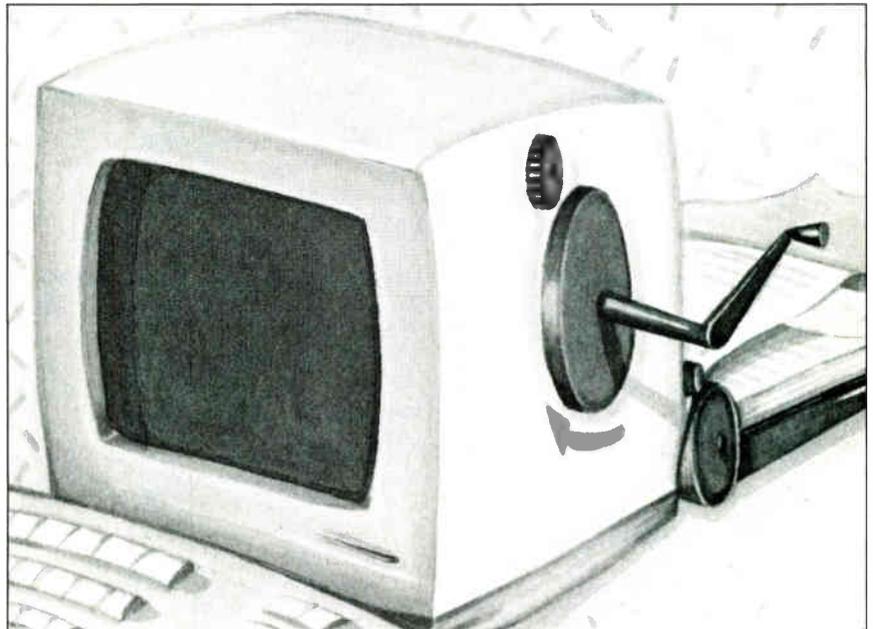
A key ingredient to success in any business is communications. Of course, I have discussed mostly data communications in this column, but there are other kinds of communications, and they do involve computers.

One such medium is good old-fashioned paper. There is a growing market for newsletters, circulars, and other forms of printed information. By now you're probably well aware of the power of desktop publishing systems in creating these items. Clearly, for businesses that must do a lot of publishing, DTP is an effective way to generate this material.

The problem is, DTP is an expensive proposition, and for a company that doesn't do publishing as a major part of its business, it may be prohibitively so. Part of the expense is in the DTP software itself. Two of the most popular packages for the IBM PC, Ventura Publisher from Xerox and PageMaker from Aldus, cost \$895 and \$695, respectively. This is in addition to the word processing software that you need to create the text in the first place.

Both Ventura Publisher and PageMaker are large, primarily graphics-based packages, and to run effectively they need fast computers and high-resolution (preferably full-page) monitors, large amounts of hard disk storage, and PostScript-based laser printers. All these items cost money.

Moreover, training is required for these complex systems. According to Mike Younts of CompuThink, based in Vienna, Virginia, his training for either publishing package costs \$225 per day,



and it takes two or three days for a computer-literate user to learn the basics of DTP. This provides the groundwork for being able to create manuals or complex documents in-house that would cost many times more if done by a typesetter and designer. If this is the capability your business needs, it's hard to beat, but do you really need all that?

Many businesses don't need and cannot afford to use DTP. They simply need to create attractive documents, such as company newsletters, that are simple in design and reasonably short. Because of the cost and complexity, these businesses are missing the benefits that DTP would bring.

Fortunately, with the advent of some of the newer word processing software and the ready availability of inexpensive laser printers, these capabilities are now available without having to buy a DTP system. The exact capabilities that you get will depend on the word processing software you choose. In general, how-

ever, to be considered acceptable for use as an alternative to DTP, the package should be able to use a variety of fonts and typefaces, use newspaper-style columns, incorporate graphics with text, flow text around a graphics box, support box captions, and include a full-page WYSIWYG preview feature.

Word Processor Publishing

I looked at three packages that support all the requirements to be used as alternatives to DTP packages. Two of the most popular word processing programs for IBM and compatible computers, WordPerfect 5.0 and WordStar 5.5, now have limited publishing capabilities. Another, Lotus Manuscript, is also very capable. In addition, I looked at a package called NewsMaster II from Unison World that will let you use text from nearly any word processor in doing limited publishing.

Choosing one of these packages will

continued

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give you a limited form of DTP for little, if any, cost above what you would have spent on word processing anyway. The only real restrictions are that you should choose a video display for your computer that will allow you to use the page preview function and a laser printer for the output.

The Software

WordStar 5.5 is probably the most limited of the three programs in its ability to support advanced features. While you have considerable control over the text formatting and the fonts you can use, WordStar does not support graphics images directly. It does, however, include a separate package, Inset, that provides this capability.

Inset can capture an image displayed on the screen and save it to disk. Once that's done, you have control over the image, and you can change its size, ori-

entation, or proportions. You can crop a portion of the image so that it can be included in a document. You can then insert the Inset image into the WordStar file for printing.

Otherwise, using WordStar 5.5 for creating image-based documents is fairly routine. The old familiar commands still work, and you can read old WordStar files. The newer version will support a variety of fonts, however, and will let you add lines and boxes to a document, provided that your printer is capable of printing them. Multiple columns are no longer difficult—a big improvement over earlier versions—and you can cut around photos.

WordPerfect 5.0 has similar capabilities, although this package will let you incorporate graphical images directly into the document. You don't have to go through the intermediate step of a program such as Inset to make it work. In

fact, WordPerfect is shipped with some sample clip art that you can use with your documents. Unlike WordStar's Inset, however, it does not let you capture images from the screen. You must import images from a compatible graphics program.

WordPerfect supports graphics from various sources, including Lotus 1-2-3, PC Paintbrush, and GEM Draw. Other software, including several CAD packages, can be used, but their files must be converted into something that WordPerfect can use.

Lotus Manuscript operates differently from the other two packages, but the results are similar. Manuscript seems to be more oriented toward creating reports than simple word processing, but it has the formatting and graphics capabilities necessary to support limited publishing. Unlike WordPerfect, which has everything in one integrated package, or WordStar, which has Inset separate from the rest of its features, Manuscript seems to be made up of closely integrated separate programs, each of which must be loaded to perform its function.

In any case, Lotus Manuscript will support the direct use of Lotus 1-2-3 spreadsheets and graphics, as you would expect. In addition, it will use PC Paintbrush files, digitized photos, and Free-lance Plus metafiles. Some files, including those from PC Paintbrush, must be converted through the use of a utility provided with Manuscript.

The Peripherals

Peripherals are an important factor in creating image-based documents. All these packages let you preview the pages before you print them, but previewing works well only if you use VGA graphics. I used a Vega VGA and a VRAM VGA to view the documents I created for this column, but other good VGA boards should work fine.

A laser printer should be considered a necessity as well. I used a Hewlett-Packard LaserJet IID and a Toshiba PageLaser 6 before writing this column, but not all laser printers are supported by all packages. Unless you have an HP machine or an HP clone, you should check carefully.

These packages will also work with some dot-matrix printers and with graphics capability with resolutions of less than VGA. I doubt if I would consider using anything except a laser printer, however, especially given the relatively small difference in price. Your objective, after all, is to impress your

continued

Why Experienced Computer Users Don't Think Very Much About Modems

Our research shows that knowledgeable MIS managers, PC coordinators, and end users simply don't want to think of modems at all.

Not exactly what modem makers relish hearing! But it's hardly surprising that you want to save your thinking for bigger and more important things.

Modems are a lot like plumbing. As long as the data is flowing, they're practically invisible. However, when something goes wrong, those little boxes are just lavished with attention.

By then, you've lost data, time, money, and perhaps an opportunity. Both senders and receivers are dismayed and disarrayed.

Fortunately, there are simple ways to limit this aggravation. Our research suggests a few points to keep in mind.

The cost of the modem is not the modem's cost.

The fixed price of the modem is relatively insignificant. Ongoing costs matter far more.

In the long run, for example, a high-speed modem can save you a small fortune on phone bills. More data sent in less time means less money to the phone company.

You can also save with more reliable and robust modems that communicate over a wide range of telephone line conditions.

Resending data costs both time and money. The less time you spend transmitting data, the more time you have to spend on your business.

Downtime and adaptation time can also cost you dearly.

Be sure to ask if the modems are compatible with their earlier generations. You don't want to start with suppliers who regularly obsolete their own products, or who don't offer you an upgrade path.

Modem support can be a real hassle with the wrong vendor.

Setting up and installing your modem can affect both your budget and your sanity. Many manufacturers forget to make their modems easy to use!

This becomes expensive when you want to start up fast or need to support a large number of users.

Dip switches, on-line help screens, and easy-to-use manuals should be demanded. It also helps to have a quick-reference guide printed on the bottom of the case.

In sticky situations, it's vital to have toll-free support and applications engineering.

Bottom line: The data must get through.

A bit of data traveling from your computer is converted by your modem and sent to your local telephone office.

From there, it is exposed to the vagaries of phone lines, various transmission media, and weather patterns.

They all conspire to corrupt your data and slow down your throughput.

All modems are not created equal; some are less sensitive to noise and have better error-correcting protocols.

Some are simply more robust and have better filters.

Modems are more than mere commodities — technology does count.

"When things go wrong, I want the supplier there."

That's when you need the *right* supplier on board. Look for one who gives fast turnaround time on repairs and adjustments, and who doesn't vanish after the sale.

Look for a company with history and promise — one that's here today and here tomorrow.

Not everyone needs the same modem.

The best way to keep modems from wasting your time and money is to buy them from a reliable supplier with a broad product line. Those with limited lines sometimes try to cram square pegs into round holes.

People with differing applications have differing requirements. Dealing with a broad-line supplier simplifies ordering, reduces training/support time and cost, and limits hassle and coordination.

In the end, if you give enough consideration to choosing the right supplier, you'll hardly have to give modems any thought at all.

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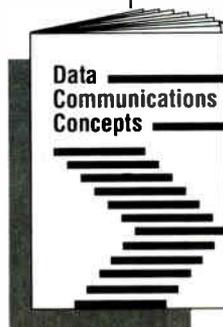
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customers or employees, and I don't think that a document printed on a dot-matrix printer will do that.

Another Approach

There are those businesses that use word processing software other than the three I've mentioned here. It's possible that all or most of the capabilities mentioned here will be supported in other packages. If that's the case, and you don't want to get one of these packages, there is another solution. Unison World's NewsMaster II is designed to be a simple newsletter package. It will allow graphics images to be imported, and it will work with an ASCII file. If your word processor will generate an ASCII file—and nearly all of them will—you can use this package.

NewsMaster II is set up to allow you to display and print text in columns on an 8½- by 11-inch sheet of paper. You can choose the number of columns and their size. In addition, the program provides for headlines and for editing both text and graphics. It's not as flexible as some of the other software mentioned here, but it works well and supports both laser and

dot-matrix printers. It's easy to use, and it's also quite inexpensive.

Is It Desktop Publishing?

Despite the considerable capabilities of word processing software, it's still not in the same league as Ventura Publisher or PageMaker. Those are professional packages for companies that put out magazines and manuals, but they are probably more than you need for a simple newsletter. In addition, those packages require equipment and training well beyond that required for WordPerfect, WordStar, or Manuscript, and you still need your word processor to create the text for these packages.

On the other hand, if you have a significant investment in staff time for publishing, you should think about a DTP package rather than an enhanced word processing package. One big difference between the two is that with a DTP package, you can always see what the end result will look like. With a word processing package, you see the text and an indication of where the text will cut around boxes, but you don't see what the result will be until you look at the page

preview. This means that you will spend an enormous amount of time shifting between the editing screen and the preview screen. If this is cutting into your productivity, it's time for DTP software.

In short, the word processing packages I've discussed aren't really complete DTP packages, but that may not be a drawback. They can do the simpler jobs that abound in many businesses, and they don't require the investment that DTP requires. More important, when the job grows to the point that publishing software is needed, the material you've already created can be used with those packages, too. ■

Wayne Rash Jr. is a contributing editor for BYTE and a member of the professional staff of American Management Systems, Inc. (Arlington, VA). He consults with the federal government on microcomputers and communications. You can contact him on BIX as "waynerash," or in the to.wayne conference.

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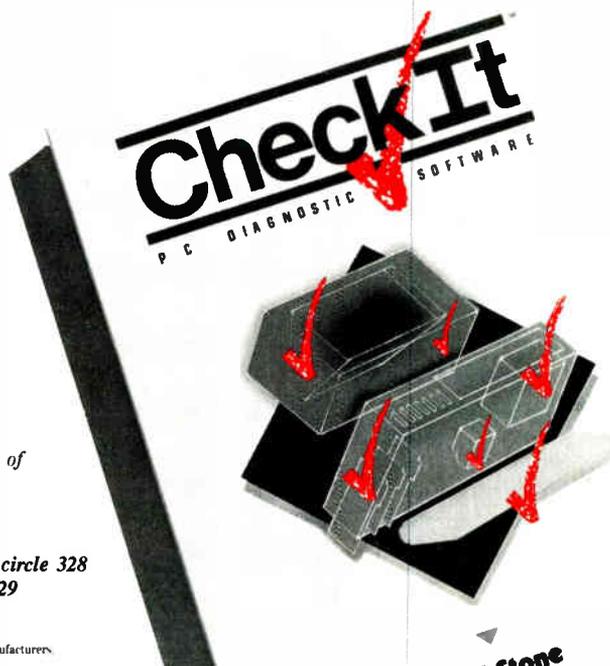
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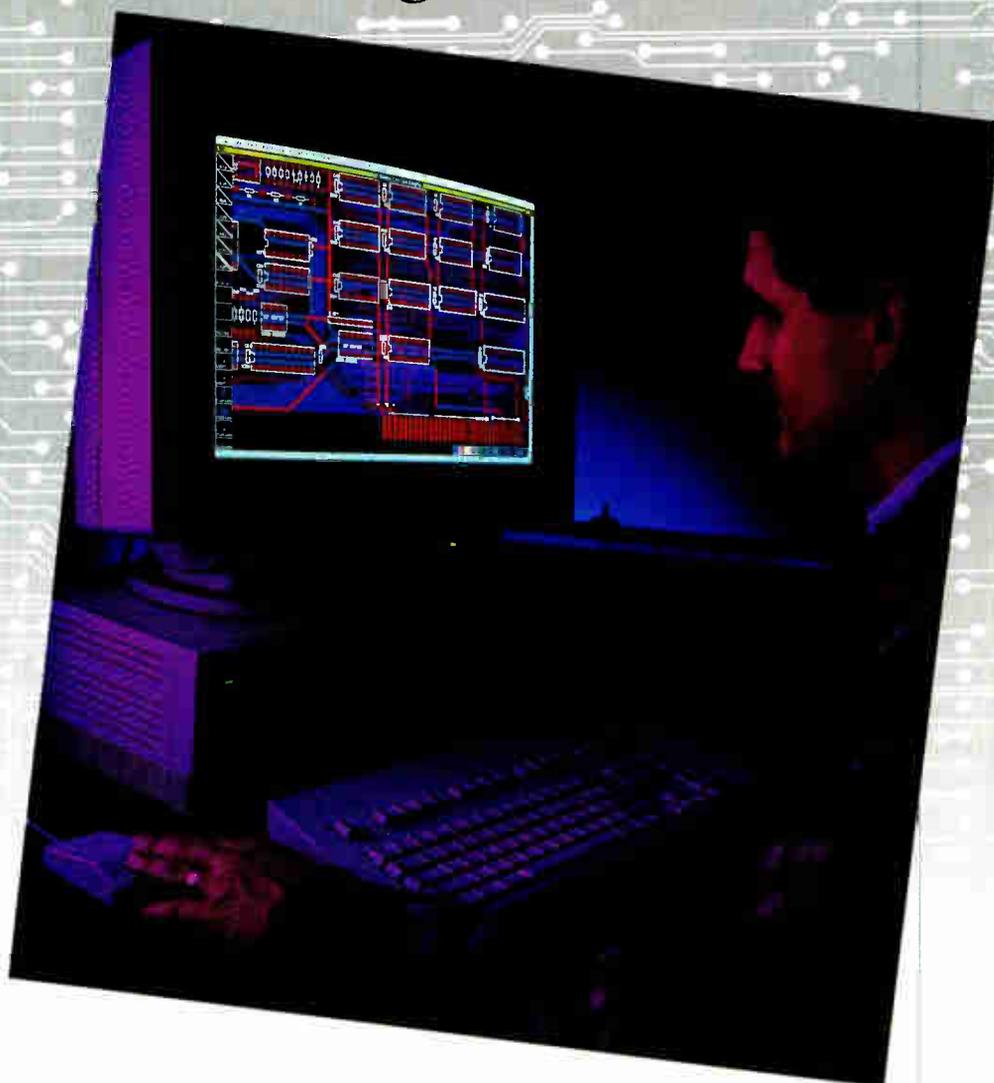


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THE BIG FOUR FOR MAC DATABASES

A survey of Macintosh software development using relational database development systems

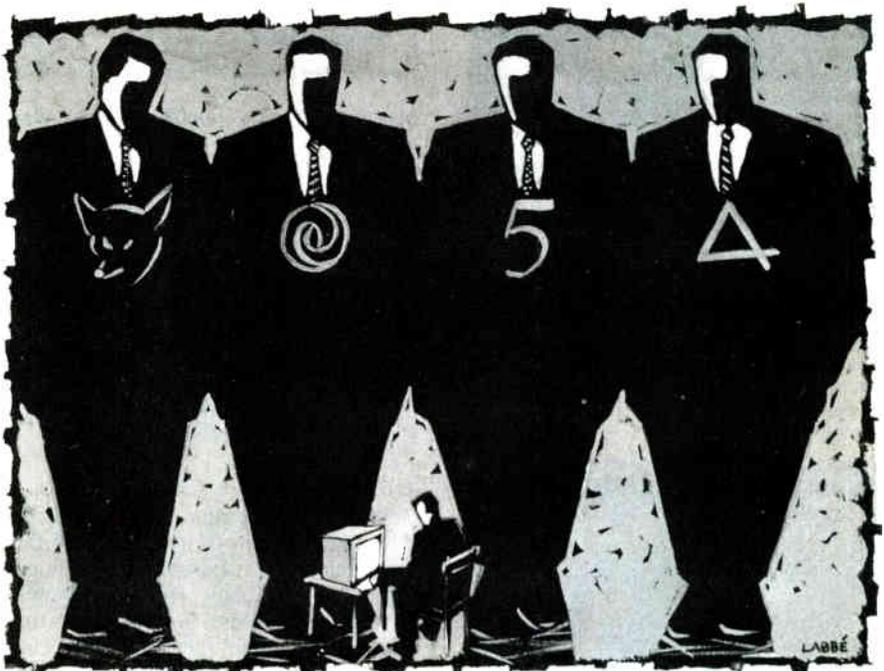
If the letters I receive are indicative, the number of turnkey software developers who used to work exclusively under DOS but have switched to the Macintosh in the last year is growing quickly. While some developers are creating vertical-market applications using traditional Mac languages and development environments (e.g., MPW Pascal and MPW C or Think Pascal and Think C), the majority of letters I get from developers ask about database development systems.

How good are they? What can they do on the Mac that can't be duplicated under DOS, Windows, or OS/2 with Presentation Manager? What are their limitations? What do you recommend? This month, I'll try to answer these questions for the top four Mac relational database development systems: 4th Dimension 2.0, FoxBASE+/Mac 2.0, Double Helix II 3.0, and Omnis 5.

The Big Four

These four programs share some common capabilities. They all can build some kind of database that links together separate data and design files. They can create printed reports about the data collected in their databases, and some include the ability to work fully with graphics information as a data type.

Double Helix II and 4th Dimension were developed from the ground up for the Mac. FoxBASE+/Mac is a port of its IBM PC program, but it has been significantly enhanced to take advantage of the Mac's icons, windows, dialog boxes,



menus, and mouse. Omnis began on the PC and the Apple II, but it has been resident on the Mac for a while.

You can build applications with each program that can include menu bars with various pull-down items, scroll bars, dialog boxes, radio buttons, check boxes, and most of the interface flotsam that we expect a Mac to have. The ease of doing this, however, and whether or not the applications really feel like Mac applications set these products far apart. On a sliding 1-to-10 scale of ease of building applications (with 1 being the hardest and 10 being the easiest), Omnis rates a 3, Double Helix II a 7, FoxBASE+/Mac an 8, and 4th Dimension a 9. As a point of comparison, HyperCard would rate a 10 on this scale.

The programs also vary in their power and flexibility. Applying my same 10-point scale (with 1 being the least powerful and flexible and 10 being the most powerful and flexible), the rankings remain the same, although the scores do

change a bit. Omnis now rates a 6, Double Helix II an 8, FoxBASE+/Mac a 9, and 4th Dimension a strong 10. In fact, FoxBASE+/Mac is probably an order of magnitude higher than Double Helix II in terms of power and flexibility, with 4th Dimension a step above that.

Each of the programs supports multiple users, which is a typical need of any custom application. If you need to develop custom database applications on your Mac, these are the ones to try. But make sure that what you really need is to develop applications that will use the Mac as their primary data engine. If you need to organize some basic information and report on it, these programs are serious overkill.

For primary organization and data reporting that doesn't involve a custom application, use FileMaker II. And if you'll need to connect your Mac data engine to a larger system, likely to a Structured Query Language database running on a

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big computer, you should consider Oracle for the Mac.

Price is not very important in this market. You should be buying functionality, power, good development tools and programming languages, multiple user capability, reliability, strong vertical-market applications, and the like. None of these qualities comes cheap in a database on any computer, let alone on the Mac. If you buy for price, you'll pay much more in the end. With that in mind, I'll take a closer look at the big four.

4th Dimension

Acius's 4th Dimension outshines all the other databases with its number of features and rich database development environment. In many ways, 4th Dimension is a complete fourth-generation language system for the Mac that specializes in database applications. It's not meant for the casual user or for half-hearted database efforts, although version 2.0 has dramatically improved its ease of use and has cleaned up some pretty ragged documentation found in version 1.0.

This program is meant to build big, sophisticated applications with elegant user interfaces. At this task, it excels. It includes a complete programming language, reminiscent of Pascal, plus a debugger, built-in graphics, a fancy layout editor, and more development tools than you can shake a stick at. Basic flat operations, especially ASCII file importing and unindexed sorting, is greatly improved over version 1.0. Only one other Mac relational database I've tested, FoxBASE +/Mac, is faster than 4th Dimension. That's a major improvement.

Of the current programs, 4th Dimension is the most complete and powerful. It's my choice for serious Mac-only database development. Designer Laurent Ribardiere deserves big-time kudos for re-

writing his brainchild and making it faster and more powerful, yet easier to use. That's no simple trick.

FoxBASE +/Mac

FoxBASE +/Mac 2.0 takes the fast and powerful FoxBASE+, 1.0 and tames it, making it a real Mac application that produces other real Mac applications. In the process, none of its dBASE compatibility has been lost. And amazingly enough, that raw speed is still there; in fact, it's even faster than before.

As fast as FoxBASE +/Mac is, you'll likely be impressed by its interface and application development environment. It combines its complete dBASE compatibility with a genuine Mac interface.

FoxBASE +/Mac includes a superset of the dBASE programming language, a much improved layout editor, and enhanced relational capabilities.

Double Helix II

Double Helix II 3.0 updates an old favorite of mine. It has the design goodies and graphical development environment that enable many end users to build professional database application programs incorporating all the typical Macintosh interface features (e.g., menus, icons, and graphics).

You build Double Helix II applications by manipulating a number of icons that represent items such as data, calculations, comparisons, and selections. This method is especially intuitive for end users who have not had any formal training in database structure or rudimentary programming, but who know what it is conceptually that they want to do.

Double Helix II 3.0 should be on the short list of any Mac manager who requires the nonprogramming staff to develop its own database applications. It also excels at ad hoc exploratory data

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analysis. Double Helix II's strengths for nonprogrammer development, however, also make it much less desirable for turnkey application developers. If you are used to procedural programming languages and haven't done much object-oriented work, you'll find its object-oriented approach daunting, and at times confusing.

Omnis

Omnis has been around for a long time in Mac terms, perhaps too long. When it came out in 1984 (as Omnis 2), I didn't like it because it had been hastily ported from the PC, making for an awful user interface. Blyth Software deserves a lot of credit for sticking with this program, steadily improving it, and adding more capabilities and speed. The current release is Omnis 5.

Sadly, the gains made a few years ago in the change from Omnis 2 to Omnis 3 Plus have not been duplicated with the upgrade to Omnis 5. This program feels rough, and I can't imagine doing serious programming development with it. The documentation alone makes me scream. Like Omnis 3 Plus, Omnis 5 is not easy to use, and it's quirky enough to be frustrating most of the time.

Omnis 5 includes a programming language and the expected set of development tools, but it just doesn't "feel" right. It smacks of being an ill-conceived upgrade, and developers will find its idiosyncrasies annoying. For example, the way that file relationships are established (through radio buttons, rather than through file-to-file directional arrows) is needlessly tedious.

Decisions, Decisions

One of the best ways to tell if any Macintosh programming environment is really good is to check out the applications written with it. I know that MPW Pascal and Think Pascal are good because hundreds of developers have written commercial programs using them. Likewise, I know that 4th Dimension and Double Helix II are good because of their large number of commercial vertical-market applications. Omnis 3 Plus fell into that same category, but so far Omnis 5 does not fall into that category.

FoxBASE+/Mac goes even further into this vertical-market stuff by offering developers the chance to port existing dBASE applications from the PC to the Mac and pretty them up.

Deciding which relational database program to use on the Mac is really much easier than it would seem at first glance. Although there is quite a lot of overlap of

capabilities, performance, and functionality, each program displays definite strengths and weaknesses.

Buy 4th Dimension if you need all the features and capabilities that the state of the art in Mac relational databases has to offer. Its multiuser capabilities are strong. Its development environment is well designed and complete, and Acius has thrown in the kitchen sink when it comes to development features and support. The 4th Dimension run-time package also works smoothly, thus letting you market your turnkey applications easily.

Some people are Double Helix II junkies. I confess to being one of them. I find that version 3.0 is just as easy to use as all the other versions I've tested. It won't appeal to everyone, especially if you think that the Mac interface uses too many icons as it is. It still suffers from some speed problems, although it is much improved over the last release. Double Helix II 3.0 is an excellent choice for organizations that rely exclusively on end users to build, maintain, and use their own database applications. As a development system, though, its nonstandard object-oriented approach may slow you down.

I've never been a big fan of Omnis 3 Plus, and I'm less enthusiastic about Omnis 5. Its one strong feature is the large number of vertical-market applications that have been written in previous versions. Still, I just can't shake the feeling that Omnis is headed for its last software roundup. Version 5 comes off as a half-hearted attempt to compete with 4th Dimension and FoxBASE+/Mac. And in this competitive market, halfhearted attempts will kill you.

FoxBASE+ has always been fast, powerful, and dBASE-compatible. Now it's also good. Real good, in fact. Fox Software's David Fulton may be the smartest person around designing databases and dreaming up data-access algorithms. FoxBASE+/Mac 2.0 has many more features and is far more flexible than version 1.0, yet it's faster at everything it does. Go figure that out. Or better yet, go buy it. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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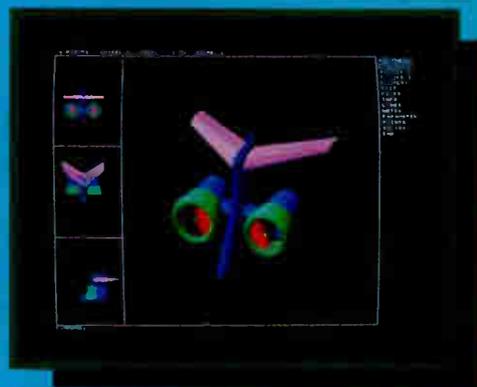
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A FIRST LOOK AT HPFS

OS/2 1.2 introduces the High Performance File System

By now, you've probably heard about OS/2 1.2, which is scheduled for release as I write this. It includes a slightly new look for the Presentation Manager and some performance improvements.

However, the most important change in version 1.2 came in the area of files—the advent of the new generalized disk interface called the Installable File System and the first example of a specific IFS-type file system, the High Performance File System (HPFS). In this month's column and next month, I'll look at this new file system.

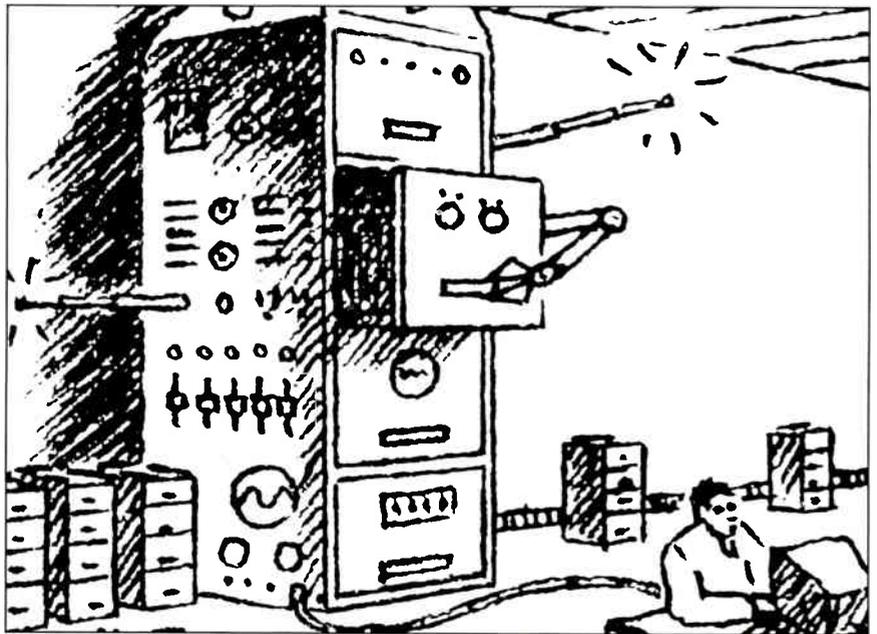
The rationale for HPFS is that it will do the following:

- increase maximum disk sizes to a level that will be able to meet the needs of IBM PC users in the next decade or so
- make hard disk data access faster
- give disk files security features like passwords
- allow both the system and users to keep more descriptive information about files

Do I Have to Reformat My Hard Disk?

The first thing almost everyone asks me is, "Will I have to reformat my hard disk to use HPFS?" The answer is, "Probably, but not necessarily." At the lowest level, HPFS shows up as a new kind of *partition*.

That's not surprising, since IBM and Microsoft have included the notion of disk partitioning in DOS since version 2.0. The original reason for partitions was that you could take the IBM PC XT's



10-megabyte hard disk drive and share it between DOS and Xenix. Without partitioning this would have been impossible, because Xenix doesn't care to organize its files the way DOS does. Rather than making you buy two hard disk drives, you could instead give some of the 10 megabytes to Xenix and the rest of it to DOS; you do this with the FDISK command. And thus was born the idea of partitions.

Most major upgrades of DOS have involved new kinds of partitions. DOS 3.0 brought a more efficient kind of hard disk partition than DOS 2.x's. DOS 4.x, with its support of disk partitions larger than 32 megabytes, brought yet another kind of partition. OS/2 1.0 and 1.1, of course, used the DOS partition types.

Thus, putting HPFS on your hard disk involves repartitioning it. Partitions divide the disk by cylinders. You could allocate the first 200 cylinders to DOS and the remainder to HPFS. But you can't re-size a DOS partition without losing the

data on the partition. So you can put both DOS partitions and HPFS partitions on the same disk, but you may have to back up and restore the DOS partition.

On the other hand, you may currently have a large (32-megabyte or more) disk partitioned—required under most versions of DOS 3.3—as a 32-megabyte DOS partition and the rest as an "extended" DOS partition. In that case, you needn't zap your entire hard disk. The first partition, the C drive, can remain in DOS format. Then back up the other partition and recast it as an HPFS partition.

An HPFS partition is of no value without the code (IFS) to talk to it. The CONFIG.SYS statement to install HPFS is

```
IFS=drive\path\HPFS.IFS /c:nnnn
```

where *nnnn* = size of cache. The neat thing about IFS is that it is, as its name implies, "installable," so you can take your pick of file systems. Perhaps a

continued

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—Stan Miastkowski

OS/2 NOTEBOOK

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Unix-like file system will appear next.

Floppy disks, by the way, remain in the DOS format, so there's no problem swapping them among DOS and all versions of OS/2.

Longer Filenames! Bigger Disks! Whiter Whites!

The notion of subdirectories remains with us. Filenames can be 254 characters long, with as many periods as you like, for a filename such as mortgage.file.for.sheila.

Directories are now sorted automatically by filename. That's not done for user convenience, but rather to speed up file access. Still, a side effect is that the directory is better organized for users.

The 32-megabyte limitation imposed by OS/2 1.0 is gone for good. HPFS does away with the DOS notion of clusters and directly allocates 512-byte sectors, offering more efficient use of space. The 32-bit allocation structures (more on this next month) allow a maximum disk size of 2^{32} sectors, or 2048 gigabytes. (Let's see, how many floppy disks will I need to back all these up?)

Extended Attributes

Wouldn't it be nice to include with every file an 80-character description of the file, kind of like what the Norton Utilities' *fi* can do? Such a feature could be essentially built into the operating system with HPFS's *extended attributes*.

Attributes under DOS are pretty minimal. Probably the best-known one is the *hidden* attribute. Set the hidden bit, and the filename no longer shows up on directories, is not erased when you erase *.* , and so forth. Another attribute keeps track of whether a file has been backed up since it was last modified. Another one tells the system to let programs *read* a file, but not to allow deletion or modification of the file. (There are others, but those are the big ones.)

These old attributes remain under HPFS, but there are others, also. Not only does the system know the date and time of the last modification (the current DOS information), it also knows when it was last *read* and last *modified*, as well as the number of times the file has been used.

A few months back, I hypothesized a program that would optimize your disk use by unfragmenting files in the background and keeping track of how often you use a file. Less-used files would be automatically compressed using a file compression technique of some kind (e.g., the one that programs like ARC and PKZIP use). This would mean, I ar-

gued, that as time went on, you would actually have *more* space on your disk—less-used stuff would get squeezed. Of course, when you needed the file, the operating system would automatically un-squeeze it. Such a program is now possible with the extended attributes available under HPFS.

In addition to this new information, a programmer can now create new attributes. Similar to OS/2's SET command, user-defined extended attributes are stored as "name of attribute" = "value

The HPFS
does away with the
DOS notion of clusters
and directly allocates
512-byte sectors,
offering more efficient
use of space.

of attribute." For example, programs might be written to use a "project =" attribute in files. Then, when a proposal to XYZ Corp. involved a spreadsheet, two text files, and a program, each file's directory entry might contain "project = XYZ" just to help the user (or some kind of user shell program) keep the relevant files together. Again, note that "project =" is not a built-in HPFS attribute.

Yet another attribute also arrives in the form of access control lists. These keep track of access rights (e.g., read, read/write, and erase/can't erase) and passwords. This will be useful in network situations, or perhaps where a single machine is shared by different people at different times.

Stop! Don't Touch That Big Red Switch!

Despite massive changes in the file system, CHKDSK is still around. Even though HPFS is a great improvement, directory maintenance is still necessary. In fact, a new feature called write-behind will actually increase the need for a CHKDSK-like program. You see, HPFS makes heavy use of caching. Caching speeds up disk access by using the fol-

continued

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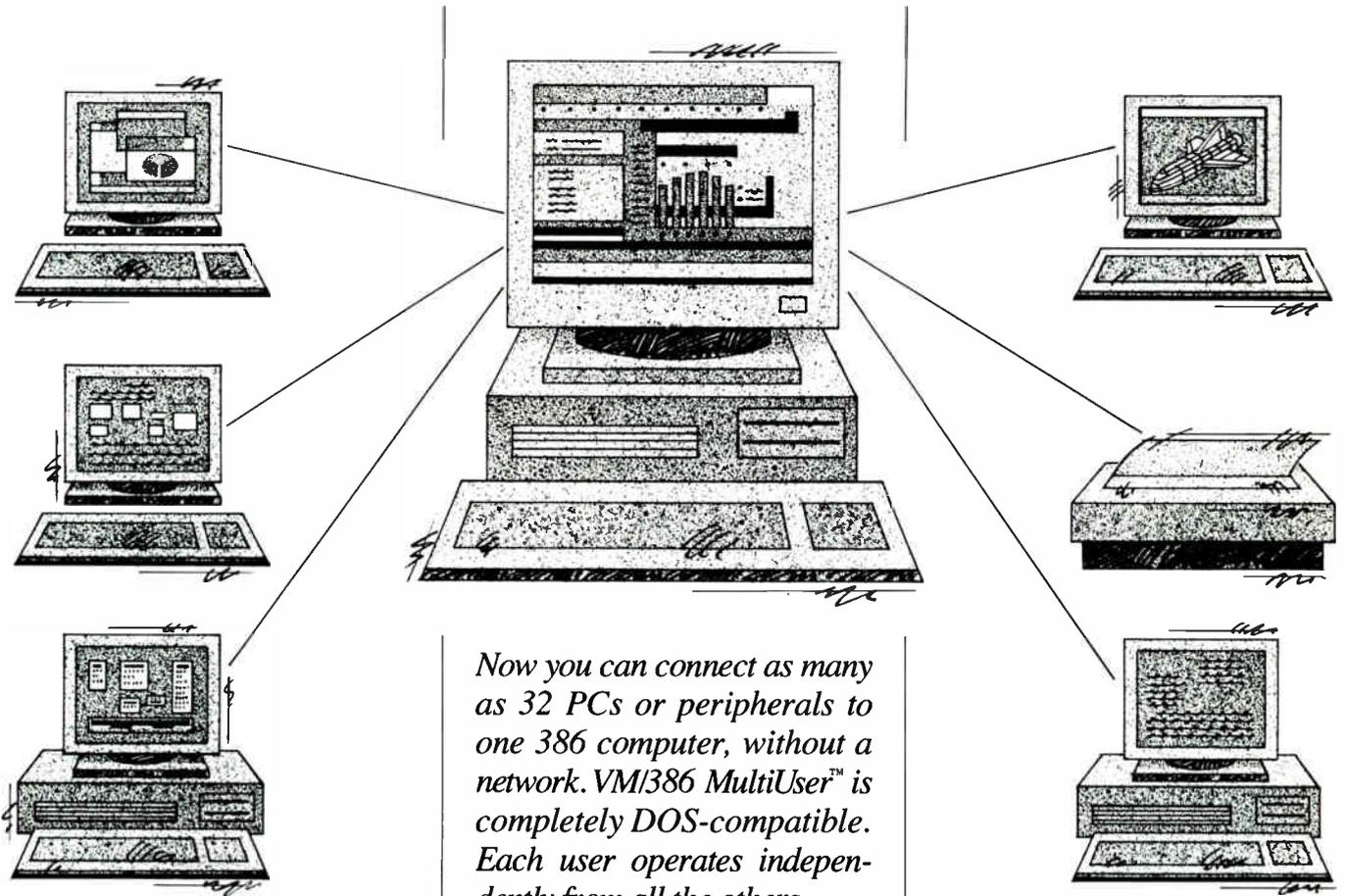
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lowing two pieces of information: (1) It takes a lot longer to transfer data from *disk* to memory than it does to transfer data from *memory* to memory. (2) Not all parts of the disk are used with equal frequency: some parts get a lot of exercise, others none or almost none.

Thus, a cache program allocates some memory and keeps copies of the most read (notice I said *read*—writes are another story) areas of disk in this memory, hence a disk cache. That seems pretty innocuous, as it affects only disk reads. A power failure won't destroy any data, as disk writes pass the cache by.

What I've described so far is a write-through cache, the common approach seen in DOS and earlier versions of OS/2. Greater speed improvement can be realized by caching disk writes also, but it's risky. Putting off disk writes until it's convenient may speed things up, but you'll lose data if the machine loses power before writing the data. Holding data to be written in a cache is called using "dirty buffers."

Did you ever notice the option in the Task Manager window to "Shutdown system?" It may have seemed superfluous before, but it's vital now. You've got to force the system to write out (*flush* is cache terminology) its dirty buffers before powering down, and that's what Shutdown does. If you turn the machine off before the buffers are flushed, HPFS remembers. Then, the next time you start the machine, it won't let you do anything until you've booted from a floppy disk and run CHKDSK to clean up the directory. (Norton and Mace, are you listening?) That's in addition to the fact that, again, you may have irretrievably lost data from one of your files.

To reiterate: With dirty buffers, even though you told WordPerfect to save a file, and you then exit WordPerfect, the file may not yet be saved. Programmers can ensure that the buffers on a file are flushed, so good OS/2 applications should give us the option to either do it OS/2's way (fast but risky) or the old way (force a buffer flush—safe but slow).

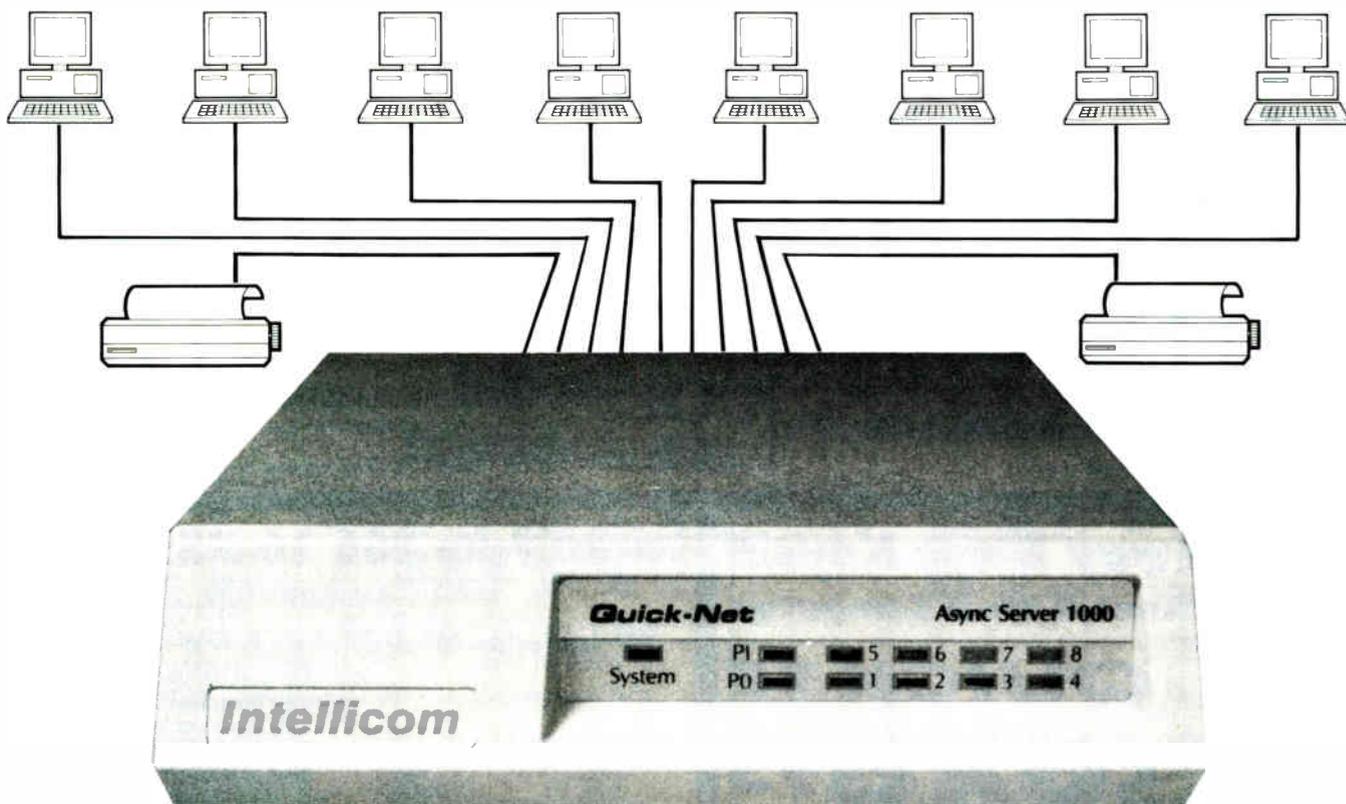
Next month: Fnodes, extents, runs, emergency blocks, and more. A look under the hood of HPFS. ■

Mark J. Minasi is a managing partner at Moulton, Minasi & Company, a Columbia, Maryland, firm specializing in technical seminars. He can be reached on BIX as "mjminasi."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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The Quick-Net Async Server 1000 offers the multi-PC office a low cost alternative to expensive and complicated LANs. The Server 1000 features 8 serial ports and 2 parallel ports. With this Server up to 9 users can share a printer. Multiple printers can also be shared in a variety of ways including general or selected user access.

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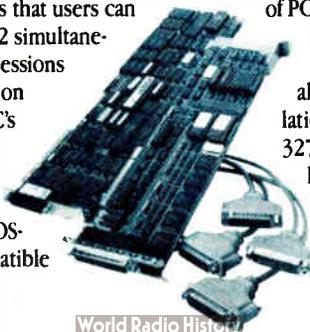
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APPLETALK PHASE 2 AND YOU

Apple's newest networking products may be just what you needed—but for some users, Phase 2 brings no benefits at all

Apple's announcement in June 1989 of the AppleTalk Phase 2 collection of products generated a lot of hype. The firm got even more press for its timely shipment of the first Phase 2 products in the months following that announcement. It's a sad commentary on the industry when a company gets widespread praise just for meeting its schedules. But AppleTalk Phase 2 represents several major steps forward for Macintosh networking, and we commend Apple for taking them.

How much you will actually benefit from the new AppleTalk, however, depends on the type of network you have and on the type of network you want to have in the future.

If you have a small Mac network that uses Apple's LocalTalk cabling, you can pretty much ignore AppleTalk Phase 2. It does nothing for you. The biggest gripe you're likely to have with LocalTalk is its relatively slow speed of 230,000 bps, and Phase 2 doesn't change that. You can still turn to products like TOPS's FlashTalk for a speed boost to 770,000 bps, but that's your only option.

EtherTalk Improvements

AppleTalk Phase 2 begins to help when you've got a larger Macintosh network. Early Mac network users quickly discovered that LocalTalk networks run out of steam when you start heaping nodes on them. As a result, a large Mac network became virtually synonymous with



an Ethernet network.

Prior to Phase 2, AppleTalk restricted the size of even Ethernet Mac networks. There was a hard limit of only 254 devices—Macs or LaserWriters—on a single network segment, or *zone*. (This limit stemmed from AppleTalk's 8-bit device address field.) You could make larger networks by linking up to a theoretical limit of 64,000 zones. (That number came from the AppleTalk 16-bit network number field.)

To link those zones, you had to use routers. Typically, a router would connect several small LANs or route one such LAN onto a main Ethernet network. Apple offered the AppleTalk Internet Router software to handle the linkage. That program runs on a Mac that has connections to both the LANs that you want to link. It can even run in the background, although you'd want a dedicated Mac for networks with heavy traffic. (Cayman and Kinetics also offer routers that, unlike Apple's software-only Inter-

net Router, contain both hardware and software.)

AppleTalk Phase 2 removes the 254-device limit and introduces a new addressing scheme called *extended addressing*. Extended addressing combines the earlier 8-bit device field and 16-bit network number field into a single 24-bit network address field. Thus, you can now have more than 16 million (2^{24}) devices on a single AppleTalk LAN.

Zones are also different. Before Phase 2, a zone was a physical entity, a group of physically connected Macs. Now zones are logical constructs; you can have multiple zones on a single physical network segment, or a single zone that spans many individual LANs.

If you have a large Mac Ethernet network, or if you want to have one, the biggest benefit of extended addressing is that it gives you two more ways to build such LANs. You can, of course, still use routers to link individual LANs. You can

continued

also just take advantage of extended addressing's larger node limit and put all the devices on a single Ethernet LAN—up to the capacity of that Ethernet. Finally, you can link those LANs with bridges. A bridge makes AppleTalk Phase 2 view the connected LANs as a larger, single LAN.

One limitation of extended addressing is that it doesn't work with LocalTalk LANs; Apple still limits LocalTalk zones to 254 devices. But that restriction shouldn't be much of a practical problem, because LocalTalk's slow speed makes it undesirable to build a LocalTalk network anywhere near that size.

When Macs Get Mixed

Where extended addressing shines is on LANs that mix Macs and PCs, as more and more do these days. If you've got an existing large PC network, it probably includes many smaller LANs that are in turn bridged to form one overall network. Extended addressing lets Mac LANs slide right into such bridged environments.

This assumes that those bridged environments are running on Ethernet.

(Sure, some PC LocalTalk LANs exist, but because of LocalTalk's inherent limits, there are no big ones.) That still leaves one of the most important PC LAN underlying network protocols, Token Ring, inaccessible to Macs.

Not to worry. If you have a Token Ring LAN, AppleTalk Phase 2 will help you, too. Phase 2 includes a Token Ring card, the TokenTalk NB (for NuBus). This 32-bit Mac II network adapter costs a hefty \$1250, but that includes an intelligent card with its own 68000 and memory, as well as ample support software. (The on-board processor keeps network overhead from bogging down the host Mac, while the memory lets much of the accompanying TokenTalk software reside on the card.) The card's biggest drawback is that it supports only the 4-megabit-per-second Token Ring, and not the emerging 16-Mbps standard.

As with so many Apple hardware products, much of this adapter's value lies in the software that comes with it. At its lowest levels, the TokenTalk software provides the same interface to higher-level AppleTalk protocols that EtherTalk does for Ethernet, and LocalTalk for

Apple's own cabling. This Open Systems Interconnection (OSI) type of separation of levels buys you exactly what it was designed to do: You can run all the usual AppleTalk higher-level software, such as AFP (the AppleTalk Filing Protocol), on Token Ring.

That ability is important for two reasons. First, organizations with a big commitment to Token Ring now can use the same network and cabling for Macs as they do for PCs. And Macs and PCs can coexist on such networks.

AppleTalk Phase 2 also lets Macs on Token Ring networks do more than just use AppleTalk to communicate with other AppleTalk systems. More than one protocol stack can run on a single TokenTalk NB card simultaneously. Thus, a Mac can also use 3270 terminal protocols over a Token Ring network to communicate with a mainframe.

Also, a new Phase 2 program that comes with the TokenTalk NB card, the SMB (Server Message Block) file transfer utility, lets Token Ring Macs and PCs exchange files. This utility is based on the same SMB protocol that IBM's PC

continued

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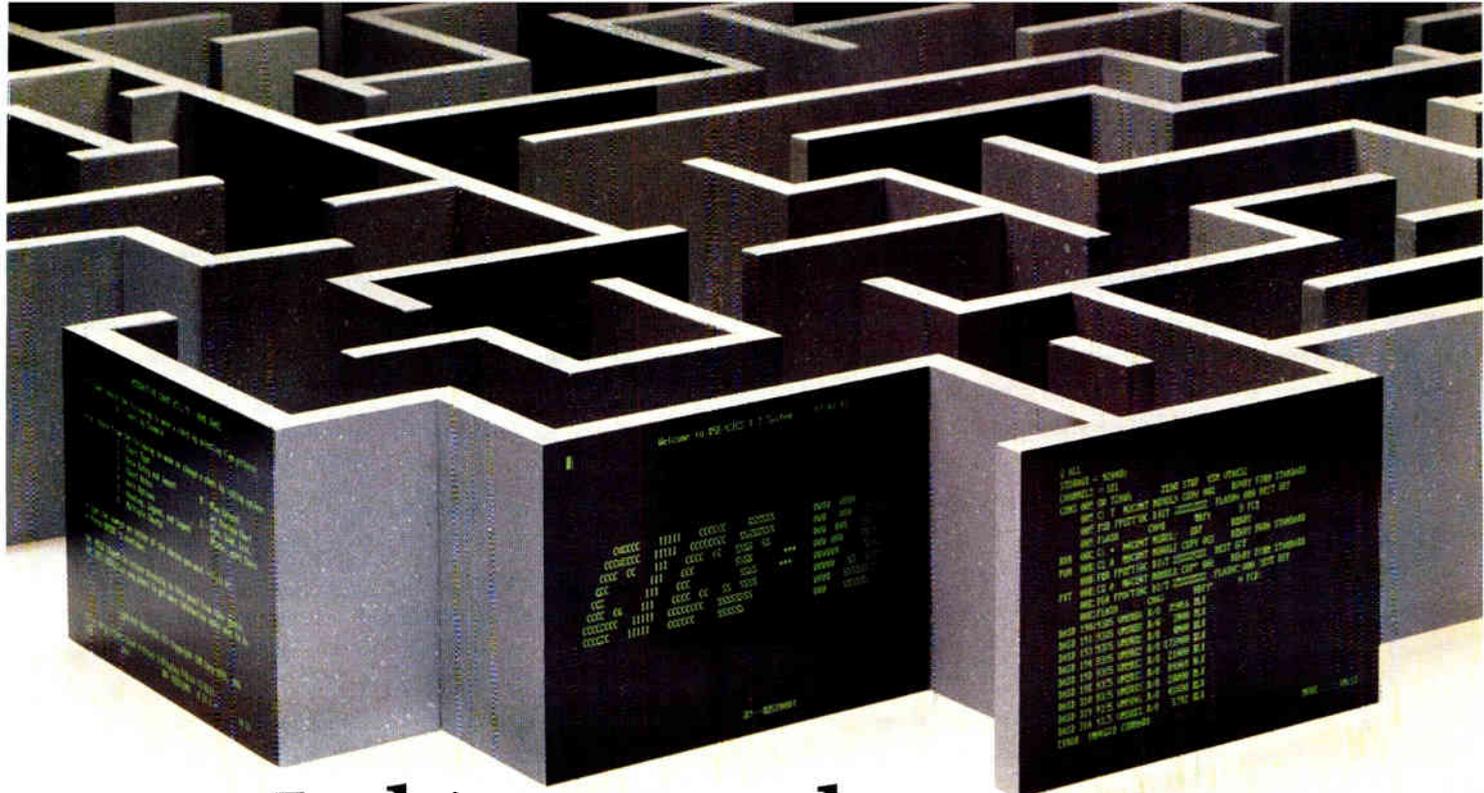
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LAN and the LAN Manager use. It mirrors the entire IBM protocol stack, including the NETBIOS Extended User Interface (NETBEUI).

The SMB file transfer utility has two main limitations. First, it can communicate only with IBM's NETBEUI protocol stack. This restriction shouldn't be much of a problem, however, because IBM is still by far the dominant Token Ring supplier.

The more important limit is implied by the utility's name: It supports file transfers, not file sharing. To exchange files with a PC, you must enter the utility and mount an SMB file system. Then that utility lets you move files to or from PCs on the Token Ring. Want to work on a PC Microsoft Word file? You have to transfer it to the Mac first. That's a shame, because it would clearly be better if PCs and Macs could operate together more readily and simply.

To its credit, however, Apple has some good reasons for not providing such features here. Chief among them is the requirement that Macs be able to communicate with standard SMB servers. Those servers know nothing of the Mac's un-

usual file system, with its resource forks, desktop information, and other special features. Without that knowledge, an SMB server can't let a Mac application run on it directly.

Apple does offer one way for Token Ring Macs and PCs to operate together: The PCs can run AppleTalk. One of the Phase 2 products, AppleShare PC, lets PCs act as AFP clients over Token Ring, Ethernet, LocalTalk, or any combination of board and driver that supports Novell's Open Link Interface. When you buy this new version of AppleShare PC, you get support for 3Com's Ethernet cards, IBM's Token Ring adapters, DayStar Digital's Micro Channel LocalTalk boards, and Apple's own LocalTalk.

The Big Picture

We've talked so far about what AppleTalk Phase 2 can mean to you on a strictly operational level. Phase 2 also indicates some strategic directions for Apple that are important for long-range LAN planning.

Apple clearly seems to have relegated LocalTalk to the low end. Although the firm still could try to speed up Local-

Talk, it seems content to leave LocalTalk in the realm of small networks, which the protocol often serves well.

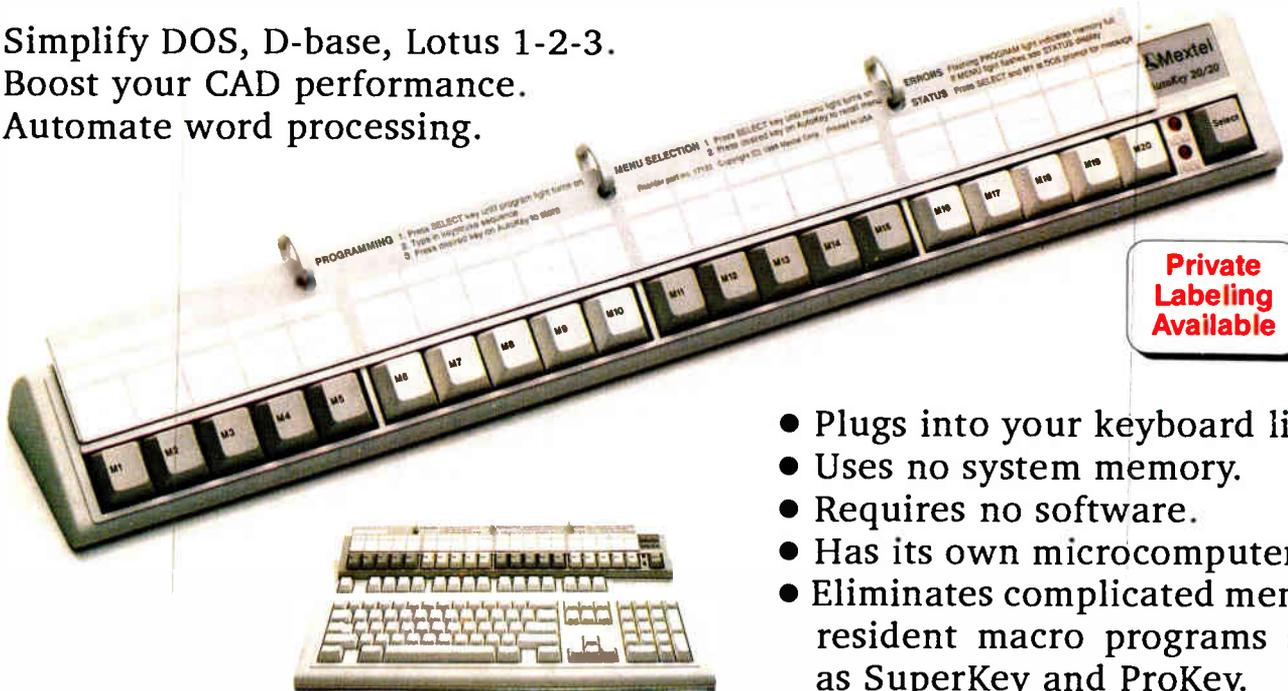
Apple's emphasis instead seems to be on the high end, but not just on the high end of Mac-only LANs. Two years ago, Apple announced a relationship with Digital Equipment, thereby accepting VAXes into the Mac networking universe. The Token Ring components of AppleTalk Phase 2, along with Apple's earlier 3270 options, signaled Apple's desire to link Macs with IBM mainframes. AppleTalk Phase 2 now clearly shows that Apple has also accepted the world of PC LANs as an environment in which Macs must be able to work. That's good news for all of us. ■

Mark L. Van Name and Bill Catchings are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "mvannname" and "wbc3," respectively.

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Recently, Dr. Pournelle looked at Northgate's 80386 Pipeline Page Mode system and reported in *BYTE* July, 1989 (excerpted):

*Jerry Pournelle holds a doctorate in psychology and is a writer who also earns a comfortable living writing about computers present and future.



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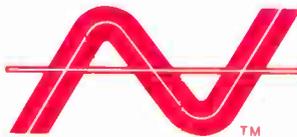
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Just What the Hard Disk Doctor Ordered

Protect against data loss and optimize your hard disk with these utilities

Stan Wszola,
Howard Eglowstein,
and Tom Thompson

It's not *if* your hard disk will have problems, it's *when*. Every hard disk will eventually break down or die. And although nothing can stop the deterioration of your hardware, some hard disk utility programs can act as insurance against sudden failure.

Why Good Hard Disks Go Bad

The great killers of hard disks include operator errors, physical abuse, excessive heat, voltage spikes, and brownouts. Another common problem is mechanical component failure. Hard disk platters, drive motors, and read/write heads are precision components, and they need to work together in a precisely controlled manner to write and read your data.

A spindle mounted on sealed precision bearings supports the platter, which the drive motor spins at 3600 rpm. With time, the bearings wear out. Some bearings may wear out prematurely because the drive is improperly mounted on its side.

The worn bearings can cause the disk platters to wobble slightly. Each revolution of the platter can vary the distance between the disk surface and the disk heads. The heads float on a cushion of air that ranges from one ten-millionth of an inch to one twenty-five-millionth of an inch above the disk surface. Because the head-to-disk surface distance varies, some data might not be properly re-

corded on the disk surface.

Head-positioning assemblies, especially on drives that use stepper motors and positioning bands, can become worn or fall out of alignment. The heads may be positioned to either side of the track. Ultimately, the heads may not be able to read the tracks at all.

Running your drive hot can also prematurely age both the mechanical and electronic components. Blocking the exhaust vents by pushing the computer flush up against a wall, resting monitors on top of vents, and taping paper notes and memos over the air intake of your computer can raise the internal temperature to dangerously high levels.

Occasionally, areas on the disk that had originally tested as acceptable begin to fail. Defects on the disk platters can grow larger, taking out more sectors (see figure). Your drive could even suffer a rare head crash; in this case, the read/write head comes into contact with the disk platter and damages the coating. The magnetic coating on a hard disk can begin to flake off. When the stray bits of material land on other parts of the platter or head, they can cause intermittent problems with your disk.

Even the daily use of a hard disk can take a toll on its performance. File fragmentation and cross-linked files cause extra work for the read/write head, and lost clusters can trip up a drive.

With time and use, the sectors on your hard disk may not exactly line up with the tracks. Wear and tear on the head-positioning assembly can cause sector data to be written over adjacent sectors. A low-level format will write new sectors and sector ID headers. It overwrites existing information on the hard disk, so there is no recovery from a low-level format.

Utilities such as SpinRite, Disk Technician, and SpeedStor can do a low-level format. They handle all the details, such as selecting the disk type, scanning for defects on the disk, and changing the sector interleaving.

File Recovery and Optimization

Programs that recover deleted files are the most widely used of all utilities. These programs, such as the Norton Utilities' Quick Unerase or Deluxe 1stAid Kit's Complete Undelete, will show you all the filenames that have been deleted. You select a file from the list, and the utility locates and reassembles the file's blocks.

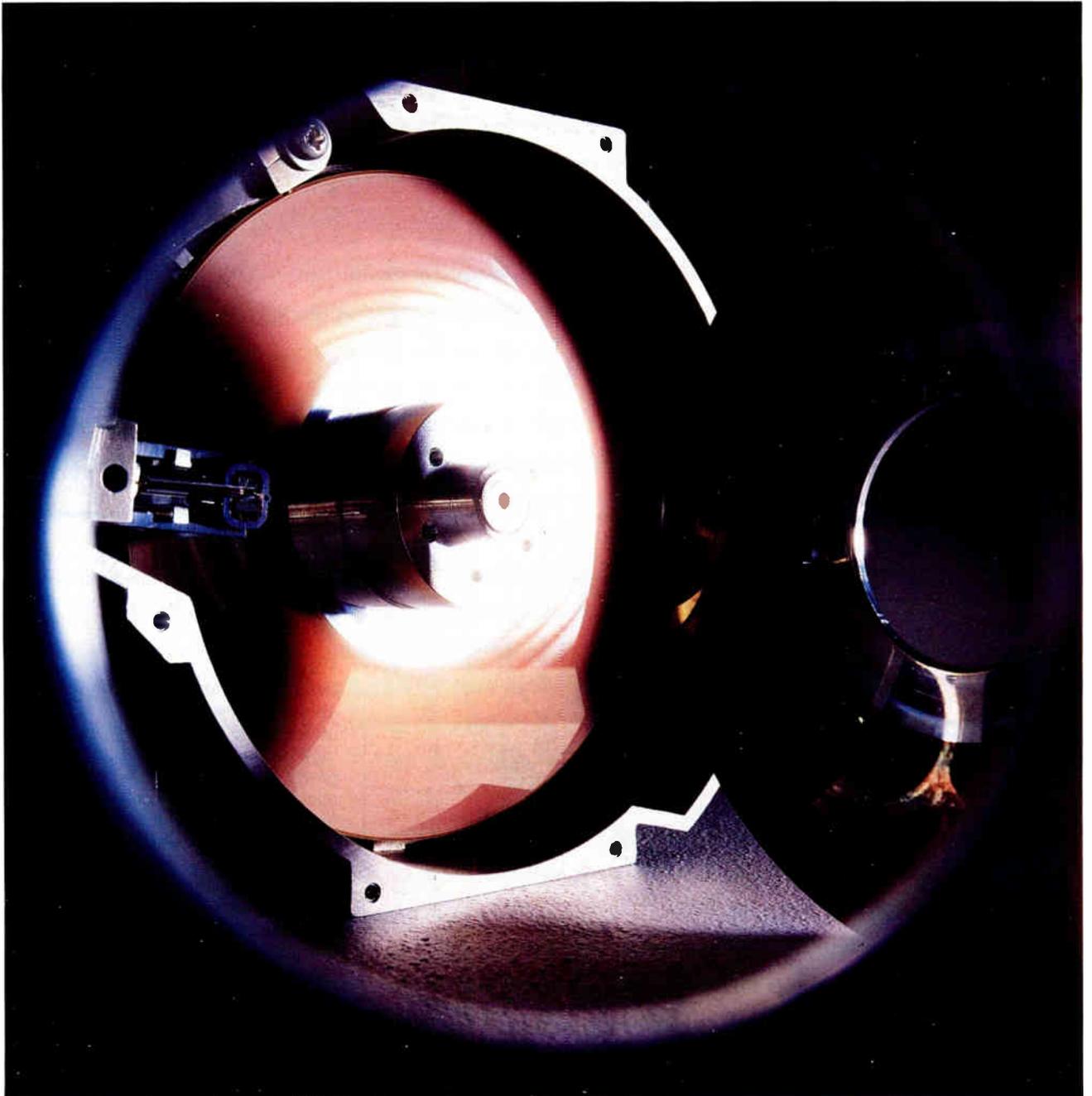
Of course, this works only if the directory entry has not been overwritten or if the sectors have not been reallocated to other files. In that case, you have to pull out a bigger gun and run a sector or cluster editor. The editor lets you examine the disk, manually select the sectors or cluster you want, and then incorporate them into a new file. This is a tedious process, akin to stringing pearls, but when a file is damaged, you may have no alternative.

Some utilities can help you recover from a formatted hard disk. Norton's Format Recover or SUM II's SUM Shield, for example, make a copy of the disk's directory tables. If you take advantage of such utilities, you can replace the erased information and bring your hard disk back to life.

With daily use, the files on your hard disk become fragmented—applications grow and shrink files. Parts of these files become scattered over the disk, reducing performance while the disk head travels all over the disk reading sectors. Operating systems have become smarter about allocating disk space, but with large files or almost-full disks, clusters are still allocated according to what space is available. The Macintosh Hierarchical File System (HFS) is efficient at allocating space, but over the course of time even those files that are frequently updated can become fragmented.

One of the easiest ways to increase the performance of your hard disk is to use a disk optimizer utility. Such a program will rearrange the sectors on your disk to

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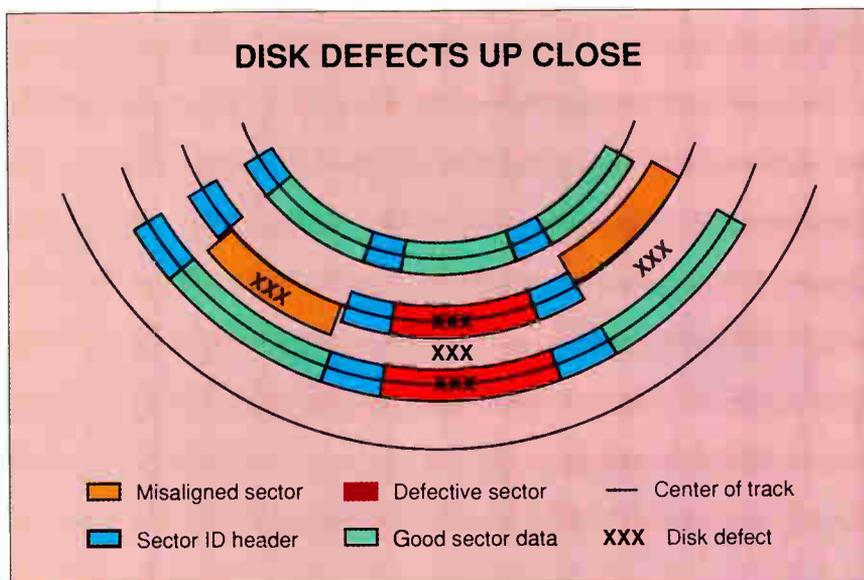
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Backup/restore	○	○	○	○	○	●	○	○
Caching	○	○	○	○	○	●	○	○
Change attributes	○	○	○	○	●	○	●	○
Change volume label	○	○	○	○	○	○	●	○
Compatible controller/ hard disk drive	E,M,R,S	M,R,S	M,R,S	M,R,S	E,M,R,S	E,M,R,S	E,M,R,S	E,M,R,S
Change interleave	●	○	●	●	○	○	○	●
Disk information	○	○	●	●	●	○	●	●
Directory sort	○	●	○	○	●	●	●	●
Disk image file	○	○	○	○	○	●	○	○
Encrypt/decrypt	○	●	○	○	○	○	○	○
Find file	○	●	○	○	○	●	●	○
File-read test	○	○	○	○	●	○	●	○
Format recover	○	●	○	○	○	●	●	○
Low-level format	●	○	●	●	○	○	○	●
Park heads	○	○	○	●	○	●	○	○
Password access	○	●	○	○	●	○	○	○
Safe format	○	○	○	○	○	●	●	○
Sector diagnostics	○	○	●	●	○	●	●	●
Sector editor	○	○	○	○	●	●	●	○
Undelete file	○	●	○	○	●	●	●	○
Unfragment disk	○	●	○	○	●	●	●	●
Wipe disk	○	○	○	○	○	○	●	○
Wipe file	○	●	○	○	○	○	●	○

●=yes ○=no E=ESDI M=modified-frequency-modulation encoding R=run-length-limited encoding S=SCSI



A disk can have defects caused by a misaligned data sector, a faulty data sector, or faulty media, as illustrated here.

reduce the read/write head travel. To maintain top performance, it's important that you run a disk optimizer at regular intervals.

Warning

Before you do anything to your hard disk, always make a backup copy first. Many utilities have built-in safety features, but they are also susceptible to brownouts, power failures, hardware problems, and operator errors. If you use any hard disk utility on a hard disk that has serious hardware problems, the results could be catastrophic. That's why it's so important to make a backup copy, verify it, and put your backup disks or tapes in a safe place.

Not every utility program will work with every type of drive, disk drive controller, operating system, or TSR program. Some hard disk drive manufacturers, such as Priam, explicitly warn against using utility software on their disks. And many utility programs don't

PC Tools Deluxe	SpeedStor	SpinRite II	Mac-compatible		
			Deluxe 1stAid Kit	PC Tools Deluxe for the Mac	SUM II
\$129	\$99	\$89	\$99.95	\$79	\$149.95
5.5	6.0.3	1.0	2.8	1.1	2.0
●	○	○	○	●	●
●	○	○	○	○	○
●	○	○	●	●	●
●	○	○	○	○	○
E,M,R,S	E,M,R,S	E,M,R	S	S	S
○	●	●	○	○	○
●	●	●	●	●	●
●	○	○	●	○	○
●	○	○	○	○	○
●	○	○	○	○	○
●	○	○	○	○	○
●	○	○	○	○	○
●	○	○	○	○	○
●	○	○	○	○	○
●	○	○	○	○	○
○	○	○	●	○	●
○	○	○	●	○	●

If
*Disk Technician's
database shows that
a given location suffers
from chronic misreads,
it will copy the data
to known good clusters.*

DT directly addresses the hard disk system and does an intensive, non-destructive read and write of all the sectors on the disk while monitoring the drive and controller board. There are four different levels of tests: *hyperspeed* is a quick check of DOS partition; *track integrity* uses read and write pattern tests; *total media* is an exhaustive read and write test; and *seek* performs a variety of head-seek tests.

If DT encounters a single misread, it makes note of the sector/cluster location in its database file. If it encounters multiple misreads, it copies the data, track, and sector-header information into RAM, performs a single-track low-level format, and then rewrites the data to the track and notes the location of the faulty sector or cluster in the database. If DT's database shows that a particular location suffers from chronic misreads, it will copy the data to known good clusters and mark the faulty sectors as bad.

DT is ideal for testing heavily used hard disks and drives in harsh environments. It's also well suited to nursing disks with known defects.

function with translating or caching controller cards. To avoid possible conflicts, you should avoid running a utility program with TSR software in RAM.

Even the version of DOS that you use can have an effect. The PC utilities that we tested are designed to work with DOS 2.x through 4.x, but only if standard partitions are used. However, you can create partitions larger than 32 megabytes with DOS 4.x. Standard partitions use 16-bit sector numbers; extended partitions use 32-bit sector numbers. This can cause compatibility problems with any utilities that access the file allocation table (FAT) and use 16-bit numbers.

We tested 14 packages in the BYTE Lab. For the PC-oriented products, we used an 80286-based PC compatible and an expendable 10-megabyte hard disk drive with a standard modified frequency modulation controller. For the Macintosh products, we used a Mac IIci and an 80-megabyte SCSI hard disk drive.

Disk Technician Advanced and Disk Technician Pro

Disk Technician (DT) comes in two versions: The Advanced version runs automatically, and the Pro version offers full manual control over the testing procedures. Both versions, however, perform the same tests.

DT examines the system area, verifies the FAT and directory area, and tests sector timing to check that the controller board is reporting the correct number of sectors per track. It also determines the optimum interleave factor for the hard disk system.

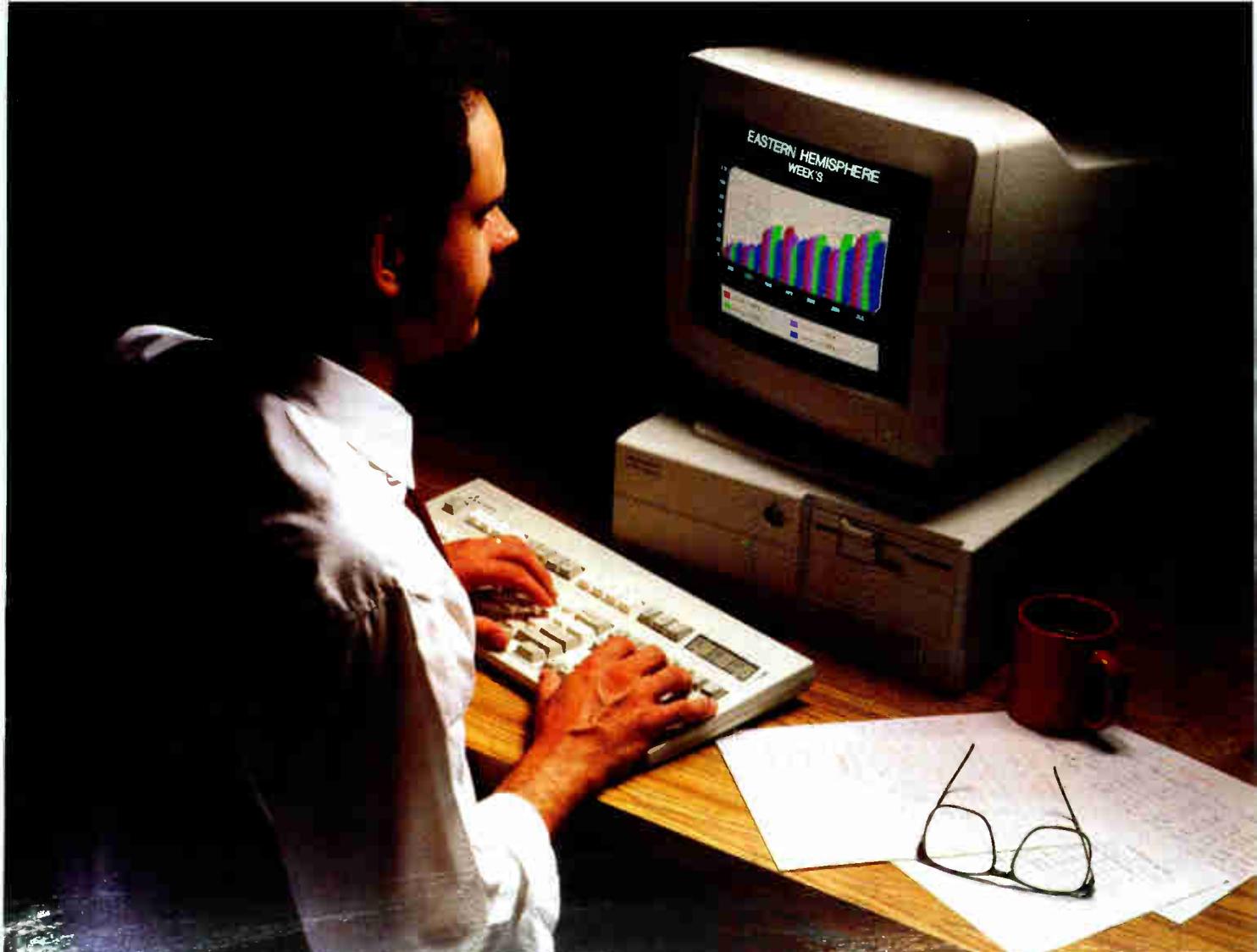
DT also maintains a "historical" database on your drive. The DT software examines that history and looks for patterns of failure. You have the option of clearing and resetting the database if you think that DT is too thorough or if you want to use your work copy of DT on another computer.

DOS Rx

DOS Rx is a dual-purpose package. Half of it, the RRx program, is a TSR DOS shell. The other half, the Rx program, displays and changes file attributes; locks out files, subdirectories, or your entire system with password protection for one or multiple users; recovers deleted files; and edits any sector on your disk in hexadecimal or ASCII formats.

Rx uses a menu bar and drop-down menu windows. You can select commands and options by moving a cursor

continued



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Circle 219 on Reader Service Card (DEALERS: 220)

Norton Utilities Advanced

The core of this package is NU.EXE. It lets you explore any area of the disk, edit the disk data in a variety of formats (e.g., hexadecimal, ASCII, directory, FAT, and partition table), display technical information about the disk and its files, search for lost data, and recover lost data and files.

The most widely used feature is, of course, UnErase for file recovery. UnErase allows you to automatically select all of a file's clusters, or to manually select clusters or a range of clusters to be saved into a file.

You can use the Explore Disk command to view and edit every file, cluster, and sector on the disk. This gives you complete control over what's on the disk. This control even extends to the possible modification of the FAT, directory, and partition tables, the most important parts of your disk.

You can use QU.EXE, which stands for Quick UnErase, to automatically recover an erased file. All you need to supply is the filename or file extension for a group of files.

The Norton Disk Doctor automatically diagnoses and corrects a variety of problems. It performs several tests on the FAT, the boot record, and each data sector. If any errors are found, NDD presents an error message, asks if you wish to correct the error, and makes the repairs. It also tests each sector. If a faulty sector is not in use, it is marked as bad. If the faulty sector contains data, the file containing the faulty sector is moved to known good clusters, and NDD marks the faulty sector as bad.

Speed Disk (SD) is a file optimizer program. It physically relocates files toward the outer edge of the disk platters to minimize the time that's required for the read/write head to locate data on the disk.

You can configure SD for a particular file layout arrangement and optimization method. The optimization methods you can choose from include complete optimization (based on your specifications for sort order of subdirectories and files) and file unfragmenting (to concatenate contiguous sectors). You can also optimize subdirectories or select a simple "quick compress" that moves data to fill any gaps on the disks, leaving the remaining space free and uncluttered.

The Norton Utilities is the granddaddy of all hard disk utilities. Despite its longevity, however, the package has not remained static. The selection of programs

has changed and been improved. The Norton Utilities remains the de facto standard of hard disk utilities.

OPTune

Gazelle Systems' OPTune offers both low-level formatting and disk optimization in one package. The optimization routines let you arrange your files so that they are contiguous or set these contiguous files so that they lie end to end. The Packed option forces OPTune to put all files from a given directory together. OPTune's optimizer also lets you sort the directories by name, extension, and date.

The software is easy to use and install, but the manual is sometimes vague and hard to follow.

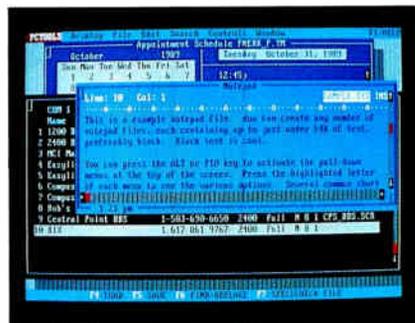
Tune-Disk is OPTune's low-level formatter. It fits nicely in the class of non-destructive formatters, like Gibson's SpinRite. Tune-Disk ran fine on our ITT Xtra, but it refused to run on disk controllers that perform disk caching. It worked fine on a standard Western Digital 1003, but it refused to run with a clone of the WD 1006 1-to-1 controller.

If you choose to buy OPTune for the disk optimizer, you can always use another low-level formatter. SpinRite has the same aversion to caching controllers, but it's not quite so finicky. If you can run Tune-Disk, you'll enjoy the Safe formatting mode. Tune-Disk can use a floppy disk to store track information before it reformats the hard disk drive. If you lose power, Tune-Disk can restore the lost data from the floppy disk. It's a handy feature that we haven't seen anywhere else.

Despite
its longevity,
the Norton Utilities has
not remained static.
The selection of programs
in the package
has changed and
been improved.

PC Tools Deluxe

Provides a handy collection of data recovery utilities and a DOS shell.



This package attempts to cover all aspects of your computer use, from telecommunications to file recovery.

Compress is the PC Tools disk-optimization utility. When you run it, it displays the contents of the selected disk as a series of colored blocks, in much the same way as the other optimizers. There are lots of options that contribute to a cluttered screen. After Compress analyzes your drive, it decides whether the drive needs optimization. When you tell it to start, the colored blocks turn into Ws, Rs, and diamonds that dance around the screen.

PC Tools' impressive show would be more useful if there were a legend on the screen. After using the product, we were satisfied that it works well, but other packages do a better job of displaying meaningful status information.

The Mirror program protects you from accidental file loss by keeping a hidden copy of the directory and the FAT. If you should happen to lose the directory, the Rebuild program can use the information that Mirror hid to reconstruct the directory. The disk will come back with the information that it had when you last ran Mirror. Central Point recommends that you run Mirror at least once per day. The standard installation puts Mirror in your AUTOEXEC.BAT file. Mirror also makes it easier to perform full file restoration with Undelete by noting the name and cluster allocation of any file before it gets deleted.

Rebuild is the companion program that uses Mirror's information to reconstruct disk images. It can even unformat a hard disk, provided that you formatted it with PC Tools' PCformat. Running from a floppy disk, Rebuild can use the Mirror file to rebuild the directory, FAT, and partition information.

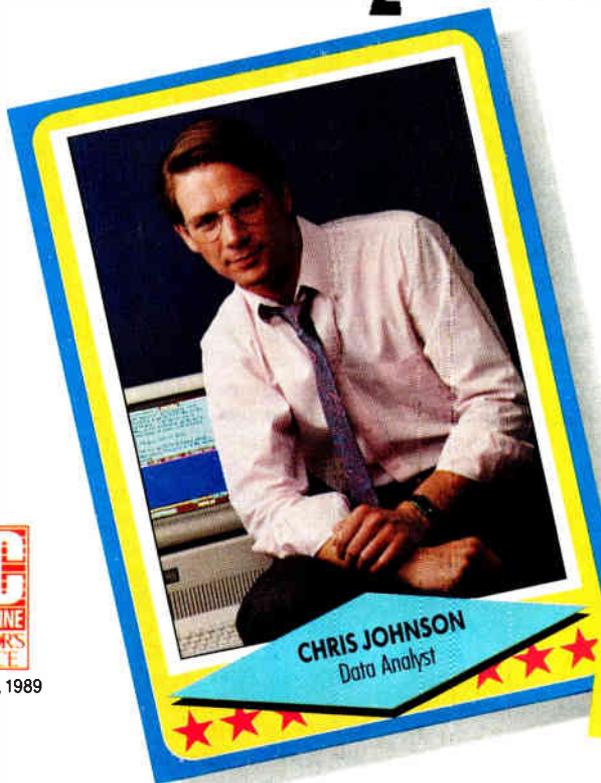
PCbackup may be one of the best

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March 14, 1989



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backup programs we've seen in some time. You can selectively choose which files and subdirectories to back up. Optional compression lets you optimize the backup by time or by the number of disks. PCbackup automatically formats the floppy disks and verifies each write.

PC Tools is a rich package. Most of the included software is easy to use, supports a mouse, and works well. The manuals are clear and thorough, often to the point of being wordy. It would be nice, though, if the disk-optimization utility had a friendlier display and better explanation messages on-screen.

SpeedStor

Features include an extensive list of standard drive manufacturers for simplifying hard disk installations.



SpeedStor simplifies the process of installing hard disk drives into your computer. It handles initializing, partitioning, and formatting the drive. It replaces FDISK and FORMAT.

SpeedStor simplifies the drive parameters. It uses an installation program and overrides your PC's drive type table. It prompts you for the number of drives you're installing. You select from a list of drive manufacturers and choose your drive model number from another list. To perform a low-level initialization, you enter the location of any bad tracks, specifying a head and cylinder number, from a list supplied with your drive. SpeedStor then asks if you want DOS partitions for your drive. It presents a list of options showing various configurations, depending on your drive's size. Finally, it performs the low-level initialization and error checking, partitions the disk as you have specified, performs a high-level format, and optionally copies the DOS system files on the disk. On 80286-based machines, it also updates the setup information in the CMOS.

You can specify up to 24 partitions on a single drive, create partitions as large as the drive capacity (larger than 32

megabytes with DOS 3.1 or higher), designate some partitions as read-only, and specify which partition will be booted when using multiple operating systems.

SpeedStor can also link multiple drives. You can span up to nine drives and make them one volume; the multiple physical drives become one logical drive.

If you are dealing with very large hard disk drives or custom configurations of multiple drives, SpeedStor should be the first software a new hard disk sees. It provides a comprehensive set of utilities for integrating almost any hard disk drive into your computer system.

SpinRite II

Among low-level formatters, SpinRite is something of a legend. It was an early leader in the field of nondestructive, low-level disk formatters. After analyzing your drive and system performance, SpinRite goes through a process of reading a full data track, doing a single-track low-level format, and rewriting the data. By changing the disk interleaving factor to the optimum one for your drive, SpinRite can also improve your system's performance radically.

The analysis locates sectors that have gone bad since the last format, as well as any good sectors that have been inadvertently marked bad. Also, by rewriting the entire track, SpinRite can correct any data "drift" (which is caused by gradual disk misalignment) that occurs as the data is read and rewritten. If the data drifts too far away from the head, read errors occur.

Running SpinRite frequently will help keep your data aligned with the drive head. As with any other low-level formatters, it's important to have your system powered up for an hour or two before running SpinRite. Hard disks have a tendency to change their alignment subtly as they warm up. If you were to run SpinRite on a cold drive, the data would be written in its "cold" location, possibly causing a misread as the drive warms up.

PC Tools Deluxe for the Macintosh

With PC Tools Deluxe for the Macintosh, Central Point Software has managed to cram a lot of utility onto a single disk. PC Tools gives you utilities that touch most aspects of file and disk management.

Fastcopy is the disk duplicator application. In addition to fast disk duplication, it gives you a way to "image" a disk before using the disk editor. The best thing is to make an image copy first and then try to recover data from the copy, lest you do further damage.

MacTools is a file-level system manager that makes it possible to modify file attributes, copy files, and much more. Used with the Mirror application, it lets you recover deleted files even after you've emptied them from the trash.

Mirror and Rebuild are companion packages that work together to protect your hard disk drive. Mirror works by keeping hidden copies of the directory, boot blocks, and B-trees on your hard drive. If your disk crashes, Rebuild can search the disk, find the information, and put the drive data back together. Naturally, the more recent the file, the better. Mirror will automatically update the file whenever you eject a disk or use Shut Down from the Finder. For the best security, you should run Mirror manually and use its "save to diskette" feature. If your hard disk gets totally mangled, Rebuild can work from a floppy disk.

Rebuild looks for the hidden file on your hard disk. If it can't find it, it romps through the disk and looks at each sector until it finds the hidden information. From there, Rebuild can piece your hard disk drive back together. When a file is deleted, Mirror catches an image of the sector chain and stuffs it away. You can delete a file and even empty the trash. Later, you launch MacTools and select UnDelete Files. MacTools looks at the sector chain to see if the file's sectors have been reallocated. If not, your file is put back together using Mirror's saved information.

PCbackup is one of the most versatile backup programs we've seen. You can back up an entire volume, selectively by folder or incrementally. Once you've selected the source volume and file/folders, PCbackup tells you how many floppy disks your backup requires. When you start inserting disks, PCbackup does the rest. It will let you store multiple backups on a single drive, a necessity if you're storing on tape or another hard disk drive.

The low-level utilities are Track Editor and Optimizer. Track Editor is part of the Fastcopy application. It lets you read any arbitrary sector off a disk, modify its contents, and write it back out. This is definitely not a program for the faint of heart. During a disk copy, you may encounter a bad sector or two. The Track

continued

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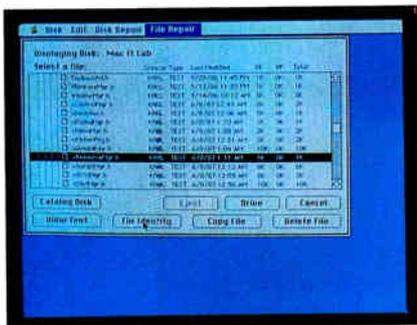
Editor gives you a way to read in the bad sector and correct it. You have to select the sector by number and make your modifications in hexadecimal format.

Optimizer does just what its name implies. For each file on the disk, it combines all the file's sectors into a contiguous string. You have four options: You can inspect the volume for sector errors, consolidate any fragmented files, erase any unused disk space, and do the erase three times. You should always do the volume inspection, because it tells you if any files contain unreadable blocks.

The file consolidation reorganizes the disk to make all the files contiguous chains of sectors. Erasing the unused sectors permanently removes any traces of data that might remain from erased files. Unless you do this, anyone with a sector editor can poke around on your drive and look at the contents of your erased files. If you click on this option, Optimizer writes a sector of zeros onto any unassigned sector. Optimizer is easy to use and has a nice status display.

Deluxe 1stAid Kit

The file repair facility lets you choose which file to repair from a menu screen.



The core of the 1stAid Kit is 1stAid HFS, a file and disk recovery application for the Macintosh, which comes with a comprehensive manual. The kit also comes with several utilities: Minor•Repairs, an application that purges a disk's Desktop file; Soft•Lock, a cdev that lets you "write-protect" hard disks via software control; and Cache•Flow, which is available either as a desk accessory or FKEY that ensures that the Mac's RAM disk cache is written out to disk.

We evaluated the Deluxe version, which includes two additional utilities. The first is Complete Undelete, a cdev that can recover recently deleted files. The second is Sector Collector, an application that identifies and isolates bad sectors on your hard disk. It does this with-

out forcing you to back up your files and perform a low-level format on the drive. 1stAid Kit has neither a disk optimizer nor a file-backup application; as its name implies, it's for use in salvaging files or hard disks.

One of the most effective tools that 1stAid Kit supplies is its manual. Nearly a third of it is dedicated to troubleshooting procedures and how the Mac manages files. It's exceptional in explaining those maddening error messages that you sometimes get before your file or hard disk crashes, and it then describes a step-by-step process by which you can determine the probable cause of the error and its remedy. This is the definitive operator's manual for the Macintosh, the one that Apple should have written.

The software is no slouch, either. With 1stAid HFS, you can modify the type, creator, and Finder attribute bits of a file. You can examine the file's data fork or resource fork and copy its contents to another file. The application can scan for and undelete files. A diagnostic function checks the integrity of the hard disk (by verifying the checksum associated with each sector), looks for damaged directories or files, and lets you copy files from a crashed drive. One nifty feature is that 1stAid can copy the boot blocks off a working floppy disk or hard disk and install them on an afflicted disk, making it bootable after a glitch has smashed this crucial portion of the disk.

The Complete Undelete cdev is the best file-recovery tool we've seen for the Mac. Like the SUM Shield, it makes an invisible •Delete-Log• file that keeps a record of the most recently deleted files. There's no special installation involved to create this log file. The number of files that Complete Undelete keeps track of is user-selectable.

Complete Undelete's big plus is that it keeps track of the unassigned sectors that make up each deleted file. The program keeps track of sectors that the Mac OS reuses. When you activate Complete Undelete, you get a list of the undeleted files, with check marks flagging those files whose sectors haven't yet been reused. This way you can tell which files have had their data compromised, and you can recover files that aren't compromised with confidence.

For those files that have lost some sectors, you get a brief summary of the percentage of data left intact. In this case, you can examine and copy the remaining data into another file if necessary. Complete Undelete won't recover a compromised application, since it is likely to crash—a well-thought-out feature.

SUM II

SUM II is a handy acronym for version 2.0 of Symantec's Utilities for the Macintosh. The package contains a set of diverse but useful utility applications for managing your Mac's hard disk. There are applications that handle partitioning a large hard disk (SUM Partition); reorganizing, or "defragmenting," its files (SUM TuneUp); and salvaging the data on a crashed hard disk (SUM Recover). There are also applications that safeguard your data by backing it up (SUM Backup) or encrypting it (SUM Encrypt). Finally, for those difficult cases, a catch-all SUM Tools application can edit data anywhere: in the resource or data fork of a file, in a block on a hard disk, or in a data structure in memory.

The core of SUM is the SUM Disk Clinic application, which serves as a shell to launch other SUM applications. It also queries you as to certain conditions regarding a crashed hard disk. It then launches SUM Recover and places you within the part of the application that's relevant to treating the problem. Disk Clinic also manages certain house-keeping chores.

SUM TuneUp is the package's disk optimizer. As TuneUp works, it provides animated icons that indicate what option is being performed, as well as a progress indicator. You select the drive to optimize and the level of file reorganization required. The two reorganization levels are defragment files, an operation that simply consolidates the file blocks; and optimize files, in which case files are both consolidated and shuffled about to provide the maximum amount of free space on the hard disk. You can select several options to be performed during this operation.

One option lets you verify the hard disk's files; another purges its free space (deallocated sectors on the drive are overwritten with zeros or random data to ensure that the information in these sectors can't be recovered). An additional option allows you to lock out bad disk sectors (this can prevent data loss as the hard disk ages, and it's normally done only during a low-level disk format). But there's no way to purge the Desktop file.

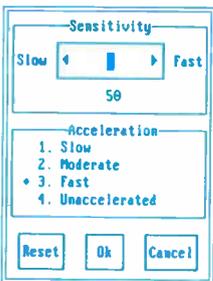
A SUM Shield cdev provides the first line of defense in hard disk crash recovery and accidental file deletion. It makes a copy of the hard disk's volume directory and stows it away as an invisible Volume Restore Record file elsewhere on the drive. Another invisible file, the Deleted

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Timeworks, Inc.
(DOS Rx)
444 Lake Cook Rd.
Deerfield, IL 60015
(312) 948-9202
Inquiry 1082.

File Record, keeps track of the last 50 files (the number is user-configurable) that were deleted and their locations on the hard disk. On a large drive, the VRR file can be quite large: 219K bytes on a 40-megabyte drive, and up to 2 megabytes on a 140-megabyte drive.

The most powerful of the utilities in SUM's arsenal is its Tools application. With Tools, you can edit both forks in a file, examine the contents of the disk drive on a block-by-block basis, modify boot blocks, and edit the Mac's memory. In the hands of technically competent MacFolk, Tools lets them probe into the nooks and crannies of the Mac operating system to isolate and patch problems that might otherwise be impossible to fix. If you have no idea what boot blocks or a drive queue structure is, then most of Tools' capabilities aren't for you. Developers, however, might want to invest in a copy of SUM II just to have access to the capabilities that Tools offers.

The SUM user's manual is decent, providing a brief overview of the hows and whys of disk optimization and the function of the Shield cdev. There's also a "panic section" (the pages are outlined in gray) that takes a novice user step-by-

step through the actions that are required to recover the hard disk.

The Last Sector

We're hard pressed to pick out the best hard disk utility software from this group. It all depends on what you want, what kind of hardware you have, and how hard you use it. Also, when picking a utility package, you'll need to take your own expertise into account—if you don't feel comfortable using the software, you probably shouldn't be using it.

For PCs and compatibles, we think that Central Point Software's PC Tools Deluxe is the best value. It offers practically every tool you'll need in one integrated package. For the Macintosh, we liked the Deluxe 1stAid Kit from 1stAid Software. It has a fine selection of tools and an excellent manual.

We also liked some of the smaller utility packages, such as Disk Optimizer, SpeedStor, and Disk Manager. Examine your needs, and get only the functions you require. Perhaps you need one sharp blade versus a Swiss army knife.

Two things are always true about hard disks: They're never big enough, and you never have too many backups. The regu-

lar use of disk optimizers and non-destructive formatters can also help by keeping your data and hard disk drive aligned properly.

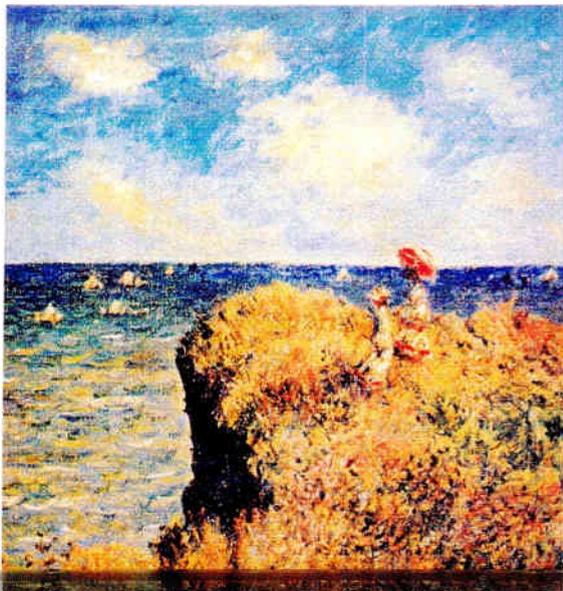
A hard disk utility can save your skin if you use it regularly. Normally, by the time most people realize they need a disk utility, it's too late! Set up a regular maintenance routine and stick to it. Optimizing your drive will give you the best performance, but if nothing else, get a good backup utility. To paraphrase St. Francis of Assisi, treat your hard disk well, for it bears you up. ■

BIBLIOGRAPHY

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Grehan, Rick. "Directory Assistance." *BYTE*, May and June 1989.
Norton, Peter, and Robert Jourdain. *The Hard Disk Companion*. Brady Books, 1988.

Stan Wszola and Howard Eglowstein are testing editors for the BYTE Lab; Tom Thompson is a BYTE senior technical editor at large. They can be reached on BIX as "stan," "heglowstein," and "tom-thompson," respectively.

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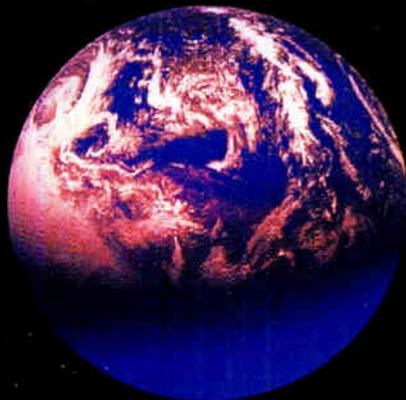
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Sizing Up the Cube

The long-awaited NeXT cube offers advanced features but only fair performance

Tom Thompson and Ben Smith

When announced in October 1988, the NeXT cube demonstrated state-of-the-art hardware that was a computer user's dream. The system's 25-MHz components and fast NuBus architecture set new standards for workstation design. Then came the delays.

The system hardware didn't start shipping until mid-1989. The finished ver-

sion of the operating system (1.0) didn't arrive until September 1989; the first NeXT owners had to make do with an extremely buggy version 0.9 of the software. We waited to test the cube with version 1.0. During this interval, however, the computing world didn't hold still: PC clone vendors introduced 33-MHz 80386- and 25-MHz 80486-based machines, and Apple debuted the Mac IIci, a 25-MHz 68030-based Macintosh. The performance gap, it would seem, has narrowed.

Still, the cube is an impressive machine. For raw processing power, it boasts a Motorola 68030 CPU, a 68882 FPU, and a DSP56001 digital signal processor chip (DSP) that can handle data acquisition and sound generation. Its four-slot NuBus, with twice the transfer rate of the Mac's bus, can accept three peripheral boards (the computer's motherboard occupies one slot).

The cube accepts up to 16 megabytes of RAM and includes a read/write magneto-optical drive that uses ejectable

256-megabyte cartridges. Its multitasking operating system, the Mach Unix kernel, serves as the backbone of the Workspace Manager, NeXT's proprietary windowing graphical user interface (GUI) that uses Display PostScript. You can write applications using NextStep, a collection of object-oriented programming (OOP) tools and class libraries. An Interface Builder application lets you quickly design the graphical front end to a program and establish message connections to your code. (For more information on NextStep, see "The Next Step," March 1989 BYTE.)

System Specifics

The NeXT Computer's system unit is a nearly featureless, flat, black cube 1 square foot in size. It comes with a 17-inch monochrome monitor, a keyboard, a two-button mouse, and cables. A single 256-megabyte optical cartridge contains the operating system and the applications software. The basic system includes 8

continued



NeXT Computer

Company

NeXT, Inc.
3475 Deer Creek Rd.
Palo Alto, CA 94304
(415) 424-0200

Components

Processor: 25-MHz Motorola 68030, 68882 FPU, and DSP56001 digital signal processor
Memory: 8 megabytes of 100-nanosecond DRAM in 1-megabyte SIMMs, expandable to 16 megabytes
Mass storage: Magneto-optical disk drive that accepts 256-megabyte ejectable cartridges; 40-megabyte hard disk drive; optional 330-megabyte SCSI hard disk drive or 660-megabyte SCSI hard disk drive
Display: 17-inch monochrome monitor with 1120- by 832-pixel screen
Keyboard: 84 keys with numeric keypad, cursor keys, and special function keys handling screen brightness, loudness, and system power
I/O interfaces: Two RS-232C/RS-422 serial ports with mini-DIN-8 connectors; thin Ethernet port; SCSI port with DB-25 connector; printer port with DB-9 connector for custom printer; video port with DB-19 connector for NeXT monitor; DSP processor port with DB-15 connector

Size

12 x 12 x 12 inches; 29 pounds

Price

Base system: \$9995
System as reviewed: \$17,185

Inquiry 855.

megabytes of RAM, and prices start at \$9995. The system that we reviewed included an optional 330-megabyte internal hard disk drive (\$3695) and an optional NeXT laser printer (\$3495). [Editor's note: *NeXT began shipping a 40-megabyte hard disk drive with the cube as we went to press. Unfortunately, we were unable to test the drive in time for this review.*]

The NeXT Computer has multimedia capabilities built in. You can use the DSP to acquire or send digitized compact disk-quality stereo sound through the cube's dedicated DSP port. Furthermore, the DSP can manipulate this information or generate synthesized sound via software. The monitor has left- and right-channel stereo jacks for analog sound output, a jack for stereo headphones, and a built-in microphone jack that can record sounds or voices.

The 400-dot-per-inch NeXT laser printer has no power switch; the cube turns the printer on as it boots. The printer operates like a QuickDraw printer on a Mac; the cube creates an image of a page in memory and then sends it as a bit stream to the printer. But don't worry about getting the jaggies that you'd normally see on SCSI printers with large text or complex graphics; Display PostScript renders the printer pages at a higher resolution than your typical laser printer. (For additional information on the cube, see "The NeXT Computer," November 1988 BYTE.)

Starting Out

Getting the cube set up and its software installed is as easy as setting up a Mac. Once you've put all the parts together, you press the power key on the keyboard. The cube emits a tone that indicates that the hardware has passed the boot-up self-test, and an animated icon appears on the screen prompting you to insert the optical cartridge. You slide the cartridge into the optical disk drive slot, and the drive pulls it inside just as a VCR accepts a videotape. The optical drive then chugs away for a few moments until the Workspace Manager appears on the screen.

Moving the software from the optical disk drive to the cube's hard disk drive is simply a matter of pointing and clicking to launch the BuildDisk application. The installation takes about an hour, because over 200 megabytes of software gets copied to the hard disk drive, directory structure and all. This software includes the Mach operating system and various Unix utilities, as well as the NextStep development software, which consists of an Objective-C compiler (actually a modified GNU C compiler), a debugger, NextStep class libraries, and an assembler and debugger for the DSP chip. Also bundled are SQL Server (from Sybase) and Allegro Common Lisp for creating industrial-strength applications.

Software for the typical user includes WriteNow, a word processor originally written for the Mac; Wolfram Research's Mathematica; the shareware packages T_EX and Metafont for preparing sophisticated technical documents; and Mail, NeXT's user-friendly Unix mail application that lets you attach either voice-mail or graphics to an electronic letter (the receiving system must be a cube to be able to reproduce the voice and graphics). Digital Webster is an on-line dictionary and thesaurus, and Digital Librarian is an on-line reference to the Unix manual and NeXT's technical reference manuals (that's right, the cube's technical manuals exist both as bound manuals and as WriteNow files on the system). The artistically inclined can summon up quotations from Shakespeare using the Digital Quotations application.

A Workspace Tour

After the cube starts up, it presents a window that asks for your log-on name and password. Once you've logged onto the system, it puts you inside the GUI provided by the Workspace Manager (see photo 1). This application functions like Macintosh's Finder. It presents objects on the screen in what's called a *Work-*

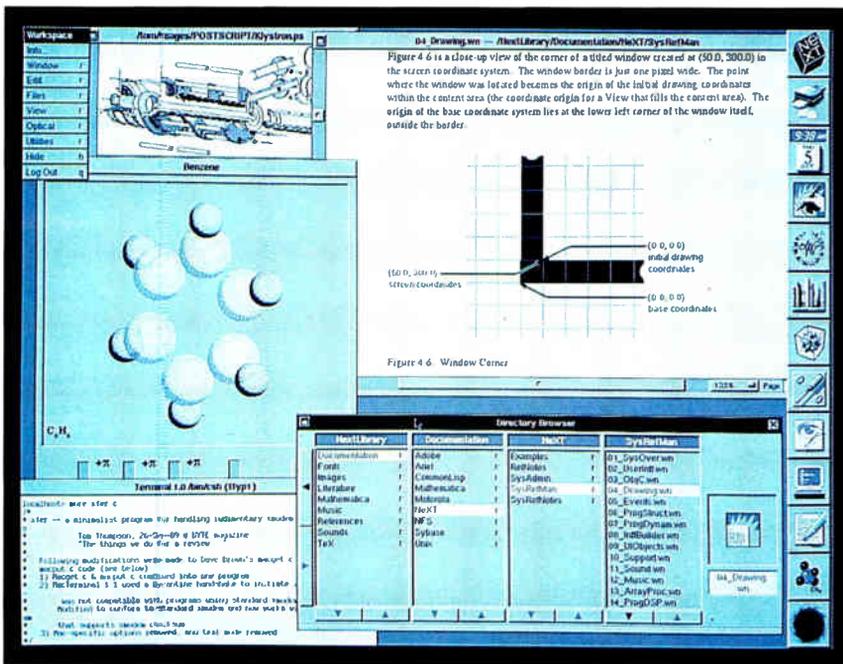


Photo 1: The NeXT Computer's Workspace Manager.



NeXT Computer

HIGH-LEVEL PERFORMANCE

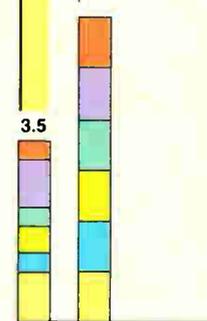
NeXT **3.5***

	NeXT		
	Time	Index	Everex
C Compiler	5.68	0.37	2.08
DC Arithmetic	0.65	0.97	0.63
Tower of Hanoi	1.63	0.34	0.56
<i>(17-disk problem)</i>			
System Loading¹			
1 concurrent background process	8.33	0.49	4.06
2 concurrent background processes	11.57	0.50	5.80
4 concurrent background processes	18.93	0.50	9.60
8 concurrent background processes	33.60	0.52	17.30

Everex Step 386/33
6.0

LOW-LEVEL PERFORMANCE

	NeXT		
	Time	Index	Everex
Dhrystone 2			
<i>(without registers; Dhry./sec.)</i>	5921	0.43	13487
Arithmetic			
<i>(10,000 iterations)</i>			
Arithmetic overhead	0.53	1.36	0.72
Register	6.83	0.43	2.92
Short	6.13	0.57	3.52
Integer	6.82	0.46	3.12
Long	6.82	0.46	3.12
Floating Point	13.02	0.92	11.92
Double	15.63	0.85	13.22
Throughput			
System call overhead <i>(5 x 400 calls)</i>	2.03	0.54	1.10
Pipe throughput <i>(read and write 2048 x 512 byte blocks)</i>	2.72	0.34	0.92
Pipe-based context switching <i>(2 x 500 switches)</i>	0.93	0.68	0.63
Process creation (100 forks)	2.22	0.55	1.23
Excel throughput (100 execs)	3.03	1.13	3.43



Note: All results are in seconds, unless otherwise specified. Indexes show relative performance. For all indexes, an Everex Step 386/33 running Xenix 2.3.1 = 1.

¹ System loading performed using Bourne shell scripts and Unix utilities.

* Cumulative index is formed by summing the indexed performance results for C Compiler, DC Arithmetic, Tower of Hanoi, System Loading (with 8 concurrent background processes), Dhrystone 2, and Floating Point tests.

- C Compiler
- DC Arithmetic
- Tower of Hanoi
- System Loading
- Dhrystone 2
- Floating Point

space, similar to the Mac's Desktop. Also like the Finder, the Workspace Manager helps you manage your files. You typically examine files through the Workspace Manager's directory browser window, which displays the files as three columns of text lists, with each column representing a subdirectory.

Double-clicking on a filename in the subdirectory column or on the file's icon launches the application that's associated with it. The software makes this association by examining the file's extension (e.g., .wn indicates a WriteNow file, and .ps is an Adobe PostScript file). There's no special file header information such as you find on the Mac.

Using the optical disk drive is quick and Mac-like. When you insert the optical cartridge, a dialog box appears, asking you if you want to mount the disk. Clicking on the OK button causes this action to proceed, and the disk's directories subsequently appear in the browser's directory window. To eject the disk, you select Unmount from the Workspace Manager's Optical menu.

Icons present on the Workspace normally represent application files or active applications. If an application icon has a small ellipsis (three small dots) in its lower left corner, the application is inactive, so at a glance you know what applications are running. You can park, or dock, up to 13 application icons at the right side of the Workspace. You place your most frequently used applications on this application dock so that you can get at them easily. You can also configure the Workspace Manager to automatically launch specific docked applications when you sign onto the system.

A running application can have windows and menus. Clicking on an application's window brings that window to the front. The previous application's menus disappear, and the menus for the application in the foreground window replace them. But since Mach is a multitasking operating system, applications whose windows are in the Workspace's background are still running. By way of contrast, in the Mac's MultiFinder, background applications get processing time only if nothing is happening in the foreground application.

NeXT as a Unix Machine

The NeXT operating system has a Jekyll-and-Hyde personality. The Workspace Manager GUI is its user-friendly side. A shell and a terminal application give you windows into the expert side, the standard Unix command-line interface. The fact that the cube puts you directly into

the Workspace Manager leads us to believe that NeXT would like you to forget that it's a Unix system. Most other Unix GUIs (with the possible exception of Sun's SunView) give you a Unix terminal console window as the default interface with the system.

NeXT gives you the option of having a terminal window, but it's not normally in the default set of docked applications. We can't blame the company for this decision. There are days when even the most experienced Unix user would just as soon *not* see a Unix shell prompt, nor have to deal with the 300 Unix commands and their command-line syntax. When the alternative is the Workspace

Manager, the decision is simple. This is the friendliest Unix interface ever.

Unix on the NeXT cube is an implementation of Berkeley release 4.3 using Mach as the underlying kernel. You'll find few, if any, of the usual System V additions that exist on either AIX (Unix from IBM) or Ultrix (Unix from DEC). The Bourne shell implementation is the atavistic BSD version. Of the 279 BSD commands and utilities that we checked, NeXT has implemented 214 of them and added 113. (This does not include system administrative commands.) It has replaced most of the missing utilities with newer methods that do the same job.

continued

System Performance

The NeXT cube has the powerful hardware that you'd find inside midrange Unix workstations, so we expected it to provide similar performance. It should easily handle a half-dozen users with hearty computing and I/O appetites. But the cube's overall performance when running BYTE's new Unix benchmark suite was far from dazzling.

The baseline machine for our benchmarks was an Everex Step 386/33 with an 80387 math coprocessor running Xenix 2.3.1. Projecting performance based on clock-speed differences (and ignoring the fact that the Everex and NeXT processors are completely different), you might expect the NeXT Computer to provide 75 percent of the Dhrystone and other arithmetic performance of the baseline machine. But with both machines running Unix in single-user mode, the NeXT Computer turned in a performance that was roughly 50 percent that of the Everex, even without the Workspace Manager's overhead. (Floating-point operations were significantly better.) The NeXT machine is not in the same performance class as any of the new low-priced engineering workstations.

Thanks to the design of the Mach operating system and its implementation on the NeXT machine, the cube showed reasonably good performance on Unix system calls, except for creating and using pipes. (But Mach has a better way to handle process communications than

pipes and semaphores; see "Mach: The Model for Future Unix," November 1989 BYTE.)

The lackluster pipe performance seemed to be in the shell implementation of pipes, as well. BYTE's shell script benchmark contains several pipes between processes (as well as tees and intermediate file I/O). The NeXT Computer's overall performance was only 50 percent that of the baseline machine. We compared the NeXT system to another 68030 machine, the HP 9000 Series 300 Model 370 with a 33-MHz CPU; the NeXT Computer offered about 65 percent of the Hewlett-Packard system's performance overall.

Another aspect of performance that doesn't show up in our benchmarks is user interaction. In other words, does the user have to wait on the computer? This is a more subjective evaluation of the system's performance. Application loading on the cube was slow, even with a hard disk drive. For example, when we brought up an X Window-based terminal window on the HP system, the delay was seldom more than 1 second. Opening a new terminal window on the NeXT Computer, however, took 7 seconds.

Once an application program was running, the screen and keyboard response time and mouse tracking were sufficiently fast for most work. But when we loaded the NeXT system with heavy background work, the delays became noticeable. The situation grows

worse for the system using only the optical disk drive: Its performance was roughly one-third to one-quarter that of the system with the hard disk drive—a performance that we found intolerable.

By today's standards, the NeXT cube's performance is not adequate for concurrent multiuser operation. It's decent as a single-user, multitasking workstation, but it's not fast enough with concurrent tasks to run more than one heavy-use application, such as Mathematica, at a time. Like the Macintosh, the system is heavily burdened with the requirements of the user interface and screen imaging model. By the time you add the overhead of the multitasking kernel, there's little performance headroom on the NeXT system.

These results explain more than what's going on in the cube, however. When you consider the cube's components, and that some of them are dedicated I/O processors handling the disk drive, the printer, and video direct memory access, it's no wonder that OS/2 with Presentation Manager hasn't a larger following, or that Apple decided to stick with MultiFinder for System 7.0 rather than implement a multitasking kernel. It's going to take very fast versions of today's processors (the 68030 or 80386), or the latest generation of processors (the 68040 or 80486), to provide a graphical-user-interface multitasking operating system that runs at the single-user rates that computer users have come to expect.

For program development, Pascal is missing, but there's GNU C and Allegro Common Lisp. The standard archive copy utility, `cpio`, is missing, but NextStep provides similar (and much easier to use) facilities through the Workspace Manager. The Unix source code control system (`sccs`) is missing, but the alternative, `rcs`, is there. As for typesetting utilities, you have everything including `nroff`, `troff`, `TEX`, and PostScript. You get it all.

Putting It to Work

The cube's monitor seems to hit just the right trade-off between a large display and manageable weight: You can easily view an entire page on the 94-dpi screen, but the monitor is light enough to jockey about if necessary. Although the display

supports only four colors (black, white, and two shades of gray), the intelligent use of these tones produces icons, windows, dialog boxes, and menus with a three-dimensional quality.

For the developer, NeXT includes several demonstration applications that show off the cube's capabilities. These include a score player that plays synthesized musical scores using the DSP, and a ring dynamics simulation that displays a ringed planet, its orbiting moon, and the effects of the moon's gravity on the planet's ring particles. We used several of these applications to load the system and evaluate its performance. We also ran the new BYTE Unix benchmarks under Mach in single-user mode (see the text box "System Performance" above).

The cube does well running several

small tasks concurrently. However, performance slows to a crawl if you run a large application like Mathematica or if you print a document (since the cube images each page in memory before sending it to the laser printer).

We stress-tested the Workspace Manager by running several applications simultaneously: the Saturn application, the score player, WriteNow printing a chapter from the NeXT technical manual, and a Unix terminal window. Activity slowed while the cube executed these applications. Because the DSP generates tones in real time, the tune playing got sloppy, but nothing crashed. The version 1.0 software seems robust and certainly has none of the printing, display, and other bugs that plagued the 0.9

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Medium of Exchange



Photo A
A 4-bit TIFF file created on a PC using a Hewlett-Packard ScanJet.



Photo B
The same TIFF file shown in photo A, displayed here on a Mac after converting to 8-bit TIFF and inverting the tones.

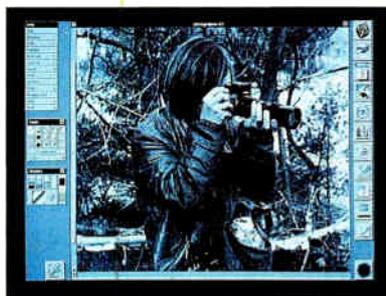


Photo C
The TIFF file sent to and displayed on the cube. As on the Mac, we had to invert the tones for the image to reproduce correctly.

One of the NeXT cube's strengths is that by making a fresh start on the operating system and interface, it avoids some of the myriad problems of attempting to remain compatible with past operating systems and file formats. But to perform useful work, the cube must work with data that comes from elsewhere—typically those computer systems it left behind.

If you can hook the cube into an Ethernet network, you'll have no problem getting the data you need. The cube supports Sun's Network File System, and its NetInfoManager application makes network hookup easy under the Workspace Manager. Typically, you can make a network connection with Unix only after editing a variety of administrative files. These files describe the system's users, its services, and the network protocols it supports. Each administrative file has a different format, making the computer's addition to a network a chore. NetInfoManager consolidates this information into a database with one uniform interface, and so reduces the difficulty of tying the cube into a network.

But if you've bought the cube with the hope of sharing information between it and PCs or Macs, things can get complicated. On the Workspace side of the system, there is no telecommunications package to support either Kermit or XMODEM protocol transfers. We edited Mach's ttys file so that we could log into its Unix side through its serial port as a VT100 terminal, and we used a Mac Plus running Red Ryder 10.3 and two modem cables as the VT100 terminal. We did this because one of the cube's serial ports is pin- and signal-compatible with the Mac's serial ports, and Red Ryder has a good VT100 terminal emulation.

That was the easy part. It turns out that there aren't any Kermit or umodem (XMODEM) programs on the Unix side, either. We could do ASCII trans-

fers easily enough by capturing text in Red Ryder or by having Unix redirect text sent from the Mac into a file. But moving large files or files containing binary data (such as TIFF files) requires a protocol transfer program. We finally cobbled together our own XMODEM program from some old C code with the GNU C compiler. With this, we were able to transfer data among Macs, PCs, and the cube (see photos A, B, and C).

Adobe Illustrator files made on either a PC or a Mac reproduced reliably on the cube; likewise, PostScript files on the cube were usable on the Mac and PC. Of course, Adobe makes the Illustrator program, but the fact that we could create the information on such dissimilar machines and have it work without modification on all of them is impressive. Because PostScript files are saved as ASCII text, we could move these files across systems using ASCII transfers alone.

The other image format that the cube uses extensively is TIFF. TIFF is designed to allow the exchange of images across different machines, but how well it works depends on whether the applications handle the TIFF specification in all its variations. For example, we were able to transfer TIFF files from the cube to the Mac, but Mac applications could read only the 8-bit TIFF files, not the 2-bit ones. We also used an Apple SCSI scanner to scan an image with 16 levels of gray into a 4-bit TIFF file, but we had to convert it to an 8-bit TIFF file before the image would reproduce correctly on the cube. A 4-bit TIFF image created on a PC using a Hewlett-Packard ScanJet also required some tinkering with the gray values before it would reproduce correctly on the cube.

Our efforts show that you can share information between the cube and other systems, but the experience may seem more like an experiment in rocket science than like modern computing.

software.

We were also able to exchange information among the cube, a Mac, and an IBM PC (see the text box "Medium of Exchange" above). It didn't take us long to enjoy the benefits of multitasking. While working on the XMODEM software, we were able to edit a C file in a Workspace Editor window, compile the

code in a Unix terminal window, and test the software on a Mac, logged on via the cube's serial port. The laser printer output was good, and you could print reliably from either Workspace applications or the Unix console window. The printer's 400-dpi resolution gives it an edge over typical 300-dpi laser printers in graphics reproduction.

As for real applications, there aren't many for the cube's Workspace Manager GUI right now, but that's due to change soon: Informix is porting its WingZ spreadsheet application, and other vendors have business and page-layout software planned. For those folks who prefer working from the command-line inter-

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Waiting for Software

So, is the NeXT Computer still a machine for the 1990s? In some ways, yes. While the amount of data we work with has grown, the ability to back up the 300-megabyte or larger hard disk drives that come with high-powered computer systems hasn't. Most of this job falls on third-party vendors, who charge a premium for their peripherals. The cube's optical disk drive provides an integrated solution to backups. And buying several 256-megabyte optical cartridges (\$99 each) isn't going to break your budget.

The built-in Ethernet port is also an integrated connectivity solution. Finally, the cube's multitasking comes from a real Unix kernel, not from the intricate gyrations that some DOS extenders or MultiFinder perform. The implementation of the Workspace Manager GUI is elegant and robust. Those who want color can only hope that NeXT will offer a NuBus color board in the future.

The situation is different when you consider the cube as a Unix system. Unix

users are ravenous consumers of computer resources, and as the benchmarks show, the cube doesn't make it as a multiuser Unix system. If it were two or three times faster and could handle heavier loads, many a Unix dragon would be lured from the rocky crags of Unix shell programming to the scenic shores of NeXT. The Mach kernel is designed to work in a multiprocessor environment, so it's possible that NeXT might boost performance by offering a NuBus coprocessor board. An easier fix would be to add more RAM. The cube's disk activity suggests that it's expending considerable effort page-swapping. Users with 12 or more megabytes of RAM have reported better performance. But in its present configuration, the cube performs adequately as a single-user system.

The NeXT Computer is an ideal developer's system: The version 1.0 operating system is stable, and NeXT bundles plenty of development tools with the system. NextStep's OOP environment promises a fast way to write event-driven code over the Mac and OS/2: Many of the objects in the NextStep class libraries are crafted to deal with user events. And the Interface

Builder application lets you design a visual interface—and test it—before hooking it into application code objects.

Since the cube uses Display PostScript for its imaging system, it's a natural for desktop publishing, but there's no software other than the WriteNow word processor available to exploit this capability. And as yet there's no easy way to get outside information into the system, unless you're tied into an Ethernet network. If you're interested in getting a multiuser system with a slick user interface, you'd best wait. As a single-user system, the cube resembles the Mac in its infancy: mediocre performance and a dearth of applications software, such as spreadsheets or page-layout applications. Perhaps, like the Mac's, the cube's performance will improve over time. As for the shortage of applications software, with the facilities of NextStep, that could change in another six months. ■

Tom Thompson is a BYTE senior technical editor at large. Ben Smith is a BYTE technical editor. You can reach them on BIX as "tom_thompson" and "ben-smith," respectively.

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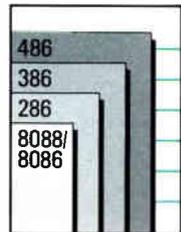
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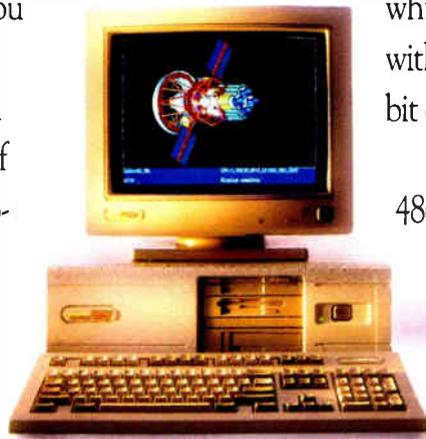


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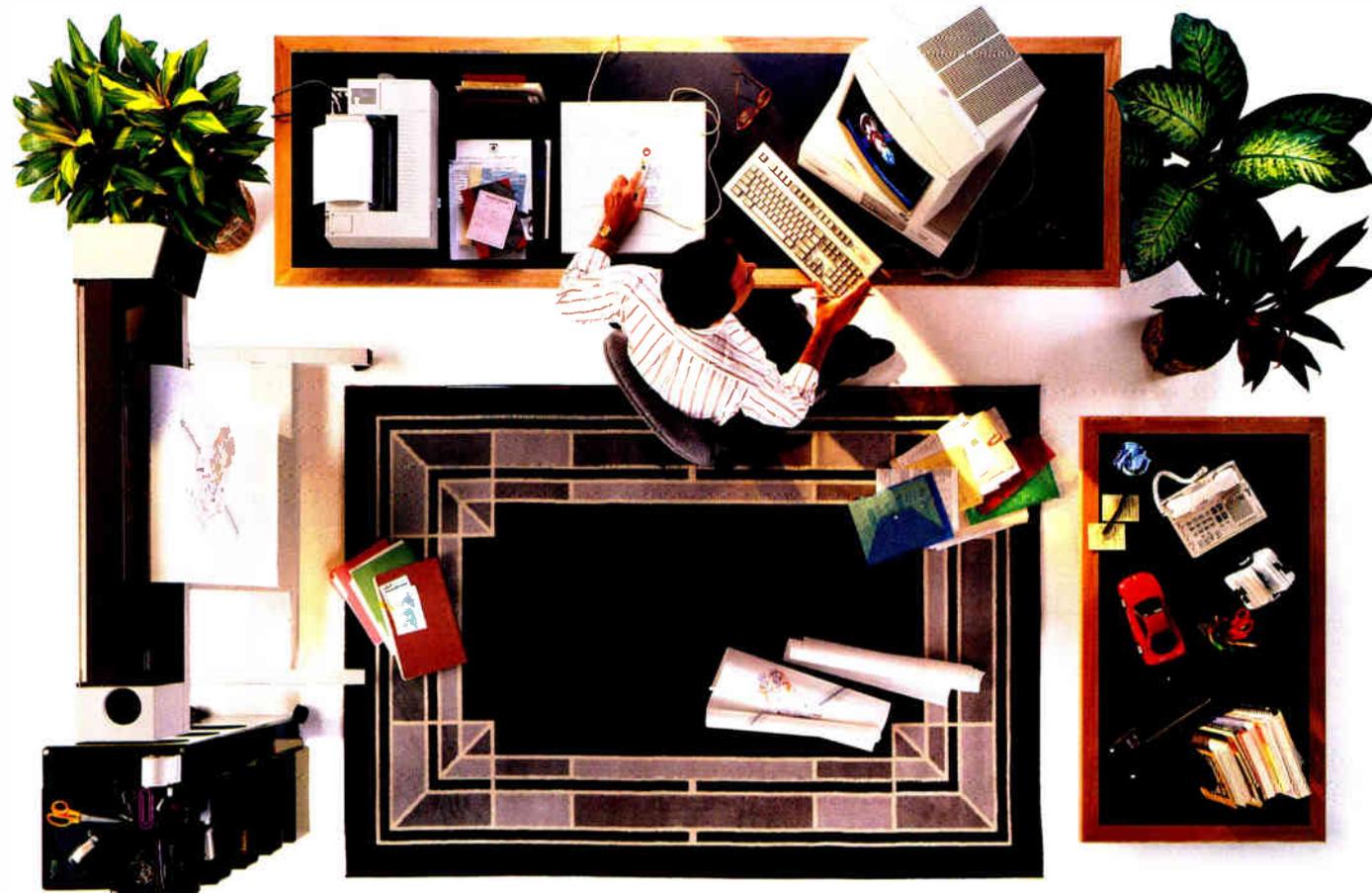
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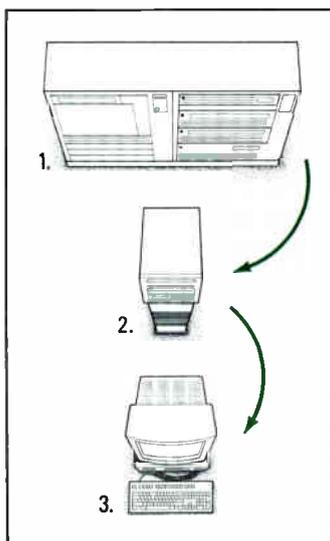
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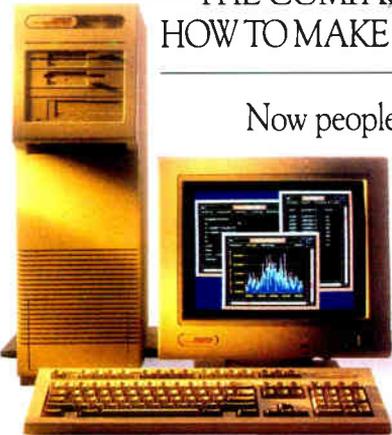
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Born to Travel

For computing en route, XT-class laptops from GRiD and Sharp offer all the features most travelers will need

Wayne Rash Jr.

Most laptop users use their machines only for word processing and communications. For these people, speed is great, but not overwhelmingly important. Rather, a good full-travel keyboard, a clear screen, and a convenient size and weight are primary. After all, it doesn't matter what processor you have if all you're going to use is XyWrite and Procomm Plus.

The extremely low end of the laptop market, populated by the Tandy Model 102, Toshiba T1000, and similar machines, is too basic for many people. The nonbacklit screens are hard to read, memory is limited, and a hard disk drive is usually not available. On the other hand, the big 80386 portables are more than most people are ever likely to need. They're power-hungry, bulky, and awkward to use on a plane.

For many users, the best fit is a machine like the Sharp PC-4600 series and the GRiD 140 XT. These IBM XT-class machines offer 8- to 10-MHz performance, supertwist backlit LCDs, 720K-byte 3½-inch floppy disk drives, a hard disk drive, and an optional internal modem. Prices range from about \$2750 to \$4000, depending on the configuration you choose.

While floppy disk drive versions are



The Sharp PC-4641 (left) and the GRiD 140 XT.

available, buying a hard disk drive makes sense, even for a relatively inexpensive laptop computer. Most software used by business travelers works properly only when run from a hard disk drive, and even those packages that work with floppy disk drives require frequent disk changes.

GRiD offers its 140 XT standard with a hard disk drive. Sharp offers a dual floppy disk drive version, the PC-4602, and a hard disk drive version, the PC-4641; I reviewed the latter. Both machines are aimed squarely at that portion of the market populated by the Zenith SupersPort and the Toshiba 1200 HB.

Sharp Specifications

There's no question that the people at Sharp investigated the laptop market

carefully before they designed their entry. The PC-4641 avoids most of the complaints leveled at computers in this class. Built around a 10-MHz NEC V40 CPU, it includes 640K bytes of RAM, a 720K-byte 3½-inch floppy disk drive, and a 40-megabyte (45-millisecond access time) hard disk drive that's twice as large as what the competition offers. The keyboard has a full numeric keypad (not an overlay), and the screen has the same aspect ratio as a standard monitor.

The machine is quiet, runs for up to 2½ hours on lead-acid batteries, and is reasonably priced (\$3595). My test machine also came with an internal 2400-bps modem (\$449). Other options include a 768K-byte EPROM card (\$49), an external 360K-byte 5¼-inch floppy

continued

Sharp PC-4641

Company

Sharp Electronics Corp.
Sharp Plaza
Mahwah, NJ 07430
(201) 529-9500

Components

Processor: 10-MHz NEC V40
Memory: 640K bytes
Mass storage: 40-megabyte (45-ms) hard disk drive; 720K-byte 3½-inch floppy disk drive
Display: 640- by 400-pixel CGA supertwist electroluminescent backlit LCD
Keyboard: 90-key IBM PC-compatible
I/O interfaces: 25-pin parallel port; 9-pin serial port; 9-pin CGA video port; 25-pin floppy disk drive interface; external bus port

Size

12¼ × 13⅞ × 3½ inches;
13½ pounds

Price

Base system: \$3595
System as reviewed: \$4044

Inquiry 862.

disk drive (\$499), a 1-megabyte EMS memory card (\$599), a serial interface card (\$99), a 1200-bps modem (\$399), and a carrying case (\$75). Extra batteries are \$49 each.

The PC-4641 is enclosed in a sleek black case that's about the same width and height as the Zenith SupersPort and about 1½ inches shorter. Folding the screen away from the keyboard reveals a supertwist, backlit, 25-row by 80-column LCD with a normal CRT aspect ratio. The screen is well lit, and the 640-by 400-pixel CGA/MDA display makes for crisp text.

The PC-4641's 90-key keyboard has a crisp tactile feedback. The numeric keypad is in the upper right corner. This location isn't as convenient as it might be, but it's a lot more convenient than the numeric keypad overlays on the GRiD and other laptops. Ten function keys sit on the upper left, and the Num Lock, Scroll Lock, Insert, and Delete keys are in the upper center of the keyboard. The arrow keys are in the lower right corner.

Directly in front of the screen's hinge is a panel containing the status lights for disk activity, low battery, and power. There's a Setup key next to the F1 key for the ROM-based setup program. (Both the PC-4641 and the GRiD 140 XT have

GRiD 140 XT

Company

GRiD Systems Corp.
47211 Lakeview Blvd.
P.O. Box 5003
Fremont, CA 94537
(800) 222-4743
(415) 656-4700

Components

Processor: 8-MHz NEC V20
Memory: 768K bytes
Mass storage: 20-megabyte (65-ms) hard disk drive; 720K-byte 3½-inch floppy disk drive
Display: 640- by 200-pixel CGA supertwist electroluminescent backlit LCD
Keyboard: 76-key IBM PC-compatible
I/O interfaces: 25-pin parallel port; 9-pin serial port; IBM Enhanced keyboard connector; 9-pin CGA video port; 37-pin floppy disk drive interface

Size

12½ × 14¼ × 3½ inches;
12½ pounds

Price

Base system: \$2750
System as reviewed: \$3050

Inquiry 863.

setup utilities located in ROM.)

On the right side of the PC-4641 is its floppy disk drive and power switch. Toward the keyboard on the same side are the brightness and contrast controls for the screen. These controls offer more of a range than those on other laptop computers I've tested.

The rear of the PC-4641 is devoid of the usual collection of communications ports and connectors. That way, if you set it down, you won't get dirt in the connectors. Instead, you'll get it into the fan. That's right, the fan. This is the first battery-powered laptop computer that I've reviewed that had a fan for the power supply.

The communications ports are on the left side of the computer. This seems to be convenient, and it means that you don't have to reach around to the back of the computer to plug in the printer. The PC-4641 also includes a serial port, an external bus port, and interfaces for an external monitor and an external floppy disk drive. The optional modem card includes a serial port; the connectors also plug into the left side of the computer.

My 2400-bps modem came separately. Sharp says the modem is user-installable, but I strongly advise against doing so. The instructions were intimidating

and required disassembling the computer. In contrast, modems for the 140 XT and most other laptops slide easily into the side of the machine.

A Sharp Performer

The speed of the PC-4641's NEC V40 processor shows up in the benchmarks. The PC-4641 is clearly faster than the 140 XT; the BYTE Lab didn't benchmark the Zenith SupersPort and Toshiba 1200 HB laptops, but these machines use a slower 9.54-MHz 8086 and 8-MHz 8088, respectively. The PC-4641 is about 20 percent faster than the GRiD laptop overall. This difference is noticeable, especially when loading WordPerfect 5.0 or reformatting text. Part of this speed advantage was also due to the PC-4641's 45-ms hard disk drive.

When you power up the Sharp, the machine moves through its diagnostics quickly and reports their results. The machine boots quickly from the hard disk drive. I attempted to run several application and communications programs, and I had no problems. For the most part, difficulty with IBM PC compatibility has become a thing of the past, and this seems to be the case here.

GRiD's Low End

The GRiD 140 XT is actually a repackaged Tandy 1400 LT. The single difference is cosmetic: GRiD changed the case color from tan to battleship gray.

The 140 XT isn't the fastest machine available. But it's less expensive at list price than the similarly configured Sharp PC-4641, the Zenith SupersPort, or the Toshiba 1200 HB.

The 140 XT uses an 8-MHz NEC V20 CPU and includes 768K bytes of RAM, 128K bytes of which you can configure as EMS memory or as a RAM disk. A blue, backlit, supertwist LCD supports CGA at a resolution of 640 by 200 pixels. But the 140 XT's screen doesn't preserve the normal aspect ratio of a CRT. The screen is shorter in height, but as a result it takes up less room. Interestingly enough, the 140 XT is slightly larger than the PC-4641 overall.

The 140 XT's smaller screen makes life a little easier if you use the computer while traveling. Although the length of the computer is important if you're in tight seating on an airliner, the size of the screen is critical when it comes to finding a comfortable viewing angle. The 140 XT's screen will adjust to any angle from straight up to completely flat, a much greater range than that available on the PC-4641.

continued

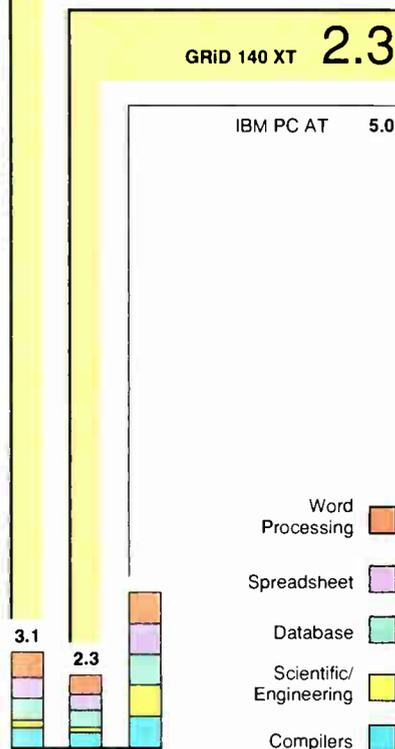


Sharp PC-4641, GRiD 140 XT

APPLICATION-LEVEL PERFORMANCE

Sharp PC-4641 **3.1***

WORD PROCESSING		Sharp	GRiD	DATABASE		Sharp	GRiD
XyWrite III+ 3.52	Med./Large		Med./Large	dBase III+ 1.1			
Load (large)	:24		:31	Copy	2:42	3:27	
Word count	:10/1:18		:13/1:41	Index	:29	:31	
Search/replace	:16/1:03		:19/1:22	List	2:59	4:50	
End of document	:05/:37		:06/:51	Append	4:42	7:14	
Block move	:27/:26		:29/:28	Delete	:07	:09	
Spelling check	:34/4:22		:44/5:38	Pack	3:14	4:02	
Microsoft Word 4.0				Count	:23	:26	
Forward delete	1:04		1:42	Sort	2:09	3:03	
Aldus PageMaker 1.0a				Index:	0.72	0.55	
Load document	:24		:39	SCIENTIFIC/ENGINEERING			
Change/bold	1:38		2:14	AutoCAD 2.52			
Align right	1:13		1:39	Load SoftWest	9:34	12:43	
Cut 10 pages	:50		1:25	Regen SoftWest	9:05	12:15	
Place graphic	:16		:23	Load StPauls	2:39	3:30	
Print to file	5:59		9:25	Regen StPauls	2:26	3:17	
Index:	0.82		0.61	Hide/redraw	1:59:27	2:36:49	
SPREADSHEET				STATA 1.5			
Lotus 1-2-3 2.01	Sharp		GRiD	Graphics	3:42	4:51	
Block copy	:14		:18	ANOVA	2:34	3:23	
Recalc	:06		:08	MathCAD 2.0			
Load Monte Carlo	1:01		1:23	IFS 800 pts.	5:13	6:47	
Recalc Monte Carlo	:28		:36	FFT/IFFT 1024 pts.	5:54	8:05	
Load rlarge3	:16		:25	Index:	0.24	0.18	
Recalc rlarge3	:05		:06	COMPILERS			
Recalc Goal-seek	:17		:20	Sharp		GRiD	
Microsoft Excel 2.0				Microsoft C 5.0	16:02	20:45	
Fill right	:20		:27	XLisp compile			
Undo fill	8:47		11:29	Turbo Pascal 4.0			
Recalc	:03		:04	Pascal S compile	:16	:22	
Load rlarge3	1:39		2:07	Index:	0.64	0.49	
Recalc rlarge3	:05		:07				
Index:	0.67		0.51				



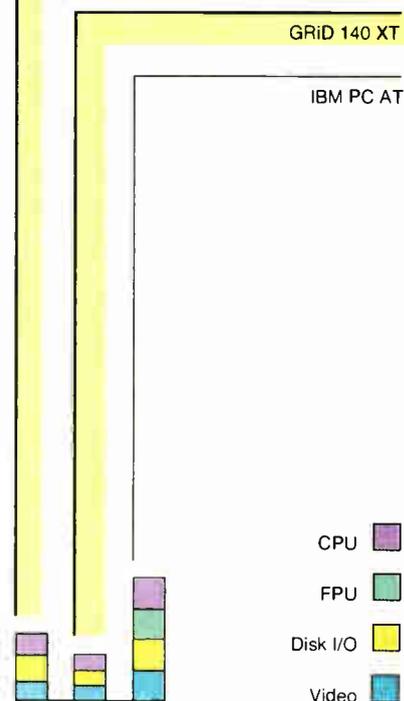
*Cumulative application index. Graphs are based on indexes at left and show relative performance.

All times are in hours:minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT = 1.

LOW-LEVEL PERFORMANCE¹

Sharp PC-4641

CPU		Sharp	GRiD	DISK I/O		Sharp	GRiD	VIDEO		Sharp	GRiD
Matrix		23.15	29.64	Hard Seek³				Text			
String Move				Outer track	4.57	8.96		Mode 0	15.56	23.60	
Byte-wide	83.27	105.73		Inner track	4.61	9.05		Mode 1	15.56	23.58	
Word-wide:				Half platter	13.84	19.35		Mode 2	15.34	22.21	
Odd-bnd.	83.27	105.73		Full platter	18.47	28.97		Mode 3	15.34	22.19	
Even-bnd.	83.25	105.73		Average	10.37	16.58		Mode 7	N/A	N/A	
Sieve	129.27	168.09		DOS Seek				Graphics			
Sort	108.06	139.27		1-sector	27.60	41.29		CGA:			
Index:	0.68	0.53		32-sector	53.86	117.29		Mode 4	8.85	11.59	
FLOATING POINT				File I/O⁴				Mode 5	8.88	11.59	
Math				Seek	0.51	0.74		Mode 6	9.27	12.11	
Error ²	N/A	N/A		Read	1.66	2.74		Mode 13	N/A	N/A	
Sine(x)	N/A	N/A		Write	1.67	2.88		Mode 14	N/A	N/A	
Error	N/A	N/A		1-megabyte				Mode 15	N/A	N/A	
e^x	N/A	N/A		Write	9.12	16.22		Mode 16	N/A	N/A	
Error	N/A	N/A		Read	7.17	13.82		VGA:			
Index:	N/A	N/A		Index:	0.83	0.49		Mode 18	N/A	N/A	
								Mode 19	N/A	N/A	
								Hercules	N/A	N/A	
								Index:	0.65	0.47	



N/A = Not applicable.

¹ All times are in seconds. Figures were generated using the 8088/8086 version (1.1) of Small-C.

² The errors for Floating Point indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.

³ Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).

⁴ Read and write times for File I/O are in seconds per 64K bytes.

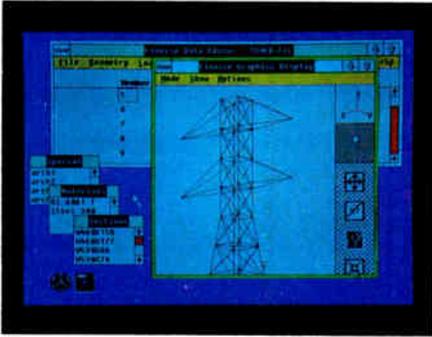
⁵ For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance.

CONVENTIONAL BENCHMARKS

	Sharp	GRiD
LINPACK	10242.83	13318.06
Livermore Loops ⁵		
(MFLOPS)	0.0021	0.0016
Dhrystone (MS C 5.0)		
(Dhry./sec.)	992	763

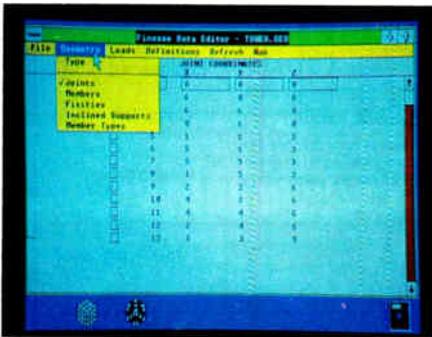
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- Steel, Concrete and Timber databases
- Ultra Fast solver
- Expanded memory use
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- Microsoft Windows Interface
- Autocad drawing DXF file transfer

CUBE Systems Inc.
77 Metcalfe St. Suite 310,
Ottawa Ontario Canada K1P5L6
(613) 236 7067 tel
(613) 236 7515 fax

While the PC-4641's screen was well lighted and crisp, the screen on the 140 XT was better. It was very bright, and the characters were unusually clear and didn't fade in and out when the text changed, as they do on the Sharp and some other machines.

My one complaint about the screen is the manner in which it attaches to the body of the computer. The two hinges seem to work independently, and if you are not careful, you can fold the screen in such a way that it will bind on the top of the drive housing. It also doesn't work as well as the others in holding the screen open.

The disk drives are directly behind the keyboard; a 720K-byte 3½-inch floppy disk drive is on the left, and a 20-mega-byte (65-ms access time) hard disk drive is on the right. In front of the drives on the left side of the keyboard are the status lights. The 76-key keyboard has 12 function keys across the top row. The arrow keys are on the bottom right. GRiD has superimposed the numeric keypad on the letter keys.

The right side of the computer contains a contrast control for the screen, the power switch, and the volume control for the internal speaker. Near the volume control is a tiny switch for choosing whether to use the internal screen or an external monitor. The communications ports are on the rear of the machine, concealed behind a thin plastic door.

Along with the normal serial and parallel connectors, there are connections for an external monitor, an external 360K-byte 5¼-inch floppy disk drive (\$250), and an external keyboard. These connections make it possible to use the 140 XT as your only computer. You simply use an external monitor and keyboard in the office, and detach them when you leave.

My test machine included an optional 2400-bps Hayes-compatible modem (\$300), which mounts in the back of the system. Unlike with the PC-4641, you need only remove a small hatch and slide the modem into place. You then replace the mounting screws and change the Set-up program, and the modem is ready to go. The modem is a Tandy, however, and it's tan, not gray like the rest of the case. This looks a bit odd, but most of the time the door on the rear of the computer covers it.

The modem has connectors for the telephone as well as the standard line connection. In addition, the GRiD has a DIN plug for an acoustic coupler. This is handy in hotel rooms where the telephones are hard-wired.

Using the GRiD 140 XT

The first thing you notice about the 140 XT is the brilliance of the screen. This is one of the better screens for a basic laptop. It's a quiet machine as well; there's no noise from the hard disk drive, and you can control the volume when the machine decides to beep at you.

When you start using the 140 XT, though, it's clear that this is the less speedy of the pair. The 8-MHz NEC V20 processor is about 20 percent slower than the PC-4641's overall. The hard disk drive is also slower.

GRiD claims that the 140 XT's nickel-cadmium batteries will let the machine run for up to 2 to 3 hours between recharges. The batteries lasted about 2 hours during actual use, and the battery light came on after 1½ hours on my test machine. Extra batteries are \$80 each.

Like the Sharp PC-4641, the 140 XT had no trouble running an array of different application programs.

Making a Choice

I didn't find a clear winner here; these are both excellent laptop computers. And they're worth what you're likely to pay for them. You can buy the Sharp PC-4641 for substantially less than list price. Tandy's corporate sales force sells the GRiD 140 XT; discounts vary. Another alternative is to look at the 140 XT's cousin, the Tandy 1400 LT, which sells for substantially less.

Before you settle for either machine, however, you should check out other laptops in this class, like the Zenith SuperSport and the Toshiba 1200 HB. Both are comparable to the two machines reviewed here, and dealers tend to discount them more heavily than the Sharp.

If you're looking for a more basic laptop computer to use exclusively for communications and word processing, and if you can live without a hard disk drive and a backlit display, you might want to consider the Toshiba T1000, which is routinely available for under \$700. If you don't need a hard disk drive, another alternative is a notebook computer such as the Zenith MinisPort or the Toshiba T1000SE. These offer backlit supertwist LCDs and substitute a RAM disk for a hard disk drive. Prices start at \$1699. ■

Wayne Rash Jr. is a BYTE contributing editor and a member of the professional staff of American Management Systems, Inc. (Arlington, VA). He also consults with the federal government on micro-computers and communications. You can contact him on BIX as "waynerash," or in the to.wayne conference.

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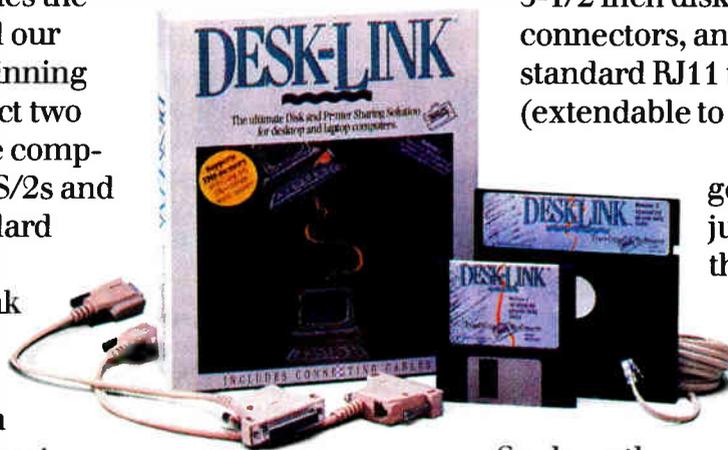
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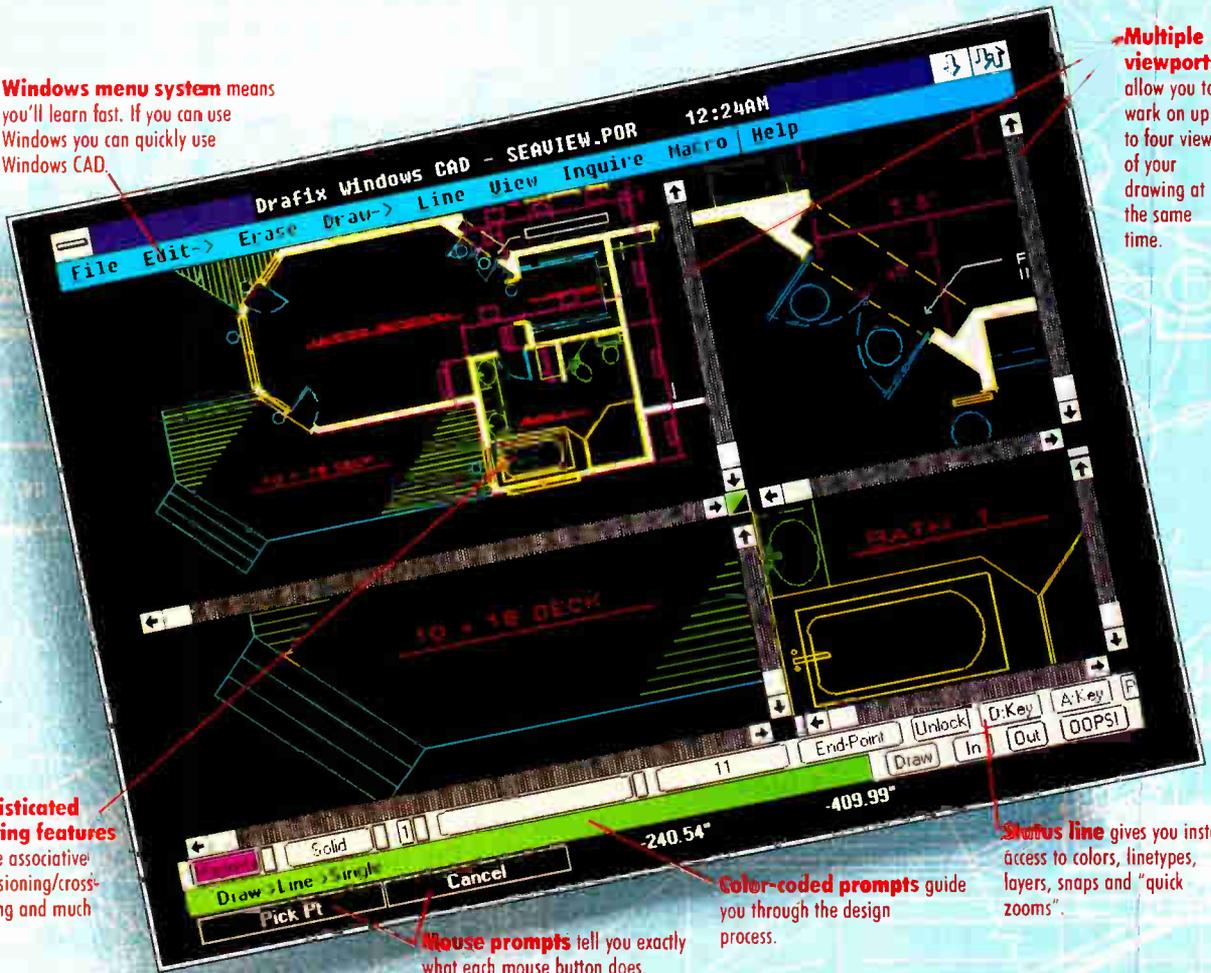
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 OOPS (Undo) feature Dynamic Drag
 Quick zoom/pan Multiple viewports, all active

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 Chamfer (bevel) Erase Copy Move
 Mirror Rotate Arrays Select items by region, entity, attribute or combinations

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 Ordinate, Elevation or Bearing format
 23 terminator types Any alignment
 Tolerancing English and metric
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Associative Crosshatching and Solid Fill 15 crosshatch patterns, ANSI specs
 64 solid fills

Text Editing Word processing window
 Multiple font styles

On-Line "Help" system

Macro Programming Language

System Requirements 286 or 386 processor Microsoft Windows 2.1 or later
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 Windows-supported mouse

File Compatibility Autocad DXF
 Drafix CAD HPGL CDF, SDF for database information



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Hard-Drivin' Mac

Utility software is the key when choosing among these 300-megabyte Mac hard disk drives

Rick Grehan

Three hundred megabytes. Roll the words around on your tongue a few times, look at that 20-megabyte hard disk drive you bought for your Macintosh a couple of years ago, and soon you feel a kind of digital claustrophobia. But that much storage space can also be frightening: A 300-megabyte disk crash would be equivalent to torching close to 700 full-length novels. On the other hand, the thought seduces: At last you have a place for all those data files and utilities, and, my goodness, what an AppleShare server you could build!

I tested three SCSI-based hard disk drives for the Macintosh. Each holds 300 megabytes or more of data in a package not much bigger than a shoebox. They are MicroNet's Wren Runner 330, Racet's SA 338, and Jasmine's DirectDrive 300.

Across the Board

The SCSI bus on the Macintosh eliminates the installation hassles that PC users sometimes face when installing a hard disk drive. To add a hard disk drive to the Mac, all you have to do is plug it in and turn it on.

SCSI also gives you the ability to daisy chain up to seven external devices. Typically, the first and last devices on a SCSI bus must include terminators, the passive circuits that reduce noise on the bus. The



Clockwise from top: The Jasmine DirectDrive 300, the Racet SA 338, and the MicroNet Wren Runner 330.

Racet and MicroNet units provide termination via a plug cap that snaps into the unused SCSI connector. Jasmine is more discreet: A door on the drive's bottom opens to reveal a portion of a circuit board that holds a terminating resistor pack.

If you use drives that operate along the SCSI bus, you can conceivably unplug any one of them, carry it to another Mac, hook it up, and keep on computing. I wouldn't recommend this as standard practice—none of these drive makers sells its unit as a portable mass storage device. But it's comforting to know that if something happens to your computer system you won't be dead in the water. Assuming that you're in an office with other Macs, you can access your data from another machine while yours is in the shop.

MicroNet Wren Runner 330

The MicroNet Wren Runner's rectangular beige box stands about half again as tall and deep as a full-height 5¼-inch hard disk drive. You set the drive's SCSI ID number via a DIP switch on the unit's back. This isn't as elegant as a rotary switch, but since you'll diddle with it only occasionally, it's probably not a problem. As the name suggests, the Wren Runner 330's stated capacity is 330 megabytes, but the actual usable space shrinks to around 320 megabytes once you've formatted the drive.

The Wren Runner's power supply is auto-ranging. This means it can monitor and automatically adjust to local standard voltage levels and surges. Consequently, you can operate the Wren Runner on voltages between 90 and 260 volts

continued

	MicroNet Wren Runner 330	Racet SA 338	Jasmine DirectDrive 300
Company	MicroNet Technology, Inc. 20 Mason Irvine, CA 92718 (714) 837-6033	Racet computes Ltd. 3150 East Birch St. Brea, CA 92621 (714) 579-1725	Jasmine Technologies, Inc. 1740 Army St. San Francisco, CA 94124 (415) 282-1111
Size	7½ × 6½ × 12 inches	7 × 5 × 15½ inches	9½ × 2½ × 10½ inches
Hardware Needed	Any Macintosh with a SCSI port	Any Macintosh with a SCSI port	Any Macintosh with a SCSI port
Software Needed	Mac OS (which includes low-level SCSI drivers)	Mac OS (which includes low-level SCSI drivers)	Mac OS (which includes low-level SCSI drivers)
Documentation	User's manual	User's manual	DirectDrive owner's manual; SUM II manual
Price	\$4395	\$4995	\$2795
	Inquiry 852.	Inquiry 853.	Inquiry 854.

AC. Unfortunately, the drive's power unit makes more noise than some people might tolerate. It didn't bother me, but at least two other BYTE staff members complained about the noise as they went by my work area.

MicroNet's utility software is a joy to work with. It locates all devices on the SCSI bus and tells you how many megabytes are available on each. It lets you format, initialize, and install the hard disk driver on any device on the bus. (It's not picky, either. It was happy to let me install the MicroNet driver on the Jasmine drive. More on this later.) If you format the drive, the software is intelligent enough to figure out what kind of Mac you're running it on and adjust the drive's interleave accordingly. For example, MicroNet sets the interleave to 6-to-1 on the Mac Plus, while on the Mac IIcx it picks a 1-to-1 interleave.

The utility software also includes a series of read and write tests for SCSI devices. This is a destructive test, however, and the help screen warns that you should not try it unless you suspect something is fundamentally wrong with the drive.

You can instruct a SCSI drive to mount either at system boot or when you request it. MicroNet provides a mounter desk accessory that lets you do the latter operation by selecting its SCSI ID number. This is handy if you have more than one drive hooked to the SCSI bus. The mounter worked until I attached the Racet drive to the chain; then the mounter bombed repeatedly. Oddly, MicroNet's other utility software easily mounted the Racet drive.

MicroNet also includes a useful shareware SCSI evaluation utility (written by William A. Long) that runs a SCSI disk through a variety of low-level read and write tests. I used the evaluator to measure the disks' seek times (more on this later).

Racet SA 338

The Racet SA 338 made an impression on us as soon as it arrived at the BYTE Lab. It shipped in a wooden crate, reminiscent of the box that housed the Ark of the Covenant at the conclusion of "Raiders of the Lost Ark"; Racet takes no chances with transport damage. Racet's documentation is also elaborately packaged in a large binder with section dividers, title pages, and other amenities.

Out of its crate, the SA 338 looks a lot like the Wren Runner: an external drive case that's been extended to hold a power supply and controller electronics. You set the drive's SCSI ID via a rotary switch on the back of the unit. Formatted capacity topped out at about 306 megabytes.

PCMS (personal computer mass storage) software runs the Racet system. The factory had already partitioned the SA 338 drive into two volumes, even though the unit held only a single hard disk drive. Racet's software also allows you to select whether the drive's volumes mount at system boot-up or after a mount request. PCMS displays a menu that lets you select the volumes to be activated. (Future releases of PCMS software will let it enable any cache memory that resides on the drive's SCSI controller, according to Racet.)

Unique to the Racet disk drivers is the capability to "span" more than one drive. This is best done with one of the company's dual-drive units (which I did not test). Spanning lets you create a single volume that sits on two drives. This is handy for huge files, but you've got to be extra careful with your setup. If you lose one of the drives, or if you change the SCSI ID of one of the drives, you'll irretrievably junk the spanned volume.

Jasmine DirectDrive 300

The Jasmine DirectDrive 300 is a sure winner in appearance. It's sleeker than the other two units with their breadbox appearance. Its footprint is only slightly larger than that of a Mac Plus, so if you're a Plus user, the DirectDrive fits nicely under your unit. The DirectDrive's power supply includes built-in surge suppression, and surge-suppression circuitry protects the two power outlets on the back of the unit. If your system isn't enjoying power protection already, this is a nice bonus. Formatted, the Jasmine's capacity totaled approximately 324 megabytes.

Feature-for-feature, the DriveWare utility software from Jasmine matches the other hard disk drive software that I tested, except for one annoying characteristic. Once every 5 seconds or so, if you haven't pressed a key or moved the mouse, DriveWare snoops along the SCSI bus to determine what devices are connected and to update its display. You have to wait a few seconds for DriveWare to finish snooping before the program

continued

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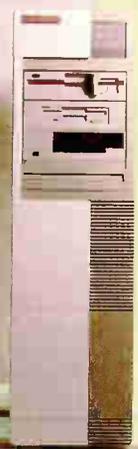
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Table 1: The three 300-megabyte hard disk drives show marked performance differences when running on the Mac Plus and IIcx. The random I/O test consists of BYTE's File I/O benchmark, while the sequential I/O test represents the combined results of BYTE's Big File (1 million characters) read and write benchmarks. The figures indicate the average bytes-per-second throughput over read and write operations. The numbers do not indicate absolute throughput, but instead suggest a relative ranking of the devices. (The MicroNet Wren Runner's throughput increased substantially on the Mac Plus when caching was enabled. See text.)

Drive	BENCHMARK RESULTS	
	Average bytes-per-second throughput	
	Random I/O	Sequential I/O
MicroNet Wren Runner 330		
Mac Plus	46,800	69,200
Mac IIcx	80,200	339,500
Racet SA 338		
Mac Plus	54,000	175,500
Mac IIcx	75,600	297,200
Jasmine DirectDrive 300		
Mac Plus	49,400	169,300
Mac IIcx	72,300	283,200

will respond again to input.

I couldn't find any way to disable this activity, and it made using DriveWare a headache. Given that most people will only add or remove SCSI devices when all the power's off, it seems that a single search along the bus when DriveWare first comes up (this is how MicroNet's utility software works) would be sufficient.

Partitions created with DriveWare offer more than those created on the Wren Runner or the SA 338. Not only can you indicate whether a partition mounts automatically or manually, you can also lock a partition (so that it becomes read-only) and make it private (so that access to the partition requires a password).

Jasmine also includes Symantec's SUM II disk utilities (for a complete review of this and other disk utilities, see "Just What the Hard Disk Doctor Ordered" on page 152). I received mine separately, but Jasmine says it now ships the utility with its drives. The software includes a file recovery utility (for undeleting files), a tune-up utility (for optimizing disk usage by removing fragmentation), a high-speed floppy disk-to-floppy disk copying utility, a disk backup utility, and a "toolkit" utility crammed with everything from a disassembler to a sector editor.

On the High Wire

To compare the products, I ran a subset of the BYTE benchmarks on all the

drives, with each drive first connected to a Mac Plus, then to a Mac IIcx. I removed all RAM caching, network, and INIT software that might skew the results. Finally, I set the Mac start-up procedure to "Finder only."

Interestingly, the drives did not rank the same on the Mac Plus as on the Mac IIcx (see table 1). The most notable differences appeared on MicroNet's Wren Runner, which was the clear winner on the Mac IIcx but the clear loser on the Mac Plus. I attribute this to the MicroNet software's ability to format the drive with an interleave appropriate for each Mac. It reformatted the Wren Runner for the Mac Plus when I ran it on the Plus, and for the Mac IIcx when I ran it on the IIcx. Apparently, the interleave that the software chose for the Mac Plus wasn't optimal.

I also ran MicroNet's shareware SCSI evaluator utility to gauge the seek times of the units. The drives ranked the same as they did on the throughput tests on the Mac IIcx. (This is understandable, since the higher speed of the IIcx places the performance burden on the disk drive rather than on the CPU.) The Wren Runner performed at 12 milliseconds, the DirectDrive at 16 ms, and the SA 338 at 19 ms.

The SCSI evaluator also demonstrated the difference a good driver makes. I ran the evaluator's read test, first using the SCSI read trap on the Macintosh and then using the driver provided with the drive.

On the Mac Plus, the difference was as much as 400K bytes per second in favor of the manufacturer's SCSI driver. On the Mac IIcx, the difference was as much as 700K bytes per second. The moral: Use the driver that the manufacturer gives you.

While I was completing this review, MicroNet sent me an updated version of its utility program. This new version engaged the drive's on-board cache memory. MicroNet told me that different drives had different amounts of memory, and enabling the cache would improve performance only if available cache memory was significant. I was able to test the software using only the Mac Plus, and the performance boost was substantial for read operations. Random read throughput improved an average of 17K bytes per second, and sequential read throughput improved an average of 64K bytes per second.

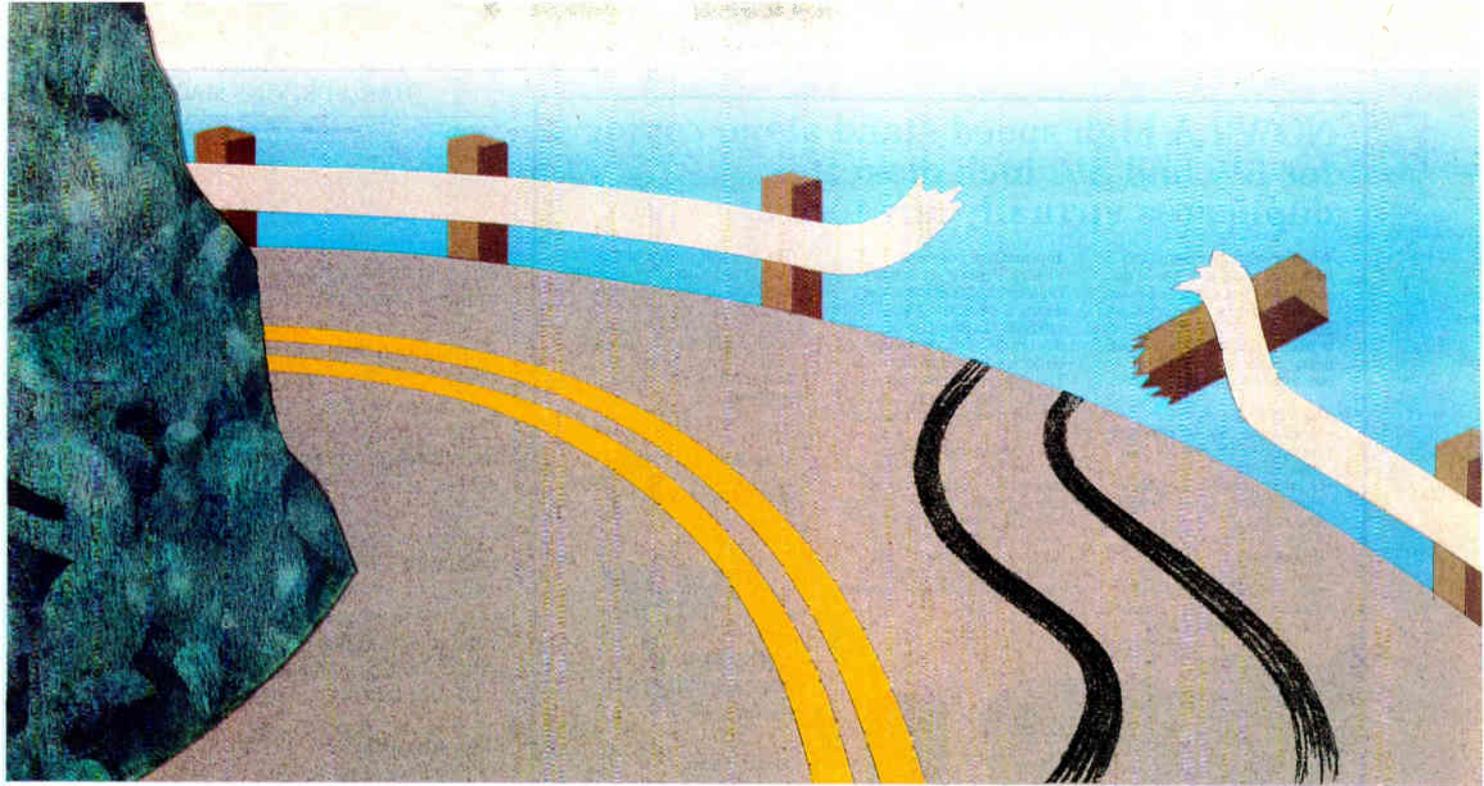
A Moment of Madness

When Jasmine sent its drive, the company at first neglected to send any manuals or disks, and initially the unit refused to respond to my Mac. In a moment of madness, I initialized the Jasmine DirectDrive using MicroNet's utilities. As I mentioned earlier, MicroNet's software readily recognized and initialized the DirectDrive, so I knew the drive and controller operated properly. Of course, I didn't dare run the benchmark tests on the drive with alien drivers installed.

After Jasmine's DriveWare utility software arrived, I loaded it onto the Mac to reinitialize the DirectDrive. However, when DriveWare saw what I had done to the DirectDrive, it was not at all happy. The situation reminded me of the advice parents give about not touching a baby robin that has fallen from the nest for fear that the mother will smell the taint on her chick and boot the poor thing out forever. My situation was even worse: DriveWare wouldn't boot the DirectDrive at all. The solution: I sent the drive back to Jasmine, where engineers performed their magic. They returned the DirectDrive two days later, and it then worked like a champ.

However, this experience raised a rather disturbing question. By initializing the DirectDrive, I obviously overwrote some key information, and Jasmine's DriveWare couldn't repair the damage. Could errant software do the same? Was it therefore possible for a crashing program to clobber the drive so severely that you'd have to send the unit

continued



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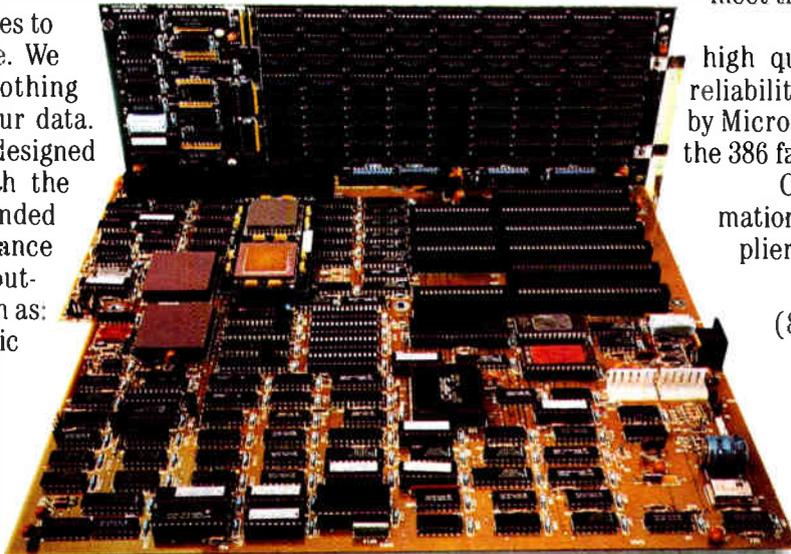
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back to the company? In these days of killer virus programs, the possibility demanded investigation.

I talked with a Jasmine engineer and learned that Jasmine marks as defective several good sectors (he was understandably unclear about how many). Jasmine then writes signature information to those sectors for DriveWare to find. MicroNet's software had apparently overwritten them. Before any faulty software or virus could destroy this signature information, it would have to execute commands at the level of the SCSI traps and overwrite sectors that the Macintosh Finder would not even know existed. In short, a crashing program probably wouldn't destroy the drive.

The Results

If price were no object, I'd pick the MicroNet Wren Runner 330. Its auto-ranging power supply means it's happy almost anywhere you plug it in. Plus, I found MicroNet's utility software easier to work with than the others'. It's true that a hard disk drive is a hardware purchase, but once you start working with the unit, you see the drive through its software. The MicroNet's winning performance on the Mac IIcx doesn't hurt its appeal, either.

However, when I consider price, my enthusiasm shifts. Jasmine's DirectDrive looks good at \$2795. It looks even better when you consider all the software that shows up with the unit and what an attractive base for the Mac SE (or Mac Plus) the DirectDrive would make. However, I must also report that Jasmine's technical support appears to be permanently busy. Twice when I called (admittedly during peak hours), I waited on the telephone for at least 20 minutes listening to a recording that repeatedly apologized for the delay.

On its own, the Racet SA 338 might have been impressive; its stature deflates, however, when compared with the other units. The SA 338 performed well, placing second in throughput (and first on the Mac Plus when the MicroNet's cache was disabled). But it is also the most expensive unit.

What's most amazing is how well the drives worked together: three drives from three different manufacturers, connected to one Mac, all operating peacefully with one another. And each held at least 300 megabytes. That's a lot of folders. ■

Rick Grehan is the director of the BYTE Lab. He can be reached on BIX as "rick.g."

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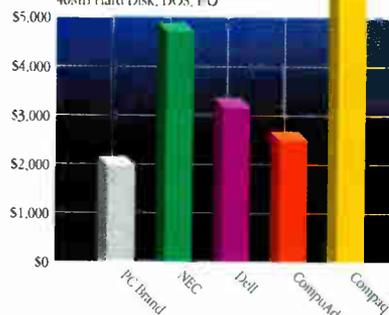
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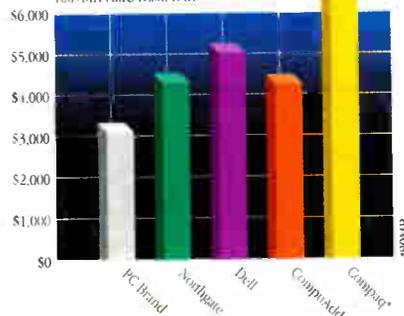
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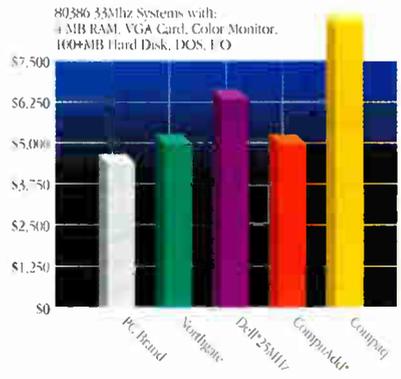
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PostScript in the Palm of Your Hand

PacificPage gives
HP LaserJet II users
a PostScript clone
to call their own

Howard Eglowstein

Disguised as a run-of-the-mill font cartridge, PacificPage from Pacific Data Products is a full-featured PostScript interpreter that fits neatly into the cartridge slot of your Hewlett-Packard LaserJet Series II printer. It requires no software drivers, weird controller boards, or internal modifications to the printer. You just insert the cartridge and turn on the printer, and your Series II printer becomes PostScript compatible.

The secret? Pacific Data found a way to put executable code into a LaserJet II's cartridge slot. PacificPage consists of 1.5 megabytes of ROM with 35 fonts and the PhoenixPage interpreter from Phoenix Technologies.

PCL Peters Out

LaserJet users share a common problem. Many people bought one because of its high-quality text and graphics. But it didn't take long to realize that the standard 512K bytes of memory just wasn't enough. Adding 1 or 2 megabytes of memory does the trick for a while, but a full page of graphics takes about 1 megabyte of memory, and each additional font takes a healthy bite out of the memory that's left.

Also, you're stuck with plain old text when your applications can use PostScript to provide the variety of font displays that the LaserJet doesn't offer by it-



self. The standard LaserJet downloadables will print black text in the typeface that you select, in either portrait or landscape orientations. PostScript can rotate fonts in any direction, in a large range of typefaces.

Desktop publishing is an obvious application. PageMaker can set fonts in almost any size and can position graphics anywhere on a page. A standard LaserJet requires one downloadable font for each attribute, size, or typeface; it's amazing how fast you can fill a hard disk with fonts. But PostScript can give you the power you need without sacrificing the space on your computer's hard disk.

The PacificPage cartridge succeeds because it provides all these capabilities without forcing you to modify your printer, give up HP Printer Control Lan-

guage (PCL) compatibility, or spend an arm and a leg. PostScript is here to stay, and PacificPage lets you take the plunge without going in over your head.

Thanks for the Memory

The PacificPage cartridge requires 2.5 megabytes of printer RAM. Storing the full-page bit map takes up 1 megabyte; the interpreter uses the rest for general execution and font caching. Assuming that you've already added 2 or 4 megabytes of RAM to your printer, you simply insert the cartridge into the left cartridge slot and turn on the printer. If you need to add RAM, any standard memory upgrade will do. Pacific Data sells 1-2-4 Plus, an expandable board that provides 1, 2, or 4 megabytes of memory (\$395

continued

with no memory, \$945 with 2 megabytes). You insert the memory into a special slot on the left side of the printer.

The first difference you'll notice is on the front panel display. PacificPage replaces the usual HP messages with new ones displayed in uppercase and lowercase letters. PacificPage puts the printer on-line after testing memory and initializing itself. When you send it a page, the display counts up to show the size of the page in K bytes. The Form Feed light blinks when the interpreter is active, and the Ready light blinks as new data is received.

Another big change is in the control buttons. PacificPage remaps them from the usual HP fare. On Line still toggles the printer between on-line and off-line. Other functions require you to press a button once instead of holding it for 5 seconds. Reset reinitializes the printer, and Menu lets you toggle from PostScript to PCL mode. You change the printer I/O and other parameters while in PCL mode. Because the printer boots up in PostScript, you need to change to PCL, press Menu in the usual LaserJet way, change the I/O parameters, and then change back to PostScript. The process is straightforward, though cumbersome. It's much easier to use the utility software included with PacificPage to switch from PostScript to PCL and back.

Timing Isn't Everything

Perhaps the most important attribute of PacificPage is that it works flawlessly. I printed hundreds of pages from many different applications. I ran examples from the Adobe "Bluebook," a collection of sample Adobe PostScript files. I used a number of third-party test applications, as well as the test files from "PostScript Printers Come of Age" (September 1988 BYTE). PostScript programs ran fine, and all the text was positioned perfectly on the page.

General compatibility with PostScript programs and operators appears to be excellent.

The print times for a large text file, a small text file, and a one-page graphic appear in table 1. Speed isn't PacificPage's forte; its performance is dependent on the processing power of the LaserJet. The HP LaserJet runs on a 68000, clocked at 8 MHz with three wait states; Apple gave the LaserWriter IINT an 11.5-MHz 68000. Thus, it's not surprising that the LaserJet with PacificPage ran from one-third to one half the speed of Apple's LaserWriter IINT.

A good print buffer makes PacificPage a joy to use. Without a buffer, printing ties up the computer for a long time. I experimented with both hardware and software buffering, and I found that a good buffer of either type worked reliably. The best software packages I found were Quikbuf2 (which came with my Intel AboveBoard) and Lasertorq from LaserTools. Most important, your buffer has to work efficiently and reliably from within your applications. Microsoft Windows was the sticky wicket that kept several buffering schemes from running.

The Proof Is in the Printing

One reason you might use PostScript on a 300-dot-per-inch laser printer is to be able to proof pages formatted for a Post-

Script typesetter. Here, PacificPage shines. PostScript typesetters most likely will be running official Adobe PostScript, which Adobe guarantees to be compatible with its 300-dpi PostScript. Any clone that claims to be compatible will have to use the same font names and have exactly the same font metrics as the real thing. Otherwise, an Adobe-based typesetter will produce different output than the proofing device, making the proofs worthless.

The PhoenixPage software uses font technology licensed from Bitstream Fontware and matched exactly with the standard Adobe fonts. The resulting output is remarkably similar to the LaserWriter's. Unfortunately, I wasn't able to compare it to any typeset copy.

Of course, Bitstream fonts aren't in Adobe format, and you won't be able to use the same downloadable fonts that typesetters use. Pacific Data says that you can use the Bitstream font outlines available from most software outlets and recommends that you use the "hinted" versions. General compatibility with PostScript programs and operators appears to be excellent; I didn't find any interpreter bugs during testing.

ROM for Improvement

A few other points are worth mentioning: The LaserJet II can support up to 4.5 megabytes of RAM. This first release of PacificPage (version 2.54) recognizes only 2.5 megabytes. Any memory beyond that is simply ignored. Also, this release accommodates only the original Series II printers. A later version of PacificPage is expected to work on the Series IID and IIP as well. HP is shipping an official Adobe PostScript cartridge for the IID (\$995) and may have started shipping the IIP version by the time you read this.

PacificPage isn't the only way to get PostScript compatibility on your Series II printer. If you have enough system RAM, some software interpreters can perform PostScript emulation in your computer and send the resulting image to your LaserJet or dot-matrix printer. These interpreters generally require a fair amount of RAM, tie up the computer for processing, and run at varying speeds, depending on the speed of the CPU. I have experimented with both QMS's UltraScript PC plus and Laser-Go's GoScript. As much as I liked UltraScript, PacificPage (with a print buffer) was more convenient to use.

Also, replacement controller boards (such as QMS's JetScript) allow you to

continued

Table 1: With the PacificPage cartridge, the HP LaserJet Series II printer prints at about one-third to one half the speed of an Apple LaserWriter IINT. Both printers were driven at 9600 bps through the printer's serial port. Times are in seconds.

SPEED TEST RESULTS

Printer	Large text file ¹	Small text file ²	Graphics file
LaserJet with PacificPage	660	142	361
LaserWriter IINT	303	70	122

¹ A 125K-byte, 16-page file with seven fonts.

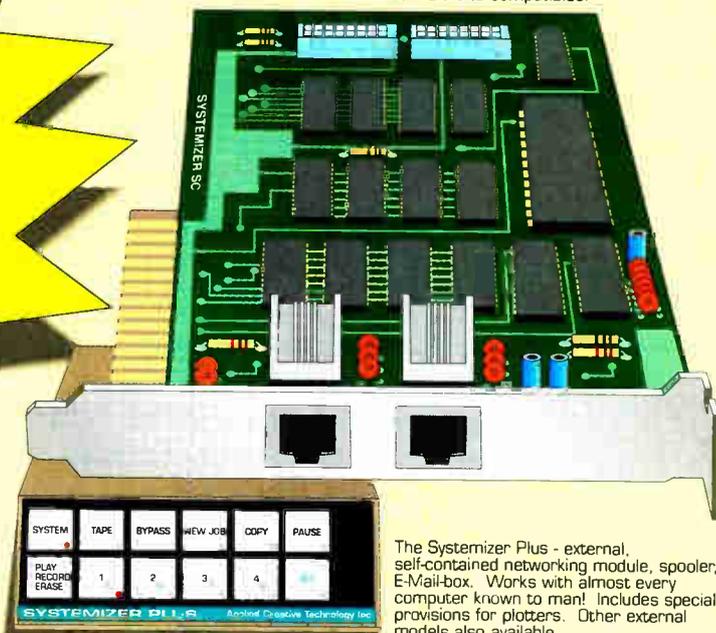
² A 25K-byte, six-page file with three fonts and graphics.

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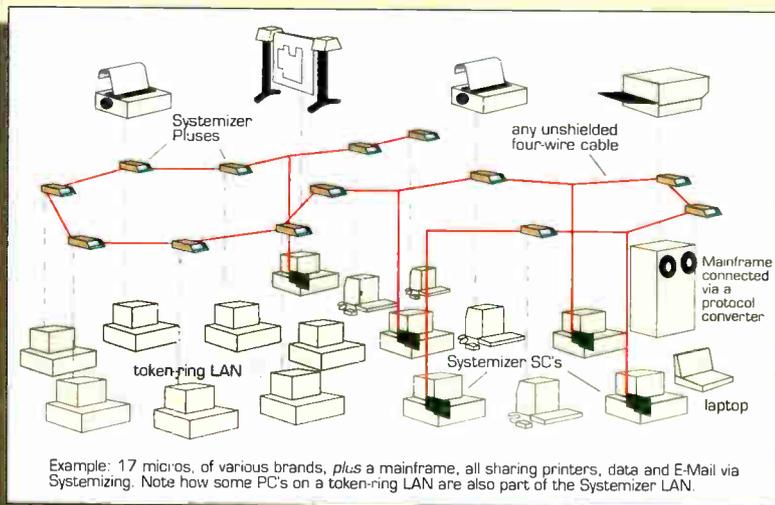
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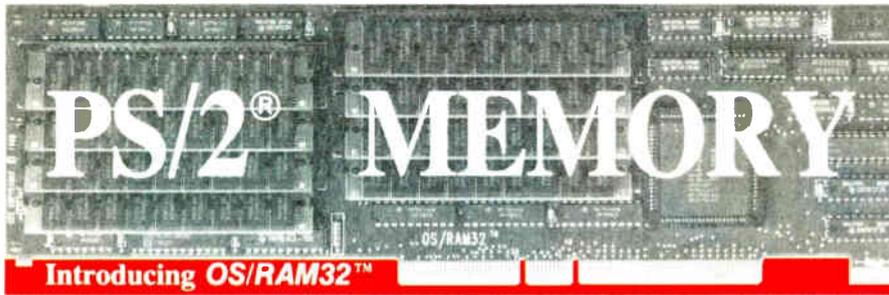
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Inquiry 851.

supplement the LaserJet's processor with a new controller. However, a replacement controller board is much more expensive than PacificPage.

The Last Word

Despite the slow performance, PacificPage is a "must-see" product. Most of us who bought LaserJets did so because we didn't need the full power of PostScript. I find that it's much easier to print a lot of text files, program listings, and quick proofs on a PCL printer, and I couldn't justify buying a PostScript printer for the amount of time I'd use it. On the other hand, PageMaker 3.0 likes PostScript better than PCL, and Adobe Illustrator is lost without PostScript.

PacificPage is not meant for people who live and breathe PostScript—the cartridge is not fast enough, and it doesn't support Adobe downloadable fonts. People who need to print a lot of PostScript should consider buying a fast PostScript printer. But PacificPage's compatibility is excellent, installation is trivial, and the cost is reasonable.

PacificPage may not be the last word in PostScript, but it certainly says good things about Pacific Data Products. I recommend that anyone with a LaserJet and an occasional need for PostScript take a close look at PacificPage.

Now, if only I can figure out what do with my box of HP cartridges and disks full of downloadable fonts that I don't need any more. ■

Howard Eglowstein is a testing editor for the BYTE Lab. You can reach him on BIX as "heglowstein."



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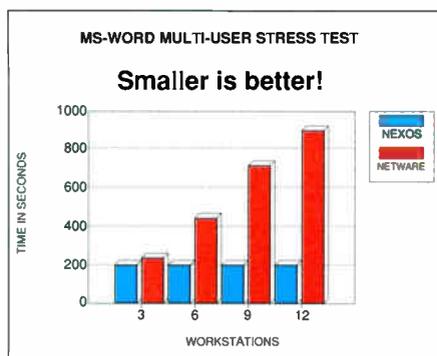
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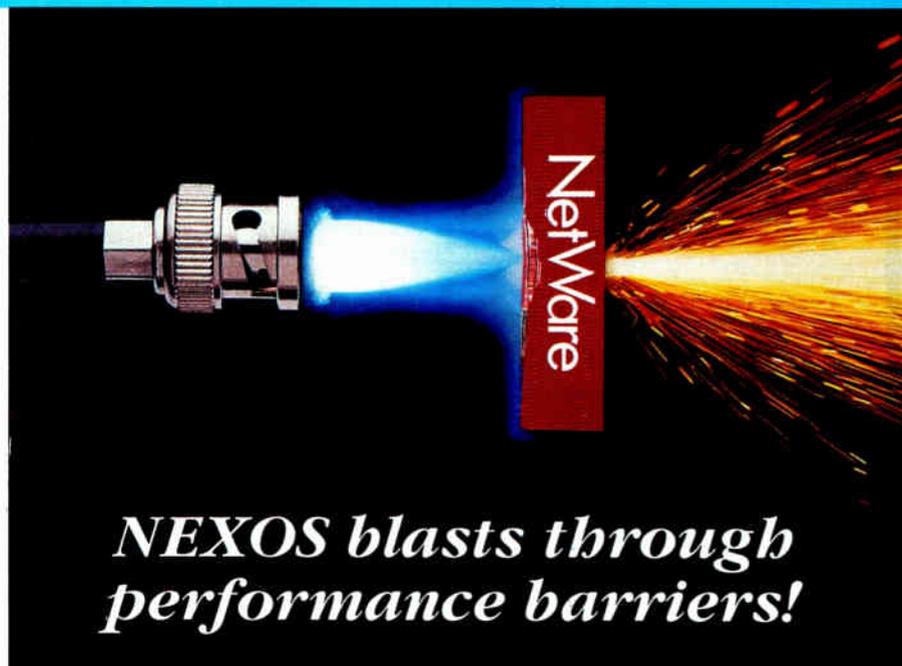
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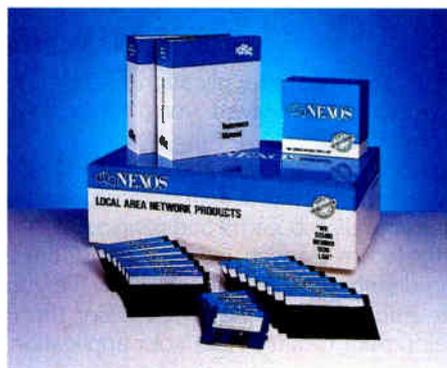
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Mac Adapters Embrace Ethernet

NuBus boards and an external SCSI adapter give Macs an easy entrée into swift Ethernet networks

Stanford Diehl

If you're serious about linking several Macintoshes together, at some point you must abandon Apple's LocalTalk network. That may not be easy. After all, LocalTalk is familiar, readily accessible, and free. Alternative networks need a significant commitment of time, money, and resources.

If you expand to more than, say, 15 nodes, LocalTalk just can't cut it. It will likely suffer from too many data collisions and not enough speed. Two options are the DaynaTALK and FlashBox enhanced connection modules (see "LAN Aid: Mac Booster Modules," November 1989 BYTE), which can more than triple transfer rates in LocalTalk networks. But for optimum performance, you should consider Ethernet, with its theoretical data transfer limit of 10 million bps. In this review, I'll look at three Ethernet options for the Mac: Apple's EtherTalk NB board, Asante's MacCon II/E interface board, and Compatible Systems' external Ether+ adapter box.

Developed by Xerox at the Palo Alto Research Center, Ethernet defines a method for computers to communicate with each other. Ethernet transmits information in packets called *datagrams* and uses a scheme called Carrier Sense Multiple Access with Collision Detection to ensure successful transmission of the

datagrams. CSMA/CD attempts to send datagrams across a clear cable, but, if conflicts occur and transmissions collide, it notifies all nodes of the collision and randomly selects a retransmission time. This scheme can accommodate much more traffic than LocalTalk can.

Speed Can Be Deceiving

At first glance, the difference in performance between Ethernet and LocalTalk is staggering. LocalTalk transmits at a standard data transfer rate of 230,400 bps, while Ethernet's theoretical limit represents a 40-fold increase. But in the real world, software overhead, reflections, and noise hamper network performance and limit the Ethernet advantage. Nevertheless, Ethernet can significantly boost the performance of a Mac network, especially as the network becomes more complex. Our tests reveal an obvious performance increase with Ethernet even on a simple network setup.

I tested the adapters using tests developed for the Optical Storage Technology Product Focus (October 1989 BYTE). I established a simple connection between

a Mac II and a Mac IIcx using a thin Ethernet cable and the interface adapter to be tested. The Mac IIcx ran as an AppleShare server, and the Mac II as a workstation (see figure 1). Our network software was AppleShare 2.0 and TOPS 2.1. The first test copied 25 megabytes of data from the Mac II to the Mac IIcx and back. A 5-megabyte copy and a simple file search were also included. To gauge application performance, I used the FoxBASE+/Mac database application to negotiate writes, sequential searches, and indexed searches (see figure 2). In all cases, the Ethernet connections outperformed our "vanilla" LocalTalk setup.

EtherTalk NB

I began my tests with the \$699 EtherTalk NB (for NuBus) board from Apple. I changed a single jumper to configure the board for thin Ethernet (*thin Ethernet* refers to a system using flexible coaxial cable to connect network nodes; *thick Ethernet* cables are larger in diameter and are used to connect network transceivers). I then slid the board into an

continued



Left to right: Asante Technologies' MacCon II/E, Compatible Systems' Ether+, and Apple's EtherTalk NB.

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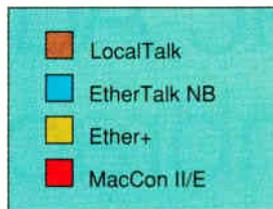


Figure 1: Although the MacCon II/e consistently outperformed the EtherTalk NB and Ether+, all three posted notable data transmission rate improvements over standard LocalTalk. In these tests, the server was a Mac IIcx running AppleShare 2.0. The local node was a Mac II running System 6.0.3.

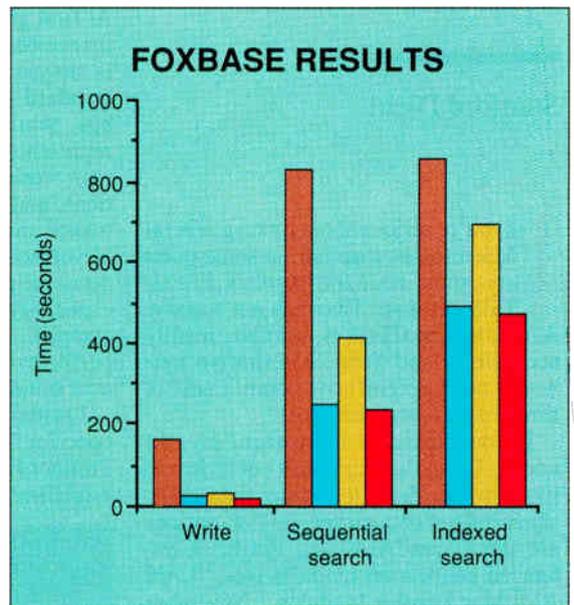
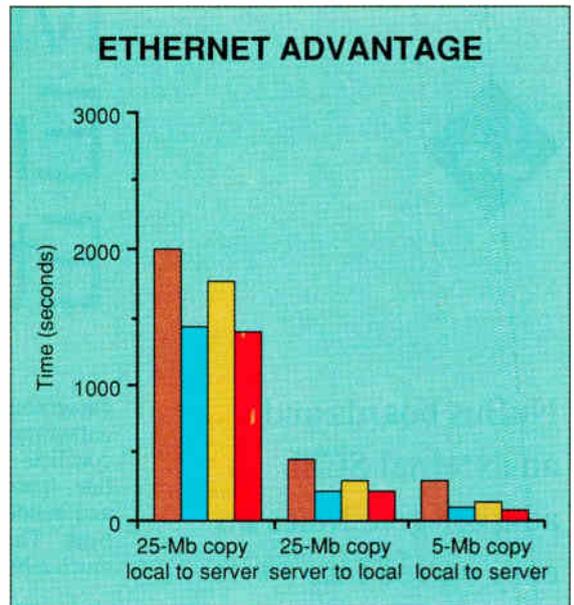


Figure 2: The Ethernet adapters also outclassed LocalTalk in tests of application performance using FoxBASE+/Mac database operations. (Times are in seconds and represent the average of five trials.)

open NuBus slot and attached a T-connector to the connector on the board.

Software installation was just as easy. I loaded the EtherTalk Installer disk, double-clicked on the installer icon, selected the hard disk for EtherTalk installation, and clicked on the install button. From the Control Panel, I then clicked on the network icon and changed the network driver from built-in LocalTalk to EtherTalk. No sweat. A long list of networking software supports the EtherTalk driver, including AppleShare, TOPS, and NetWare.

The EtherTalk NB ran flawlessly under both of our test networking-software platforms, AppleShare and TOPS.

Transmission speeds increased 30 percent to 60 percent over the LocalTalk configuration. The package did not include any special utilities, but the documentation was clear and well organized. Although you shouldn't need it, a troubleshooting guide at the back of the user's manual offers suggestions if you run into problems installing the board. A glossary and an index are also included.

MacCon II/E

Asante's MacCon II/E Ethernet interface board (\$595) slides into a Macintosh NuBus slot to support both thin and thick Ethernet cabling. The MacCon II/E is even easier to install than Apple's Ether-

	EtherTalk NB	MacCon II/E	Ether+
Company	Apple Computer, Inc. 20525 Mariani Ave. Cupertino, CA 95014 (408) 996-1010	Asante Technologies, Inc. 1050 East Duane Ave., Suite G Sunnyvale, CA 94086 (408) 736-3360	Compatible Systems Corp. P.O. Box 17220 Boulder, CO 80308 (303) 444-9532
Hardware Needed	Macintosh II or other member of NuBus family of Macintosh computers	Macintosh II or other member of NuBus family of Macintosh computers	Any Macintosh with a SCSI port
Software Needed	System 6.0.3 or higher	System 6.0.2 or higher	System 6.0.3 or higher
Documentation	User's manual	Installation guide	User's manual
Price	\$699	\$595	\$495
	Inquiry 856.	Inquiry 857.	Inquiry 858.

Talk board. It has no configuration jumpers to worry about. A configuration ROM senses the connector being used and automatically configures the board. An LED indicates packet transmissions, receptions, and data collisions.

You load the software drivers through the Installer module. The EtherTalk driver is activated from the network option of the Control Panel. As with all the Ethernet adapters reviewed, software installation was a snap. The MacCon II/E is fully compatible with Apple's EtherTalk driver, so it will run under any network operating software that supports EtherTalk.

The MacCon II/E proved to be the fastest of the adapters tested, helped by a 16K-byte multipacket buffer. The buffer stores packets to relieve I/O bottlenecks and to allow back-to-back packet transmissions. The MacCon II/E posted the fastest times on every test we ran.

Asante includes no special utilities. The documentation offers clear installation steps, but that's it. It provides little background and no troubleshooting information. The manual also lacks a glossary and an index.

Ether+

Compatible Systems takes a different approach to Ethernet connectivity. Instead of sliding into an expansion slot, Ether+ is an external box that connects to the SCSI port of the Macintosh. At \$495, the box offers a lower-cost alternative to internal boards. You can connect Ether+ directly to the Macintosh SCSI port or to the end of a SCSI chain. A SCSI chain comprises up to seven SCSI devices cabled together and connected to the SCSI port of the Macintosh.

Ether+ installation couldn't be easier. You simply plug one end of a 25-pin SCSI cable to the back of the Ether+ box and

plug the other end into your Mac's SCSI port. You then attach the Ether+ power supply and your Ethernet cabling. Ether+ supports both thin and thick Ethernet connections.

From the front panel of the Ether+ box, display lights show status information, configuration data, and diagnostics. Display light 1, for instance, indicates a thin Ethernet connection.

To install the driver software, you boot from an Ether+ disk, double-click on the installer icon, choose an active drive, and click the install button. You then select the EtherTalk driver from the network module of the Control Panel. I had some trouble installing the driver, but only because I had previously installed the Apple EtherTalk NB board. It seemed to confuse my Mac a little. I finally junked the System Folder and reinstalled the driver without incident. Not to worry, though. In the real world, users will rarely face such a conflict. After all, few people would ever install more than one EtherTalk device per machine. Ether+ is register-level-compatible with Apple's EtherTalk driver.

The Ether+ package includes a utility program called Manager+. I found the utilities simple to use and effective. Options from the Manager+ menu cover loopback testing, network statistics and errors, SCSI statistics and errors, and a chart displaying all SCSI devices connected to your Mac, along with their associated SCSI identification numbers.

As expected, the SCSI connector slows down Ether+ somewhat. It ran faster than the LocalTalk connection but slower than the two internal boards. The documentation is clear and has an index.

Taking the Ethernet Plunge

Not everyone needs Ethernet for his or her Mac. LocalTalk should suffice for

small networks with simple traffic patterns. But when nodes start multiplying and traffic gets heavy, your LocalTalk network will bog down. Even so, providing all your nodes with an Ethernet interface is costly, perhaps prohibitively so. You might consider breaking your network into a few LocalTalk workgroups connected to an Ethernet backbone. That way, you keep traffic manageable on the LocalTalk nodes and use Ethernet to handle the heavy-duty traffic.

The Ether+ external box offers some unique advantages over the Ethernet boards. It requires no internal slot, and although it's slower than the internal boards, taking 6 minutes longer to negotiate our 25-megabyte transfer test, it does the job at an attractive price. Also, it doesn't require a NuBus slot. Given the wide range of Apple bus architectures, that can be a significant advantage. Your Mac needs only a SCSI port to join an Ether+ network. If speed is not a primary concern, the Ether+ box is your best bet.

On the other hand, the two Ethernet boards deliver better performance than Ether+, and the cards are tucked out of your way. The MacCon II/E edged out the EtherTalk NB in our tests. It shaved 44 seconds off the EtherTalk NB's time on the 25-megabyte write test. The difference becomes negligible when small files are transferred (a 3-second difference when writing a 5-megabyte file), but speed is not the MacCon II/E's only advantage. It delivers the performance for over \$100 less than the EtherTalk NB board. For Ethernet connectivity, the MacCon II/E boasts the optimum balance in the price/performance ratio. ■

Stanford Diehl is a testing editor for the BYTE Lab. He can be reached on BIX as "sdiehl."

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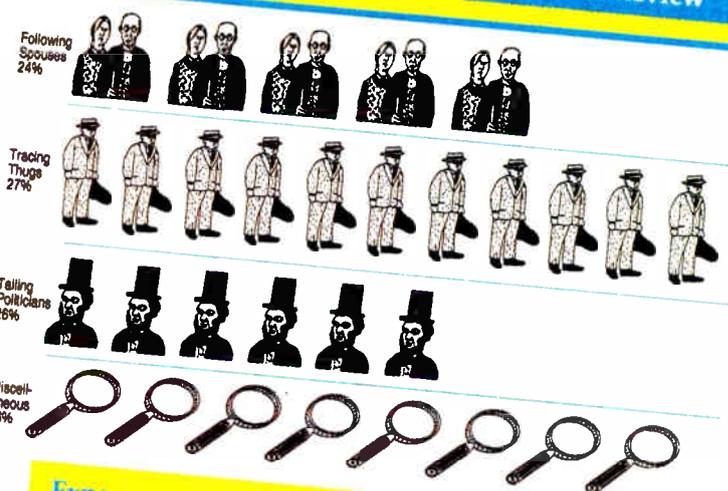
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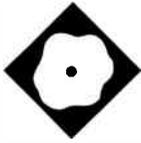
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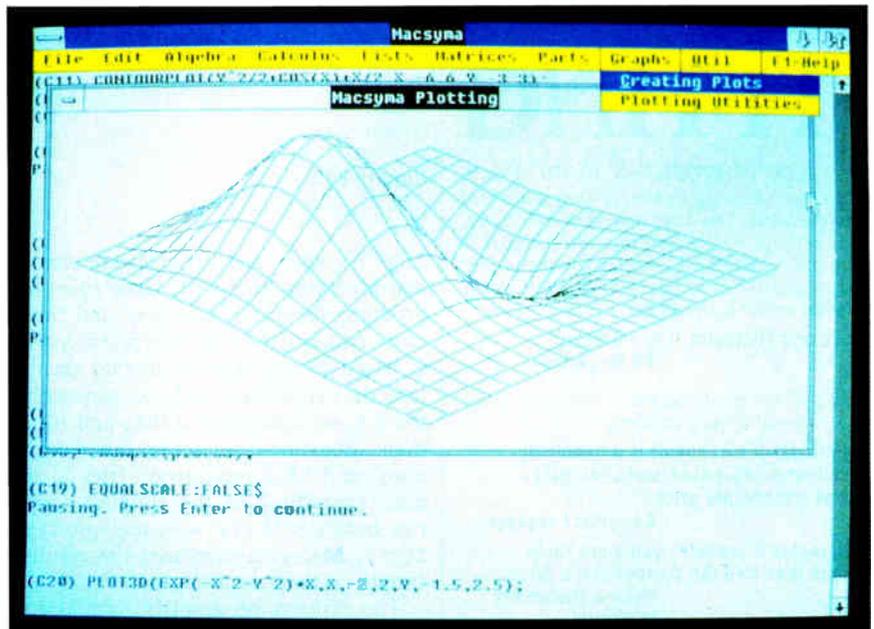
Run Macsyma,
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of computer algebra,
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Peter Wayner

Unlike most PC software, Macsyma—the well-known symbolic algebra program—has a venerable 20-year history, and that's both good and bad. The PC version is an almost complete implementation of the mainframe original that's benefited from an estimated 150 worker-years. But like other mainframe programs, Macsyma is not a small system. The software requires over 18 megabytes of hard disk space to hold the program, and 9 megabytes more for swapping space on disk.

The biggest advantage of Macsyma's 20-year history is reliability. There has been 20 years' worth of bug testing and fixing, and, consequently, the Macsyma code is quite stable and trustworthy. Still, like any program, it's not perfect. For instance, the manual's list of known bugs mentions that Macsyma may flip the sign bit when computing some determinants of sparse matrices. It would be better to have the bug removed, but at least there is a warning.

There's also a huge volume of folk knowledge about the program. Many books about Macsyma are already sitting on the library shelves. Additionally, campuses and laboratories are filled with people familiar with the program and its idiosyncrasies. Many people have even written their own extensions to solve particular problems, and some of the better ones are included in the Macsyma pack-



Menus save you keystrokes when entering equations into PC Macsyma, while windows let you view the resulting graphs.

age as share files. These share files attack a variety of different problems, such as finding Groebner bases, antiderivatives, and solutions to periodic ordinary differential equations. These files alone make up several megabytes of information and experience.

Of course, old age brings its problems as well. Although the basic foundation of the system was designed years ago, layers and layers of modification, revision, and changes have been added. This is part of the reason for Macsyma's large size. Another reason is the language. Macsyma is written in Lisp, and compiling this language into fast, efficient code is difficult because Lisp handles all the memory allocation.

There is, however, one big advantage that Lisp brings to Macsyma: automatic garbage collection. When Lisp runs out of space, it repacks the memory and col-

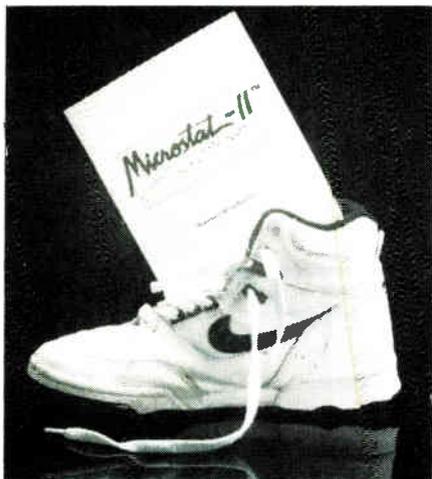
lects all the locations that are no longer used. Symbolic algebra uses plenty of memory, and, when big problems overflow the bounds, garbage collection can often free enough space for the program to continue and finish. Macsyma actually implements 9 megabytes of virtual memory on the hard disk for itself. Most good programs save temporary information to disk, but very few microcomputer programs have used virtual memory on this scale before. For example, Mathematica on the Macintosh does not use virtual memory techniques, which greatly limits the size of the computations Mathematica can handle (see "Symbolic Math on the Mac," January 1989 BYTE).

Macsyma with a Lisp

The basic structure of Macsyma closely parallels the structure of its foundation,

continued

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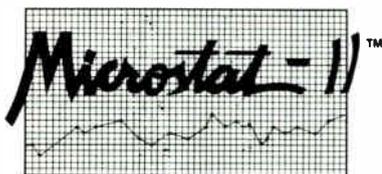
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Inquiry 883.

Lisp. Numbers and variables are *atoms*, and Macsyma knows the basic rules for grouping them into equations and functions. Much of the structure of the system is based in one way or another on the lambda expression, and, consequently, there is no separation of data and functions. Equations can act on other equations, and Macsyma always tries to reduce everything to the simplest form. For instance, if $f(x)=x^2$, and you type $f(y^3)$, Macsyma combines the results, simplifies them, and returns y^6 .

The process of simplification is the most complex part of Macsyma's job. It must try to recognize when it can combine terms or cross out factors. If it finds the integrate function applied to an expression, it must try to find the correct answer. For instance, if Macsyma encounters $\text{Integrate}([f(y^3)], y)$, it must choose the order to evaluate the expressions. In this case, it first expands $f(y^3)$ to give y^6 and then integrates with respect to y and returns $y^7/7$. You can control the amount of simplification or expansion, and learning the often byzantine ways to do this is one of the necessary lessons in becoming a Macsyma guru. For instance, you can specify that polynomials be left in a regular or a rational form; this can make a difference in the speed in which Macsyma discovers the answer.

The language doesn't, however, have the Spartan simplicity of some Lisp implementations. Many baroque extensions are available to tweak system performance for various problems. For instance, you do not have to specify the type of parameters for a function, but

doing so could speed up the program. There are also different versions of many of the main functions used for integration and other operations.

You can use the small functions that these main functions use to internally manipulate expressions and write new simplification routines with them. This can be an advantage for the clever user. For example, you can access the differential equation package in several ways. You can feed the equation into the top, and Macsyma will try many methods until it finds a solution. You can also try the various functions for these different methods alone, and the astute user will be able to guide Macsyma into trying the more specific techniques, like Laplace transforms or Ince's nonlinear equation variations. This sort of access to the high-level functions is typical for all the functions in Macsyma. Unfortunately, you can only really strip away the top layer of the program. The rest is still hidden inside.

In contrast, the basic premise of Mathematica's language is quite different from Macsyma's, and this has advantages and problems. Mathematica is first a pattern-matching simplifier and later a Lisp-like environment. Much of its structure was influenced by latter-day programming language innovations such as Prolog, ML, and Pascal. You can specify extensions in the form $\ln(x*y):=\ln(x) + \ln(y)$, and Mathematica automatically adds them to the table for checking thereafter. But this flexibility has its bad side. Several rules might combine in unforeseen ways to yield infinite loops. Macsyma, in all its baroque glory, also contains many of the same pattern-matching features, but they are not part of the basic structure of the system and are harder to use. Few people even remember that the functions are there.

A Windows Environment

The basic interface of the Macsyma system is not much different from the old versions that ran on teletypes and Tektronix terminals years ago. The equations are formatted with special printing commands that produce integral signs and sigma summation marks out of a handful of well-placed brackets, parentheses, and other characters. The main difference is that all this occurs in a window that has menus to save you keystrokes. Graphs appear in a separate window.

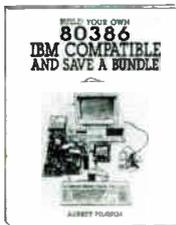
Macsyma runs on top of Microsoft Windows. In case you don't have Windows installed on your system, Macsyma comes with a smaller run-time version of

continued

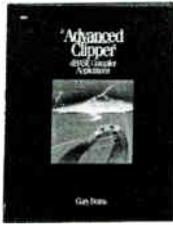
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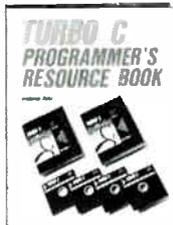
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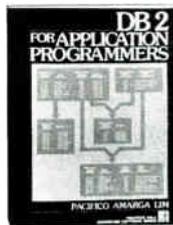
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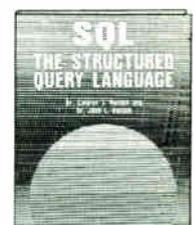
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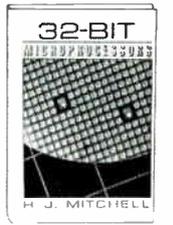
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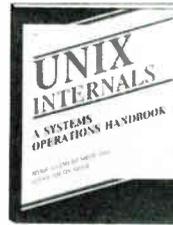
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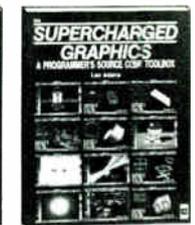
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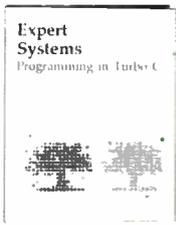
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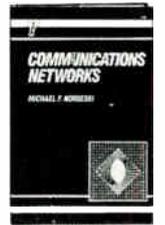
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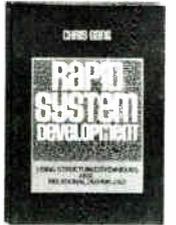
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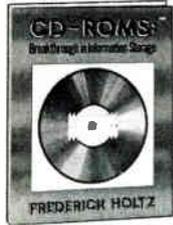
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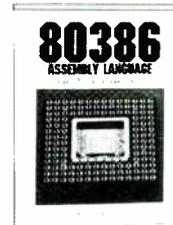
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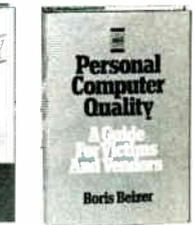
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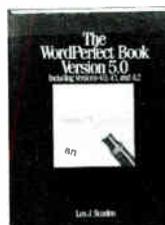
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Windows to let you use the product. The Windows environment lets you pass Macsyma graphs and text to and from other Windows applications, which makes writing documents quite easy.

Macsyma's graphics are complete and functional but lackluster. The system can make line graphs of two- and three-dimensional functions as well as polar coordinate graphs and contour plots. Unfortunately, the output does not rival the sophistication of Mathematica's. There is no shading or color implemented, and the general appearance of the plots dates stylistically to the days when squarish vector fonts were the best computers could do.

Macsyma lets you create demonstration files. These are just a sequence of Macsyma commands and some comments that Macsyma will load in turn. A demonstration file lets you watch the commands run in auto-pilot and learn from the author.

The manuals for Macsyma are just as extensive as the system itself. There are about 1000 pages of documentation divided into three manuals. The first manual is slim and describes all the details

about setting up the PC version. It also discusses the differences between the PC and mainframe implementation. The second manual is a simple introduction to computer algebra. It also has questions at the end of each chapter and answers at the end of the book. The final manual is the largest, and it contains much of the nitty-gritty details about the program.

The prose is efficient and aimed toward mathematically sophisticated engineers and scientists. When algorithms are used, the manual often describes them by name and references them. This is one big advantage over Mathematica.

A good part of the manual is on-line and accessible from the front end. Unfortunately, Macsyma must load the entire help file into memory before it can answer the first question. This takes about 30 seconds. After that, the answers to other help questions come instantly.

The Hardware Variable

As mentioned earlier, PC Macsyma is almost identical to its mainframe implementations. Hardly anything is missing. Unfortunately, it still needs a substantial computer—a fast 80386-based machine

with at least 4 megabytes of RAM and plenty of spare hard disk space (about 28 megabytes for everything).

I also ran a version of Macsyma on a Sun-3/110 and found that the performance was slightly faster than on an 80386 system. The difference is that these workstations have a much faster hard disk drive. The floating-point calculations on the 80386 were much slower because no dedicated hardware was available.

Few will argue that PC Macsyma is the grande dame of the computer algebra world, and this position of age and experience is the source of both its strengths and its weaknesses. Researchers have used the system for 20 years, and these millions of hours of use have shaken several of the bugs out of the system and produced a huge body of sample programs. The guts of the system contain the ability to do a great deal, but you have to contend with its baroque complexity. ■

Peter Wayner is working toward a Ph.D. in computer science at Cornell University. You can contact him on BIX as "pwayner."

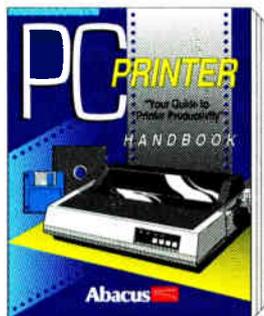
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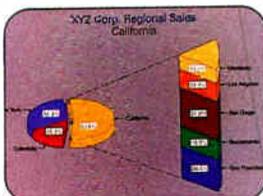
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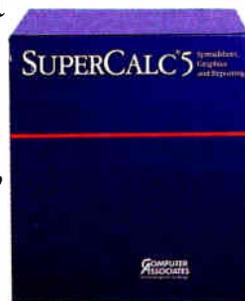
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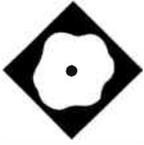
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Glockenspiel Puts C++ to Work

CommonView is a C++
class library
for Windows and PM

Andrew Schulman

Why haven't more C programmers switched to C++? They've been waiting for someone to develop useful class libraries. Glockenspiel's CommonView, a graphical user interface (GUI) toolkit for Microsoft Windows and the OS/2 Presentation Manager (PM), is one of the first such libraries to arrive on the scene.

C++ is defined by a tension between the Spartan machine-oriented world of C and the luxurious object-oriented environment best represented by Smalltalk. An example of a Smalltalk-like C++ class library is Keith Gorden's enormous public domain library for the National Institutes of Health. As in Smalltalk libraries, the NIH class hierarchy descends from a "cosmic" object from which all other classes inherit. CommonView, by contrast, is minimal. It doesn't implement a full-blown class hierarchy. For example, you can't cause any object to appear in a window by sending it the message "Print Yourself." Instead, it's a framework for constructing graphical applications that port across platforms. Without a doubt, the C++/CommonView combination is far more congenial than Microsoft's gruesome Windows and PM software development kits.

The C++ program in listing 1 (HELLO.CXX) is a GUI "hello world!" program. By changing a few command-line switches to the Glockenspiel C++ trans-

lator, you can compile the program either for Microsoft Windows or for OS/2 PM. The source code does not change. The program behaves identically in the two environments; it displays four windows with the text "hello world!" in 18-point Times Roman. You can manipulate each window independently of the others. Double-clicking in a window changes the text from "hello world!" to "C++ CommonView" or back again. If you resize a window, the text stays centered in the window; the program prevents you from making the window smaller than its text.

As is typical in graphical environments, you need a lot of equipment to compile and run even this simple program. Although CommonView comes with the excellent Glockenspiel C++ translator, you must separately acquire the Microsoft C Compiler 5.1 or higher and either the Windows software development kit (SDK) or OS/2 PM Softset. The C++ translator turns C++ source

code into rather unreadable C target code, which is then passed to the Microsoft C Compiler. To link a Windows or PM executable file, you need the import libraries, and any but the most trivial programs need the resource compiler and dialog box editor provided with the Microsoft development kits. For serious work, you want the version of the C++ compiler that uses Rational's DOS/16M extender; it's available for \$100.

You won't be directly calling any of the routines in the Windows or PM Application Programmer Interface (API), however. Instead, a CommonView program calls routines from the class library—a Windows or PM dynamic-link library (DLL) that can be freely distributed with any application that uses CommonView. In listing 1, I created a class Hello that inherits from the class TopAppWindow. As table 1 shows, a TopAppWindow inherits from the AppWindow

continued



CommonView simplifies the classic "hello world!" demonstration.

class, which in turn inherits from the Window class, which inherits from the EventContext class. Therefore, any function I write as part of my Hello class can call any public function implemented by the classes above it in this hierarchy. For example, the constructor for the Hello class calls `AppWindow::EnableSysMenu` and `Window::ChangeFont`.

These functions do the actual work of calling the Windows or PM APIs.

Event-Driven Programming
Veteran GUI programmers will find HELLO.CXX refreshingly different. It is a lot smaller than the API-oriented equivalent. `CommonView` invisibly handles registering the Window class, setting

up the message loop, and dispatching the window messages. C++ constructors—functions called implicitly when an instance of a class enters scope—can automatically create windows. In the function `App::Start`, which is equivalent to `WinMain` in a Windows program, I created four windows simply by creating an

continued

Listing 1: *The CommonView version of "hello world!" is refreshingly different from the Windows or Presentation Manager equivalent.*

```
// hello.cxx -- CommonView "hello world!" application
// Windows: ccxx -Gw -Zp hello.cxx hello.def /NOE -lw
// OS/2 PM: ccxx -Lp -Gw -Zp hello.cxx hi_pm.def os2.lib /NOE -lcap -ohi_pm

#include "commonvu.hxx"

inline int operator< (Dimension& d1, Dimension& d2)
{ return (d1.Width() < d2.Width()) || (d1.Height() < d2.Height()); }

inline Dimension operator+ (Dimension& d, int i)
{ return Dimension(d.Width() + i, d.Height() + i); }

inline Dimension operator- (Dimension& d1, Dimension& d2)
{ return Dimension(d1.Width() - d2.Width(), d1.Height() - d2.Height()); }

inline Dimension operator>> (Dimension& d, int i)
{ return Dimension(d.Width() >> i, d.Height() >> i); }

char *str[2] = { "hello world!", "C++ CommonView" };

class Hello : public TopAppWindow {
    Dimension dText, dWin;
    char *s;
    Font f;
    int i;
    long far Expose(ExposeEvt e); // WM_PAINT
    long far ReSize(ReSizeEvt e); // WM_SIZE
    long far MouseButtonDb1C1k(MouseEvt e); // WM_?BUTTONDBLCLK
public:
    far Hello();
};

void App ::far Start() {
    Hello h[4]; // create four initially identical, but independent, windows
    Exec(); // go! start the event-handling loop for this app
}

Hello ::far Hello() : s(str[0]), i(0), f(Roman,Dimension(18,18)) {
    EnableSysMenu();
    EnableBorder();
    SetCaption(s);
    ChangeFont(&f);
    dText = TextSize(s);
    Show(); // to inherit from class W, move Show() out of constructor
}

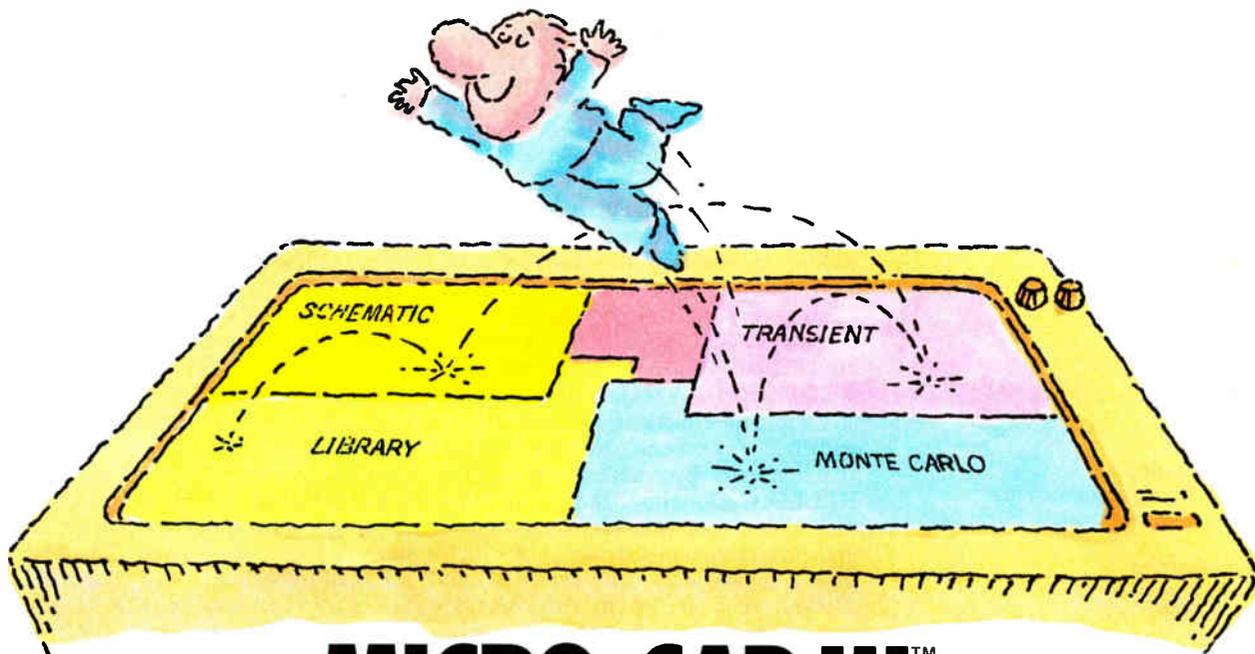
long Hello ::far Expose(ExposeEvt e) {
    Dimension tmp = (dWin - dText) >> 1;
    TextPrint(s, Point(tmp.Width(), tmp.Height())); // center text on window
}

long Hello ::far ReSize(ReSizeEvt e) {
    if ((dWin = e.GetNewSize()) < dText) // store away window size
        ChangeSize(dText + 100); // make sure it's not too small
}

long Hello ::far MouseButtonDb1C1k(MouseEvt e) {
    s = (i ? str[1 = 0] : str[1 = 1]); // toggle the string
    if (dWin < (dText = TextSize(s))) // store away text size
        ChangeSize(dText + 100); // make sure window's not too small
    RePaint(); // redraw the window
}
```

Table 1: *Rather than a single tree, CommonView has a forest of classes.*

- COMMONVIEW
CLASS HIERARCHIES**
- Accel
 - App
 - Bitmap
 - Brush
 - Caret
 - Color
 - Control
 - FixedIcon
 - FixedText
 - ScrollBar
 - HorizScrollBar
 - WndHorizScrollBar
 - VertScrollBar
 - WndVertScrollBar
 - TextControl
 - Button
 - CheckBox
 - PushButton
 - RadioButton
 - Edit
 - MultiLineEdit
 - SingleLineEdit
 - ListBox
 - Cursor
 - Event
 - ExposeEvt
 - ReSizeEvt
 - MouseEvt
 - FocusChangeEvt
 - ControlEvt
 - etc.
 - EventContext
 - Window
 - AppWindow
 - ChildAppWindow
 - TopAppWindow
 - DialogWindow
 - Font
 - Icon
 - MessBox
 - ErrorBox
 - Menu
 - SysMenu
 - Pair
 - Dimension
 - Point
 - Range
 - Selection
 - Pen
 - Rectangle
 - ResString



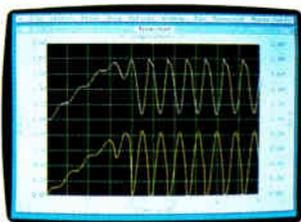
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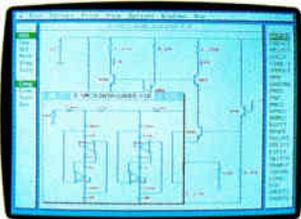
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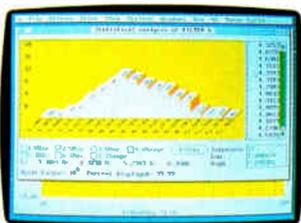
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Software Needed

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Windows or OS/2; Microsoft C Compiler
5.1 or higher; Microsoft Windows SDK
or OS/2 Softset

Documentation

Programmer's reference manual

Price

\$499
DOS-extender version of compiler: \$100

Inquiry 886.

array of four instances of the Hello class.

What I like best, though, is that there is no event loop. Instead of the central switch statement at the heart of most GUI programs, a CommonView program uses a collection of handlers for specific events. For example, I wanted all windows of my Hello class to handle WM_SIZE and WM_PAINT messages, so I wrote the functions Hello::ReSize and Hello::Expose. Note that these functions are never called from within HELLO.CXX. How, then, can they work? The Window class implements several private virtual functions, of which these are two. Any class derived from Window, such as Hello, can override these functions. When the CommonView dispatcher calls Window's Expose, Hello's Expose runs. This loosely structured approach is ideal for handling the event-driven GUI environment.

The Expose function "knows" where to send output. In Windows and PM, you've got to explicitly acquire a handle to a device context (hDC) and then supply that as an argument to all drawing commands. But in HELLO.CXX, Text-

Print simply sends a string to a window. CommonView automatically maintains the connection between the handler and the window. Note also that no static variables are used to store the application's state, as is often the case in Windows code. C++ classes are the perfect place to put state information. For example, in ReSize, I store window dimensions where they belong—in each window's own dWin variable. Since Expose and MouseButtonClick are derived from class Hello, they refer directly to dWin.

I also have to commend Glockenspiel for simplifying Windows' handle-based heap management scheme. This feat is achieved by means of two classes, GlobalAllocator and LocalAllocator, derived from a general class called FreeStore. For example, within an instance of GlobalAllocator, calls to new and delete use the Windows global heap. You can then create a lock object that converts a handle to a pointer; when the object leaves scope, its destructor performs the corresponding unlock. More generally, FreeStore (along with a related class, Container) provides a flexible, extensible framework for

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implementing RAM- and disk-based storage schemes for C++ objects.

Where's the Beef?

Although CommonView excels at handling events and managing storage, it's minimal in other respects. For example, although the Window class provides the function `ChangeFont`, which changes the font associated with a window and returns the previous font, if you want to query the current font without changing it you have to resort to trickery. There's no built-in function to query the current screen dimensions. The only graphical objects are lines and rectangles.

A sample program on the distribution disks shows you how to use the undocumented `DrawObject` class, with its "back-door" functions `GetDeviceContext` for Windows and `GethPS` for PM, to draw ellipses, but it's silly to resort to these functions for something so basic. (Apparently, the `DrawObject` class will be documented, and expanded to include ellipses, in the next release of CommonView.) Many important aspects of the Windows interface—printing, the clipboard, metafiles, and dynamic data ex-

change—aren't supported in the current version of CommonView.

Glockenspiel's answer to this is that you can always "kick down" to the underlying Windows or PM interface to add functionality. That's a good feature, but when its use is recommended not only for fine-tuning but to perform basic tasks, such as drawing ellipses or finding out the current screen dimensions, something is wrong.

CommonView does not provide the level of convenience you expect from an object-oriented toolkit for GUI programming. Table 1, which depicts the CommonView classes, shows one reason why. Instead of a single tree with its root in the `Object` class, there is a forest of classes. Because they do not have a common ancestor, these classes do not support the kind of polymorphism that is available in a Smalltalk-like class library. For instance, in CommonView, a `Control` object and a `Window` object have nothing in common, even though conceptually these classes have a great deal in common. In fact, in PM, a control is a type of window, but such connections will be hard to establish with CommonView's

multiple class hierarchies.

One of the main objections to the Smalltalk approach to class libraries is that applications built on such a foundation grow to unmanageable proportions. Yet, ironically, both of the environments that CommonView now operates in support dynamic linking, and the CommonView libraries are already in DLL form.

CommonView 1.1 should be out by the time you read this, with new documentation, large-model support for Windows and PM, and better support for graphics. CommonView 1.2 is due soon. Along with the C++ 2.0 translator, it's slated to provide support for printing.

Glockenspiel is to be applauded for showing how C++ can manage many of the notorious difficulties of event-driven GUI programming. Still, CommonView must offer more conveniences if it's to become a compelling alternative to low-level API-oriented programming in C. ■

Andrew Schulman is a software engineer living in Cambridge, Massachusetts, and specializing in networked CD-ROM products. He can be contacted on BIX c/o "editors."

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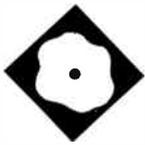
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Develop Advanced Expert Systems

GoldWorks II brings the power of graphical, Lisp-based expert-system development to 80386 PCs

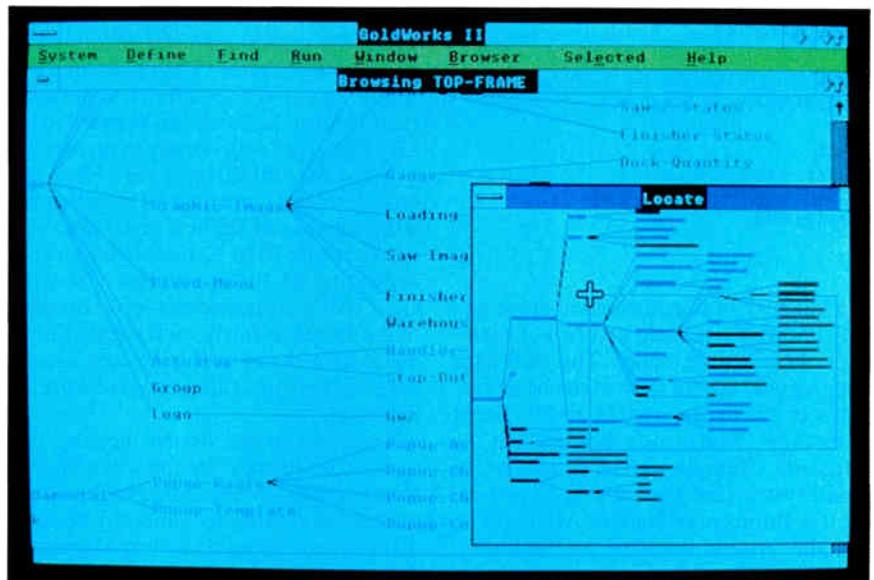
Rodd Halstead

GoldWorks II brings a set of features to the 80386 PC platform that previously were available only on Lisp machines and other high-end workstations. These features include a full implementation of Common Lisp, a graphical user interface, object-oriented programming (OOP), rule-based programming, and tutorial and reference documentation, all integrated within a hybrid expert-system development environment.

All this power, of course, comes with a price. GoldWorks II costs \$7900. To run it, you need an 80386-based machine with at least 8 megabytes of extended memory (in addition to the base DOS memory), approximately 16 megabytes of hard disk space, and an EGA, VGA, or other high-resolution monitor supported by Microsoft Windows (which is also required). A mouse is not strictly required but is essential to efficient navigation of the system. All this just lets you develop applications. When you decide to deliver your expert system, you need to purchase run-time licenses from Gold Hill at a cost of between \$100 and \$300 each, depending on volume.

What Is GoldWorks II?

GoldWorks II is a serious effort to render, on a PC, the basic features of a high-



The rule and frame browsers in Gold Hill's GoldWorks II give you the ability to navigate with ease.

end expert-system shell like Intellicorp's Knowledge Engineering Environment (KEE) or Inference's Automated Reasoning Tool (ART). Just a few years ago, software researchers were laying out upwards of \$100,000 to experiment with these systems, which ran only on Lisp machines. An expert-system shell has the same relationship to expert systems as a DBMS has to database applications. A shell provides the reasoning engine and a comprehensive set of tools for building applications.

GoldWorks II is a scaled-down version of this same technology with one big plus in its favor: It doesn't require a Lisp machine to develop or deliver applications. The basic idea behind GoldWorks II was to implement 80 percent of the functionality of its expensive cousins and make everything run on standard PC hardware. Like KEE and ART, GoldWorks II has a menu interface that lets nonprogrammers build applications, and a de-

veloper's interface that allows full access to the underlying Common Lisp implementation. It's a "hybrid" expert system, because it implements both "rule" and "frame" strategies of representing knowledge. It also sports a user interface builder that lets you define screen objects, such as active dials and gauges.

By the time you read this, versions of GoldWorks II for the Sun and Macintosh platforms will have been released. Because these products rely on the operating systems, window systems, and Common Lisp implementations available on those platforms, GoldWorks II applications developed on any platform are immediately portable to the others. This review, however, pertains only to the PC version.

The GoldWorks II package is imposing. Along with the software, you receive three boxes of documentation—approximately 3000 pages in all. But don't let

continued

GoldWorks II

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the quantity of documentation scare you off. It's well organized and full of examples with source code. The 300-page user's guide covers most of the basic features of the expert system and its menu interface. The guide begins with a hands-on example called ShipMate, a small system that gives advice on cost-effective shipment of freight. After you've got the system installed and running, you'll be able to create a small, but real, expert system in about an hour.

Of course, you must locate a machine with enough memory and hard disk space to install the seven high-density floppy disks that contain the software. The machine I used was a Compaq 386/25 with 9 megabytes of extended memory. The major installation hurdle I encountered was simply locating a copy of Microsoft Windows/286 version 2.1. You might think this requirement is strange considering that GoldWorks II runs only on 80386 PCs. But Windows/386 doesn't work with the Virtual Control Program Interface (see "Stretching DOS to the Limit," *IBM Special Edition*, Fall 1989), and so it conflicts with GoldWorks II's underlying DOS extender, Eclipse Computer Solutions' OS/386.

Stress Testing

After running the demonstration programs, I decided to see how GoldWorks II would perform with a sizable database. The Gold Hill demonstrations are interesting enough, but none contains more than a dozen rules or frames. In real life, an expert system uses hundreds

of rules. I didn't have access to such an expert system, so I simply defined a frame called COMPANY, wrote a Lisp program to make instances of that frame, and used the Lisp program to import a database of 500 companies into the GoldWorks II environment.

The source file containing these object definitions was 150K bytes in size. When represented in the GoldWorks II lattice (i.e., the expert-system object database), the system RAM available decreased by 1 megabyte. When I used the menu system to view the COMPANY frame definition, there was a long pause before the inspector came up, after which the system memory decreased by another 600K bytes. Then I defined two simple rules. While trying to match the rules against the database, I landed in the Lisp debugger with no way to recover.

What does all this tell you? First, you probably need more than 10 megabytes to build substantial applications. (Gold Hill recommends 10 to 12 megabytes and up, depending on the application.) Second, Gold Hill's representation of knowledge in the lattice is fairly inefficient. Third, the system is not well protected against the eventuality of running out of working memory.

Lack of generic virtual memory is a serious deficiency in the current PC-based system. While Gold Hill has some technology to swap function code to disk, there is currently no way to use hard disk space to hold objects and rules. The result is system fragility under memory stress. Since the memory required for matching rules to objects in the lattice is likely to be vast, there appears to be no way to guarantee that a system will continue to run in all circumstances.

A second major issue in evaluating GoldWorks II is the quality and completeness of the underlying Common Lisp compiler. The compiler's adequacy clearly impacts on the GoldWorks II implementation itself and on any application-specific code called within rules or the object system. While it would take another article to fairly evaluate the Lisp system alone, my test was relatively straightforward: Could Gold Hill compile and run a Common Lisp implementation of OPS5, a rule-based programming language invented at Carnegie Mellon University? OPS5 was actually used by DEC to build XCON and XSEL, expert systems that configure computer installations and sales. Here Gold Hill passed with flying colors. A few compiler warnings later, the classic "monkey and bananas" example was running in OPS5. The compilation, however, took a

long time, but after all, a Compaq 386 is not really a Lisp machine.

Inside a GoldWorks II Application

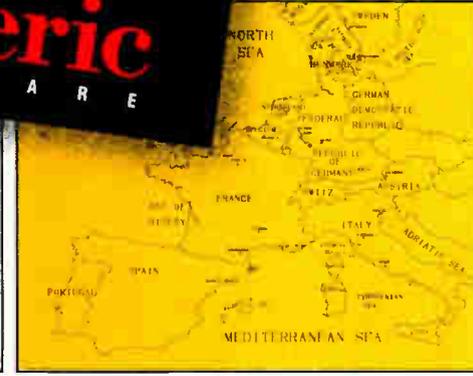
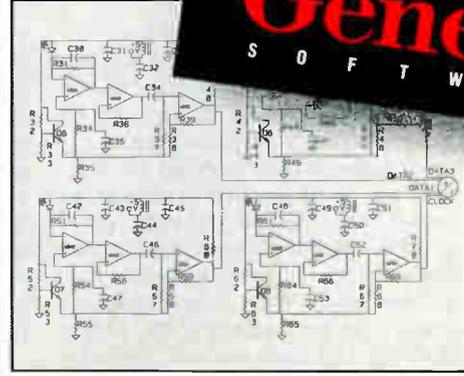
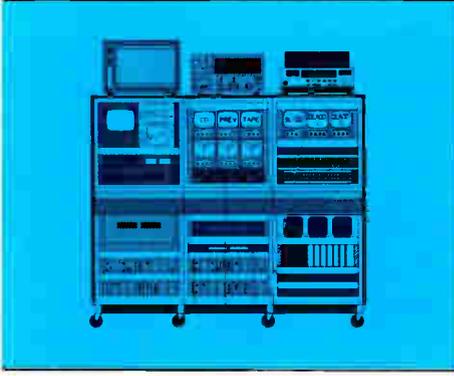
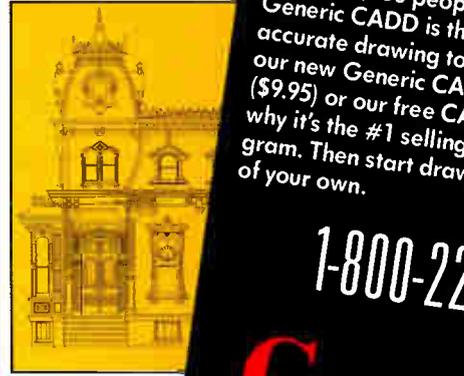
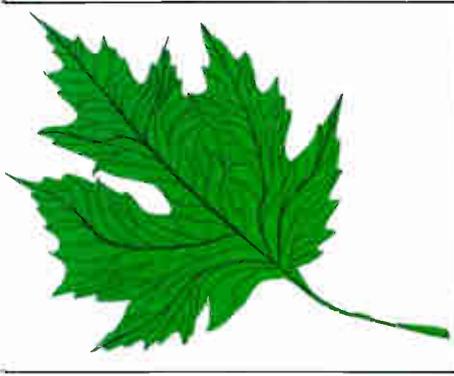
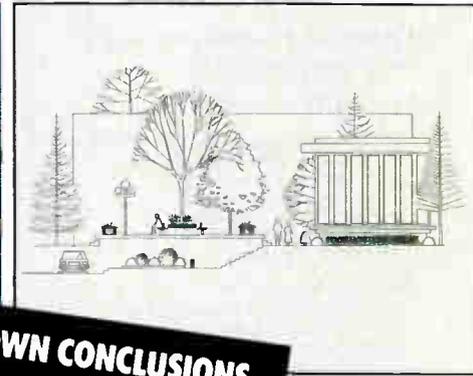
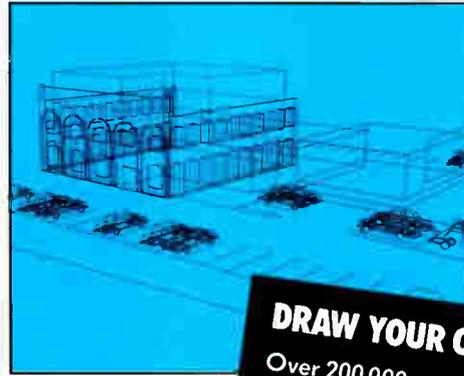
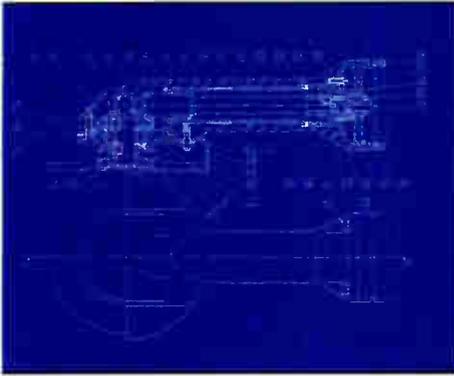
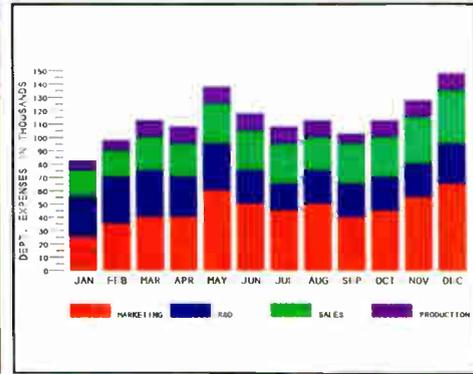
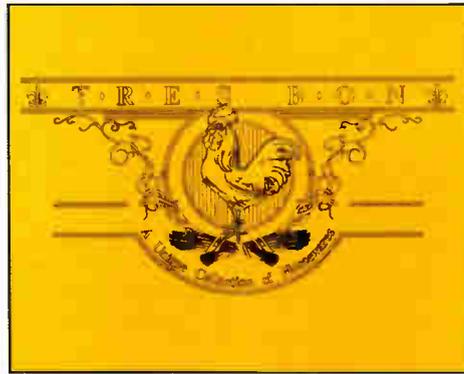
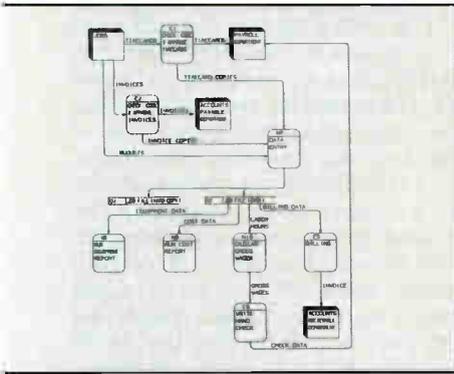
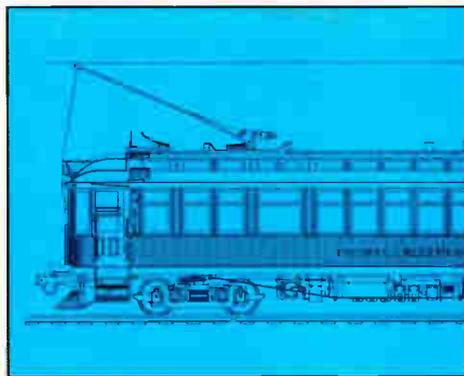
To illustrate GoldWorks II in action, I made some changes to the power plant demonstration, an application that simulates the workings of an electrical power generation plant. This example uses the frame language, message handlers, rules, and objects from the user interface builder to create a working control-panel layout. The application presents a screen with a master shutdown switch, active dials that represent individual turbine outputs in revolutions per minute and watts, total plant output, and gauges to represent operating temperature and pressure of the turbines. When the pressure in one of the turbine housings exceeds a maximum value, the color of the gauge changes from blue to red and a warning appears in the status window.

The DEFINE-FRAME form, shown in listing 1, creates a template for a turbine-housing. A turbine housing has five "slots" of its own, and it also inherits all slots belonging to the machine and plant-property classes. Slots have facets (attributes) that govern their behavior. This form shows some of the simplest facet types, like :CONSTRAINTS and :DEFAULT-VALUES. GoldWorks II defines 14 standard facets and also supports user-defined facets. In this case, the turbine slot is constrained to hold an instance of the turbine class.

The DEFINE-INSTANCE form (see listing 1) shows you how to create an instance of a turbine-housing. Note that the instance does not have to provide definitions or values for all the slots defined by the frame. For example, the max-pressure slot along with its facets (the default value) is inherited by the turbine-housing-1 object. This definition also illustrates the linkage of instance slot values to graphical objects in the interface. The pressure and temperature slots define a when-modified facet that contains a list of functions that are run whenever the slot value is updated. In this case, the function called is a GoldWorks II screen-update function.

Like all other objects in GoldWorks II, graphical objects can be created interactively with the user interface builder or by editing frame and instance definitions. GoldWorks II defines a small class system of about a dozen graphical images; these can be used directly or customized by the developer. The standard images include dials and gauges, which can display values within a numeric

continued



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Listing 1: Frame and instance definitions from the power plant application.

```
(DEFINE-FRAME turbine-housing
 (:IS machine plant-property)
 (pressure
 :CONSTRAINTS (:RANGE (20 480))
 :DEFAULT-VALUES (100))
 (max-pressure :DEFAULT-VALUES (400))
 (min-pressure :DEFAULT-VALUES (100))
 (state :DEFAULT-VALUES (normal))
 (turbine :CONSTRAINTS (:INSTANCE-OF
 turbine))
 )

(DEFINE-INSTANCE turbine-housing-1
 (:IS turbine-housing)
 (pressure
 :VALUE 279
 :WHEN-MODIFIED (GW::UPDATE-IMAGE))
 (turbine turbine-1)
 (temperature
 :VALUE 1000
 :WHEN-MODIFIED (GW::UPDATE-IMAGE)))
```

Listing 2: A rule that reacts to a low-pressure situation.

```
(DEFINE-RULE pressure-low
 ()
 (INSTANCE ?housing IS turbine-housing
 WITH pressure ?pressure
 WITH min-pressure ?min)
 (<= (- ?pressure ?min) 20)
 (INSTANCE ?tank IS GAUGE
 WITH DISPLAYED-OBJECT
 (?housing pressure))
 THEN
 (INSTANCE ?tank IS GAUGE
 WITH FILL-COLOR :YELLOW)
 (INSTANCE ?housing IS turbine-housing
 WITH state low-pressure)
 (INSTANCE status-window IS
 OUTPUT-WINDOW WITH DISPLAY
 ("Pressure too low in " ?housing)))
```

range, as well as enumerated types (e.g., high, medium, and low).

Other standard images implement single and multiple choice menus, line and dialog boxes. The graphical images are active in the sense that they can both display and modify values. When you point to a gauge and click, the value of the underlying object is updated.

Programming with Rules

All the GoldWorks II features I've examined so far fall within the domain of OOP. At the OOP level alone, GoldWorks II stands out as a simple, powerful, and complete application generation system. Yet GoldWorks II is unlikely to be used for its OOP features alone. Other languages, such as Smalltalk and Actor, have similar characteristics at a fraction of the size and cost. What makes GoldWorks II an expert-system shell is its inference engine, which applies procedural

knowledge represented as rules to the database of instance objects. Here is an example of a simple rule:

```
(DEFINE-RULE turbine-shutdown
 ()
 (INSTANCE ?turbine IS turbine
 WITH state shutdown)
 THEN
 (INSTANCE ?turbine IS
 turbine
 WITH output 0))
```

The rule has two parts, the antecedent ("if" clause) and consequent ("then" clause), which define patterns that the inference engine matches to the knowledge base. When the rule is run in a forward direction, the antecedent is used to query the database and the consequent to update the database. This rule says, "Look for all turbine instances with the state slot equal to shutdown, and set the output slot equal to 0." Note that the syntax of the antecedent and consequent clauses is identical. The consequent says nothing about updating values. This similarity is required, because rules can be run in two directions. GoldWorks II supports all the major strategies for rule matching: forward and backward chaining and goal-directed forward chaining.

At this level, rule-based programming does not appear to be all that different from nonprocedural database query languages. But rules are really what separates expert-system technology from conventional programming. Rules let you control system behavior without specifying the exact flow of control. In an expert system, the equivalent of the conventional programmer's "flow of control" is the dynamic pattern created by the inference engine as it matches and fires sets of rules. Rules have two important properties as a programming language: They are closer to English than they are logically independent statements—you should be able to change one of the rules in your system without having to modify other rules.

The power plant demonstration contains rules that monitor turbine housing and signal dangerous pressure conditions. The simulation, as shipped by Gold Hill, had a surprising behavior. After a high-pressure warning was triggered, you could intervene and reset the pressure of the offending housing. However, if the pressure was set too low, the pressure gauge did not return to its normal blue state. Why? The pressure-normal rule was designed to recover from both high-pressure and low-pres-

sure situations. But when the pressure changed from too high to too low, no rules matched; the user interface continued to display the pressure gauge in sure states by adding a new rule, pressure-low (see listing 2).

This simple illustration gives the flavor of the rule-definition syntax but just barely touches on the GoldWorks rule language. Since this language is implemented on top of Lisp and the frame language, a programmer can easily incorporate Lisp function calls within rules, as well as directly manipulate objects using message-passing protocols. The rule language also sports many other advanced features, like support for certainty factors, active rule sets, sponsors, and agenda items. Certainty factors allow the representation of statements like "if X then it is likely that Y" in the rule base.

Rule sets and sponsors are mechanisms for reintroducing procedural control over the firing of rules by the system. The inference engine works in a two-part cycle. First, all the rules are matched against the lattice. Every time a rule matches, an agenda item is created. The agenda item is a promise to fire that rule at some later time. Only after all possible agenda items have been created does the engine change the state of the system by firing clauses in the rule consequents. Agenda items let the programmer exercise control over the order in which rules fire and change the state of the lattice.

At the simplest level, rules can be assigned priorities, and the program puts the agenda items in order according to those priorities. At the next level, agenda items can be divided into hierarchical groups called sponsor objects. Sponsors can be enabled and disabled, allowing further control over when and if rules are fired. Rule sets are similar to sponsors with the additional twist that a deactivated rule set is effectively removed from the system. This prevents the inference engine from wasting time matching rules that do not apply to the current task.

No discussion of the GoldWorks II environment would be complete without a look at program debugging features. GoldWorks II supports a wide variety of breakpoint types that enable the developer to halt the inference engine and inspect the state of the system. Breakpoints can be set to monitor rules, frame instances and slot values, Lisp functions, sponsors, and assertions. Once a breakpoint is triggered, you can use browsers to visualize the frame and instance lattice, as well as the dependency graph of

continued

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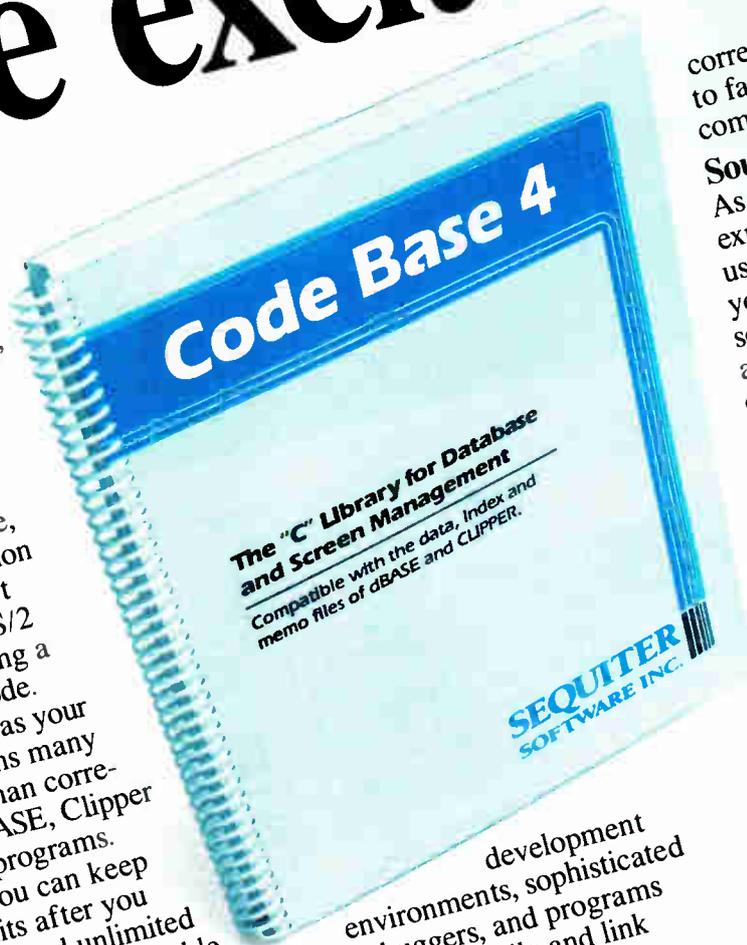
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rules and associated agenda items. The partial matcher provides another way to debug rules. You can set a breakpoint to interrupt before a rule fires and then use the partial matcher to inspect each clause of the rule to see how many instances or assertions match at that point.

Going for the Gold

Just how well has Gold Hill succeeded in putting Lisp and expert-system technology in a PC box? Overall, Gold Hill has done an excellent job. GoldWorks II is notable for the simplicity and power of its basic design.

The biggest current weaknesses in the 80386 environment are the lack of virtual memory management and questionable performance. Gold Hill indicates that future development of its DOS system will be in the direction of industry standards like Windows 3.0 and OS/2, and the company hopes to solve the virtual memory problem in that context.

The performance issue has two facets. First, how good is the Gold Hill compiler? The consensus in the developer community is that Gold Hill has a fast, but not the fastest, Lisp around. Second,

what about the inference engine and development environment? Here I think improvement is needed. GoldWorks II seems much slower than stripped-down rule-based languages like OPS5, or logic languages like Prolog. If raw performance and application size are big concerns, you might consider GoldWorks for prototyping but switch to a more economical language for delivery.

The portability of GoldWorks II applications to Sun and Mac workstations is a big win for Gold Hill. Since GoldWorks is written in Common Lisp, system code, which does not involve the user interface, is directly portable to other Common Lisp implementations. To make its user interface portable, the company has built the GoldWorks II interface and facilities on top of its own Lisp Windows package. By rewriting the internals of the Windows package for each platform, Gold Hill has defined a generic user interface model that all three hardware platforms can share. An added advantage to the Sun platform is that Unix provides virtual memory, which would make large applications run more securely.

By the time you read this, Gold Hill

should have released a run-time delivery system that will enable applications developed in 10 to 12 megabytes of memory to run on machines with 2 to 4 megabytes of memory. In the past, Lisp-based systems have been great for developing the application, but impractical for delivering it. An efficient delivery scheme will be the acid test of Gold Hill's claim that GoldWorks II is "the practical shell."

The unanswered questions about GoldWorks II are really the unanswered questions about Lisp technology in general. Does a Lisp environment provide tremendous leverage for application prototyping and development? Yes. GoldWorks II provides most of that leverage. Is Lisp a commercially viable alternative to C? Well, that depends on who you are and what you need to accomplish. In most markets, Lisp is clearly out. But if your application is low-volume, high-value, and maintenance-intensive, GoldWorks II just might be the answer. ■

Rodd Halstead is a software engineer and Lisp aficionado based in Cambridge, Massachusetts. He can be reached on BIX c/o "editors."

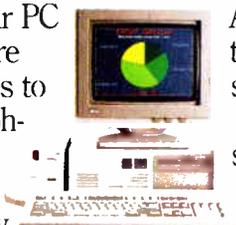
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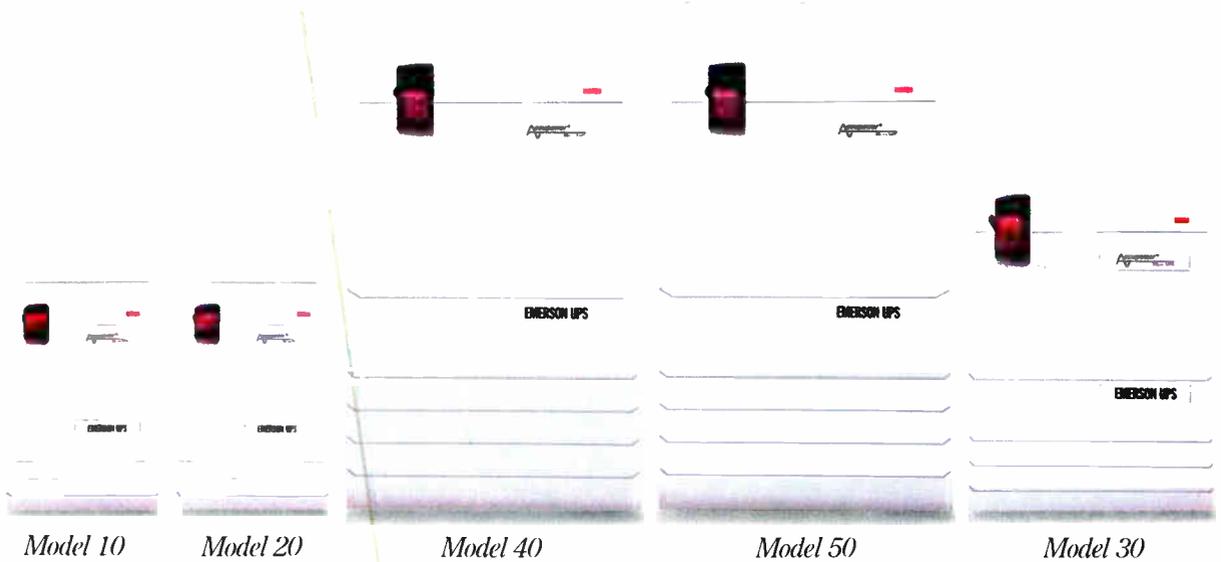
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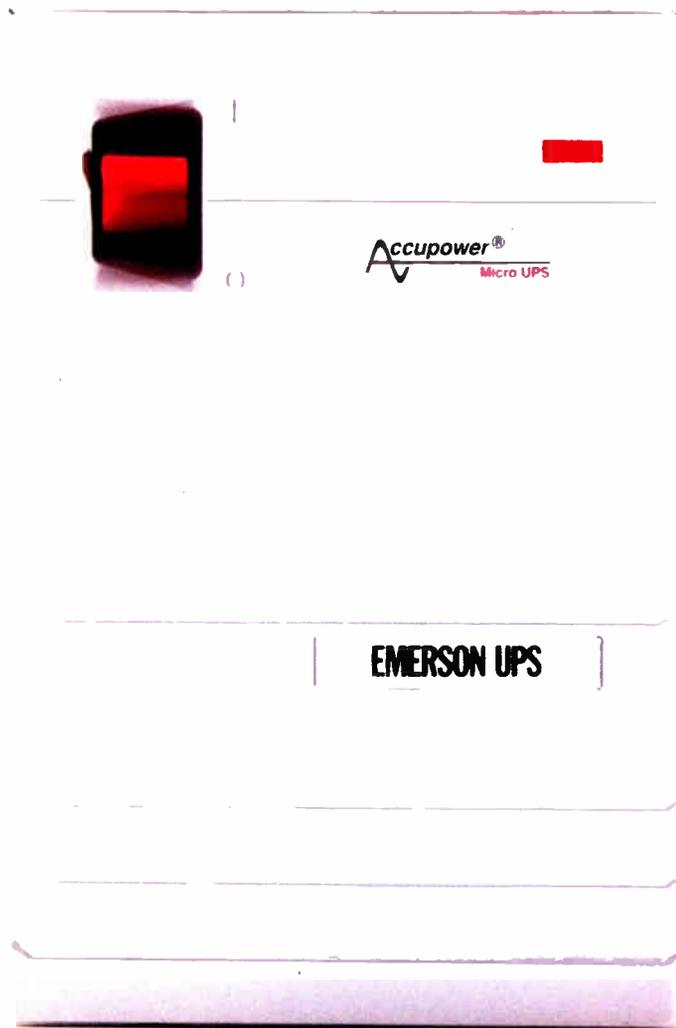
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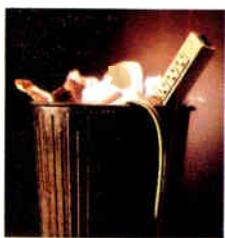
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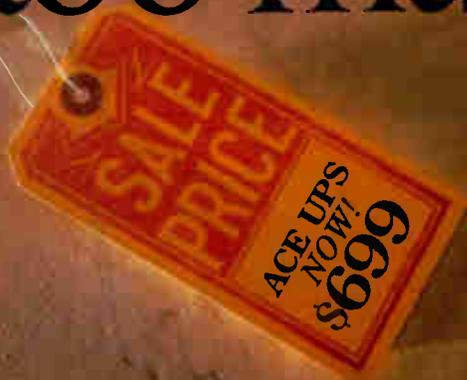
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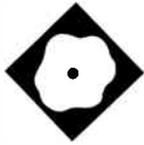
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Dan Bricklin's PageGarden broadens the repertoire of your LaserJet-compatible printer

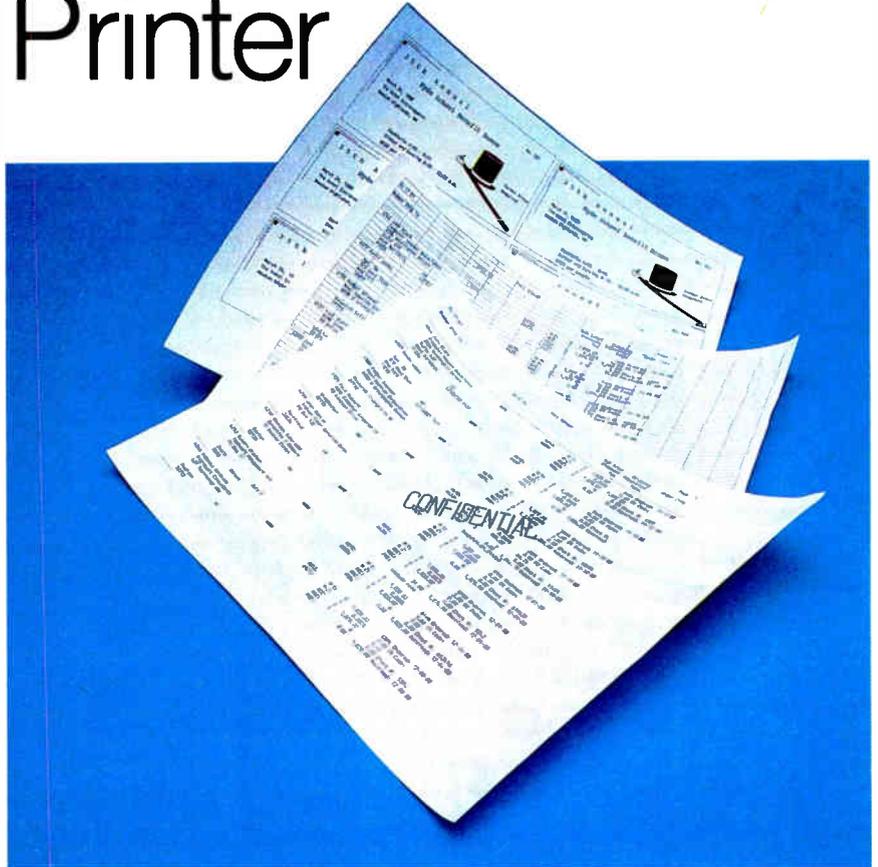
G. Michael Vose

Long-time personal computer users are going to love Dan Bricklin's PageGarden. This text formatter, designed specifically for laser printers, bucks the current trend toward WYSIWYG software products and hearkens back to a day when you formatted printed documents with flexible, programmable tools. Although not as sophisticated a formatter as Donald Knuth's T_EX, PageGarden gives you formatting power mixed with a pleasant dose of simplicity.

PageGarden lets you use your Hewlett-Packard LaserJet-compatible or PostScript printer to print out a database file or even a bit-mapped graphics file stored in .PCX format—without resorting to the native applications. PageGarden becomes an invaluable tool when you work with older versions of software that have no laser printer support. PageGarden can even print sequentially numbered badges and tickets, white-on-black letters, and gray images and type. You merely supply an ASCII file and the creativity to build an appropriate description file.

A Fertile Field

PageGarden's 107K-byte executable file works with a description file that you create to engage the features of your laser printer. The first time I printed a file



Dan Bricklin's PageGarden formats plain ASCII text on laser printers. The grid lines, shaded bars, and "CONFIDENTIAL" stamp shown here are all done by PageGarden.

with PageGarden, I was stunned by how quickly my printer started spitting out printed pages. Neither the printer driver in my word processor (XyWrite) nor the one in my desktop publisher (First Publisher) work as fast with my HP LaserJet II as PageGarden.

You call PageGarden from the MS-DOS command line with one or more options or switches. These command-line calls take the form `lsr -test1 myfile.asc`. PageGarden's filename is `lsr`, `test1` is the filename of a description file, and `myfile.asc` names the ASCII file that PageGarden prints.

Invoking PageGarden from the command line like this will appeal to traditional power users who've resisted the

move to graphical user interfaces. Unfortunately, if you haven't resisted that move, you will have a tougher time launching PageGarden, since you must first shell out of your GUI to get to the MS-DOS command line, run PageGarden, and then return to your windowing system.

PageGarden features 27 switches, including options that let you change the output device name, sort filenames, print only odd or even pages, output Encapsulated PostScript, or print a range of pages. You can even use the @ character followed by a filename to tell PageGarden that there is further option text in the named file. All PageGarden command-

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Matrix Ops	13.2	66.2	56.5
QuickSort	1.6	2.5	2.3
4P CALLS	0.3	1.0	0.6

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line options use a hyphen (-) for identification, similar to many language compilers.

The PDSL

Description files contain the text commands of the PageGarden Description Statement Language (PDSL). These commands give PageGarden its power and flexibility. The 63 PDSL commands let you place text on a page, change fonts, draw boxes and lines, incorporate bit-mapped graphics into a document, orient the text on a page, repeat actions, and obtain variable input from a user during printing. In short, PageGarden's language lets you write programs to control the format of your printed documents.

These "programs" exist as description files. You can write and save on disk as many description files as you like. When you need to print a file, you choose the description file you need—or write and save a new one—and invoke it as an option with the PageGarden program.

Each PDSL command takes a variety of arguments. For example, the Place command, which displays lines from a file on a printed page, requires at least four arguments—a starting point expressed by *x* and *y* coordinates, plus a number for the first and last lines to be printed. This language gives you a great deal of programming flexibility.

Harvesting PageGarden's Bounty

You can accomplish much with the programming power of the PDSL and description files. For example, you can print labels that include your company

logo in the return address. You can print tickets—several to a page—that might be used for a theater performance or charity raffle, and you can use PageGarden's number utility to sequentially number those tickets. You can print the filename and directory path—plus the date last modified—in headers or footers of program listings.

PageGarden comes with eight Bit-stream fonts plus a special font for printing the extended IBM PC character set on a PostScript printer. The program also includes over 35 sample description files, and you can use PageGarden without ever writing your own description file. The package even provides a translucent plastic rule for inch, centimeter, and typographical point measurements for designing your own layouts.

The manual supplies a top-notch tutorial and a full reference for the PDSL. The fully indexed manual is well written and organized to let you easily find the information you need.

Garden of Delight

PageGarden becomes an addiction when you first start using it. The PDSL provides you with plenty of opportunity to experiment with different kinds of formatted output. I found myself writing new description files just to play with different looks for fonts and boxed and shaded text areas.

Once the novelty wears off, you'll probably find yourself using PageGarden frequently. After a few weeks, I began to wonder how I got along without it. I've always had trouble printing Quattro files on my LaserJet, but PageGarden solves that problem nicely. Printing out downloaded E-mail with good-looking, space-saving designs without having to manually format the text (I have a standard description file just for that purpose) also saves me time and effort.

Finally, I get real satisfaction from programming PageGarden. I use desktop publishing software to lay out text and graphics, but I actually enjoy writing a quick program to do a similar job. Of course, PageGarden can't do all the things a desktop publishing program can (e.g., you can't put a single word or phrase in a different font), but what it lets you do, it lets you do easily. PageGarden falls into that genre of programs that provide utility with a good deal of personal satisfaction. ■

G. Michael Vose coauthors OS Report, a newsletter on OS/2, and writes frequently about the PC industry. He can be reached on BIX c/o "editors."

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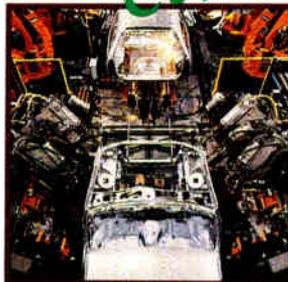
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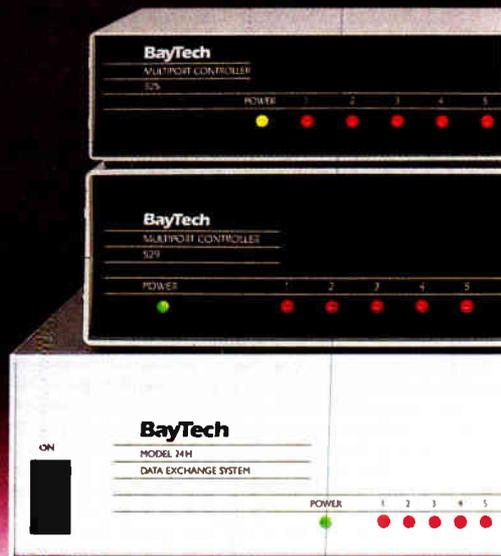
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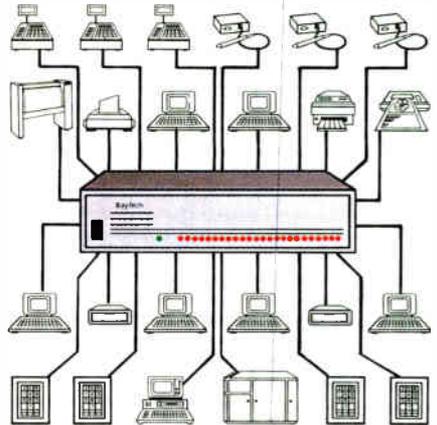
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Reviewer's Notebook

Reviewer's Notebook is a compilation of brief reviews and updates to previously published evaluations. BYTE will publish Reviewer's Notebook each month on a space-permitting basis.

33 MHz on the Cheap

Fortron sells PCs directly to end users at rock-bottom prices, and its 33-MHz 80386 system is no exception. The \$3950 NetSet 333 is the least expensive 33-MHz system BYTE has reviewed.

I tested the NetSet 333 tower version. The basic machine (\$4050) includes 1 megabyte of 70-nanosecond DRAM, 64K bytes of 15-ns static RAM cache memory, one 5¼-inch or one 1.2-megabyte 3½-inch MiniScribe floppy disk drive, two serial ports, a parallel port, a Western Digital ESDI hard disk drive controller, and a 230-watt power supply.

My \$6150 test system included 4 megabytes of RAM, a 33-MHz 80387 math coprocessor, a Tatung 14-inch multisync monitor, a 16-bit VGA controller, a 157-megabyte MiniScribe ESDI hard disk drive, and a 300-watt power supply. Multisoft's Super PC-Kwik disk accelerator utility was also included.

Inside, the system has eight expansion slots (one 8-bit, one 32-bit, and six 16-bit). Four slots hold the ESDI controller, I/O card, and display adapter. The hard disk drive hides on a shelf inside the box. In my test machine, a 5¼-inch floppy disk drive occupied one of the two half-height 5-inch bays, leaving one 5-inch



Fortron's low-cost 33-MHz 80386 system, the NetSet 333.

bay and two 3½-inch bays available.

The system is well designed overall, but the tower case is flimsy. A gentle push against the top of the box twisted it; a good shove against a floor-mounted unit could move expansion cards in their slots, possibly causing a short. If you buy the NetSet, get the desktop model.

Compatibility was not a problem; various add-in cards and programs ran fine.

I compared the NetSet against the Compaq Deskpro 386/33 and the 386/33 from PC Link, another direct-mail vendor (see table 1). (To see how 14 other

33-MHz machines fared, see "Megahertz Madness," *IBM Special Edition*, Fall 1989.) The Deskpro 386/33 was slightly faster than the NetSet in the low-level benchmarks, and differences in the applications tests were even less significant. The NetSet held a clear margin over the PC Link in the low-level CPU tests and easily beat the PC Link's poor showing in the low-level video tests and the scientific/engineering application tests.

The NetSet performs well against the Compaq, but it competes more directly against the PC Link and other mail-order machines. At press time, a similarly configured PC Link machine was several hundred dollars more. Fortron also offers better performance and the same one-year on-site warranty. If you'd like to get 33-MHz performance without the \$10,000 price tag, Fortron's NetSet is worth a look.—*Rob Mitchell*

continued

NetSet 333

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(415) 373-1008
Base system: \$3950
System as reviewed: \$6150
Inquiry 859.

Table 1: *The Deskpro held the advantage in the low-level tests, but the application benchmarks showed less difference. The NetSet bested the PC Link's weak video performance. (Indexes show relative performance; an 8-MHz IBM PC AT=1.)*

BENCHMARK RESULTS

	Low-level indexes				Application-level indexes					
	CPU	FPU	Disk I/O	Video	WP	Spread-sheet	Data-base	Sci./Eng.	Compilers	Cumulative
NetSet 333	5.65	14.85	2.45	3.76	4.37	4.27	2.88	7.57	4.04	23.13
Compaq Deskpro 386/33	6.09	15.50	2.90	4.53	4.28	5.01	3.00	7.86	4.46	24.61
PC Link 386/33	5.10	14.87	2.83	2.11	5.03	4.43	2.68	5.51	4.36	22.01

For a full description of all the benchmarks, see "Introducing the BYTE Benchmarks," June 1988 BYTE.

Track Calls Automatically

TimeScribe, an automatic call tracker, just might be a better way to use the telephone. It is a combined program and add-in board. Whenever you receive or place a call, the program pops up over whatever application you may be running and lets you enter notes about the call. It tracks how long you talk, generates reports for billing purposes, and displays previous discussions you have had with each caller. If you've talked about a particular subject with a number of people, TimeScribe will bring up notes from each of those conversations.

If you dial a number manually (TimeScribe can also dial numbers for you), TimeScribe captures the number and compares it to the numbers it knows. If it recognizes the number, the program asks for a topic and lets you enter notes about the conversation.

It handles incoming calls almost as efficiently. Although TimeScribe has no way of knowing who's calling until you tell it, it does the next best thing. TimeScribe presents its people directory in a point-and-shoot menu, and you select the

name of who's calling. If someone new calls, you just type in his or her name.

I used TimeScribe on my 80386-based AT compatible. The half-length TimeScribe board fits into an 8-bit slot. The board includes two telephone jacks for in-line telephone connections.

As a stand-alone program TimeScribe worked fine, but I also tried it in other ways. I loaded it as a TSR program and ran other applications in the foreground. TimeScribe normally takes only about 70K bytes of free RAM. But most of the program (64K bytes) located itself in my EMS memory; it took up just 6K bytes in my 640K-byte DOS partition.

I found only two compatibility conflicts. One was with Lotus Agenda, a personal information manager often used for call tracking; few people would probably want to run it with TimeScribe, anyway. The second occurred with XyQuest's XyWrite, which takes complete control of the keyboard.

I used TimeScribe successfully as a separate program with DESQview 386, although I had to remember to switch to

its window. It did not work well, however, as a TSR program loaded before DESQview.

I didn't like the way TimeScribe presented information on the screen. Whenever I made a phone call, TimeScribe displayed a lot of information—too much for my tastes. I might need to know the exact time of the last call sometimes, but not always. And I'd like to be able to remove the function key template from the bottom of the screen.

Also, I would have preferred TimeScribe to handle free-form text like Agenda does, by extracting the information it needs to assign topics. However, for such a small TSR program, that may be too much to ask.—*Dennis Allen*

TimeScribe 1.01
WordTech Systems, Inc.
P.O. Box 1747
Orinda, CA 94563
(415) 254-0900
\$299.95
Inquiry 860.

Pascal for Purists

What is it that sets Visible Software's Dr. Pascal apart from Borland's, Microsoft's, and MetaWare's Pascal compilers? The other three flunked the British Standards Institution's ISO 7185 validation suite. Dr. Pascal came "fairly close to conformity." Why does conformity matter? As C programmers are discovering, a language standard (and products that conform closely to it) is important for multiplatform development.

Dr. Pascal doesn't compile standard Pascal programs; it only interprets them. On the PC, its capacity is limited: 64K bytes of program text, 28K bytes of "executable" code, and 20K bytes of data. Further, it provides no direct access to the machine or to the operating system. But for \$89 you get a highly integrated package that includes the interpreter, a debugger, a structure editor, and a text editor. The price and mix of features will appeal primarily to educators, which is appropriate because Dr. Pascal is a great environment for Pascal beginners.

Dr. Pascal stores your source code in a single .PAS file, but you view that file as a hierarchy of module names. Using the structure editor, you create and rear-

range a program's modules. To edit a module's text, you highlight its name and invoke the screen editor.

The interplay between the structure and text editors goes beyond what typical integrated environments offer. That's because the Dr. Pascal interpreter constantly updates its internal representation of the program. The interpreter knows a lot about the program and can communicate intimately with the editors. In the screen editor, for example, you can jump straight from an identifier to its declaration, or from a procedure call to the module that contains the procedure.

The debugger steps through source code and automatically displays all the static variables that are in scope. Each procedure or function occupies a box divided into code and data regions. These procedure boxes scroll, and as the call stack deepens, pending modules move off-screen. There are a couple of ways to control how much code and data you can see: Each module has adjustable visibility settings, and if your main program contains global variables that you want to watch, you can instruct it not to scroll.

You can also control the size of each

module's procedure box. The breakpoint facility helps you focus on the part of the program that you want to examine.

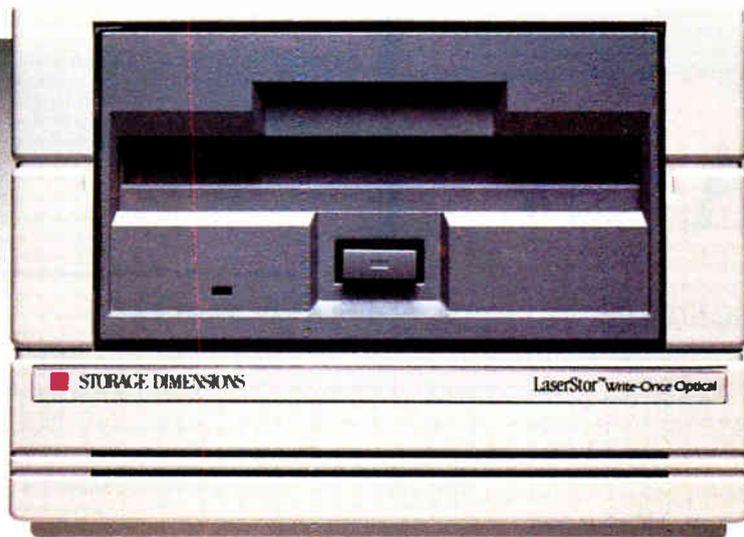
Although the debugger isn't as fancy as, say, Borland's Turbo Debugger (you can't view pointer-linked structures or evaluate expressions), it delivers useful information with a minimum of fuss.

I couldn't find a single standard Pascal program to test Dr. Pascal on, so I "de-Turbo-ized" a Turbo Pascal program. In the process, I rediscovered the elegant simplicity of standard Pascal. Although Modula-2 and object-oriented Pascals are rapidly superseding it, standard Pascal remains an excellent foundation for novice programmers. Dr. Pascal's faithful and accessible implementation makes it a valuable educational tool. ■

—*Jon Udell*

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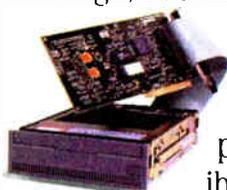
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BIX CALENDAR

JANUARY

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J A N U A R Y

Amiga Exchange Opens

BIX now has an exchange tailored to the needs of Commodore Amiga computer users. Edited by Joanne Dow, the Amiga Exchange brings together Amiga users from all over the world so that they may discuss all aspects of working with an Amiga computer, exchange tips, and download files from BIX's huge Amiga software library. With the exception of some Commodore-sponsored conferences for commercial developers, the Amiga Exchange conferences are open to the public. They include: *amiga*, *amiga.arts*, *amiga.hw*, *amiga.int*, *amiga.special*, *amiga.sw*, and *amiga.user*.

Special Event

THURSDAY, 1/4, 8:30-9:30 PM EST. Ada when the chips come down.

Ada is a large language, but it's one of the first languages to be available when a new chip comes out. Hear Randy Brukardt and Dan Stock of R.R. Software discuss Ada's portability. (join *janus.ada/cbix*)

All-Month Conferences and Special Events

IBM Exchange—Each Wednesday night this month at 10 PM EST, the IBM Exchange will focus on computer languages (join *ibm.exchange/cbix*). More specifically, we'll help PC-users learn about C and how to write a communications program, and we'll provide a question-and-answer session for beginning and intermediate PC-users. Check *ibm.exchange* for a master directory of all files for the IBM PC- and MS-DOS-based computers that are available through the IBM Exchange. We also have CBix sessions every weeknight at 10 PM EST.

Mac Exchange—With the new year, let the Mac Exchange help you resolve to clean up your hard disk. In *mac.products/jan.90*, we'll help you defragment your life by taking a long look at disk utilities and discussing various products such as SUM II and Disk First Aid. Meanwhile, the *mac.novice/tutorial* will continue for the C programmer.

BIX Conference News

The law and the computer virus is a topic that will be discussed in the "law" conference by experts from Illinois and Minnesota, two states that passed new legislation in 1989. (join *law/virus*)

Which computer viruses—are lurking about? Find out in a special conference about these critters. (join *security/critters*)

If you've got a grammar gripe, or if you're sick of sullied syntax, you can vent your spleen on-screen in the "journalism conference." (join *word.flame*)

Ryan McFarland, developers of COBOL language products, has joined the BIX Vendor Support Group, and the company

is ready to answer your questions concerning its products and their applications. (join *ryan.mcfarland*)

The "Bowl Games" aren't the only games in January . . .

Consider this full calendar, on the Interactive Games Exchange:

Sundays, 9 PM EST—Poetry, art, music and stories from by-gone days to yet-to-come days are featured in this conference. (join *fun.n.games/game.room*)

Sundays, 9:30 PM EST—Learn about role-playing games on line and off line at Fantasy Foundation College. (join *ff/ff.col*)

Mondays, Thursdays, and Saturdays, 9 PM-Midnight EST—Check into the Meade & Mirth Inn and enjoy free-form, role-playing games that take you back to the Middle Ages—and sometimes far into the future. (join *mnm/inn*)

Tuesdays, Wednesdays & Saturdays, 9:30 PM EST—Enjoy real-time fantasy role-playing games as well as message-based player interaction in Ledinworld, the Advanced Dungeons & Dragons center of the IGX. (join *lworld/ledinworld*)

Thursdays, 10:15 PM EST—Break in on Pandemonium, the contemporary parlor games and other social activities in the "game room." (join *fun.n.games/game.room*)

Fridays, 9 PM EST—Begin your T.G.I.F. nights in the pursuit of trivia. (join *fun.n.games/game.room*)

Fridays, 9:30 PM EST—Play a role in a variety of role-playing games. (join *encounters/new.worlds*)

And don't miss the special *Mystery Guest Night*, Thursday, January 11, at 9 PM EST (join *more*)

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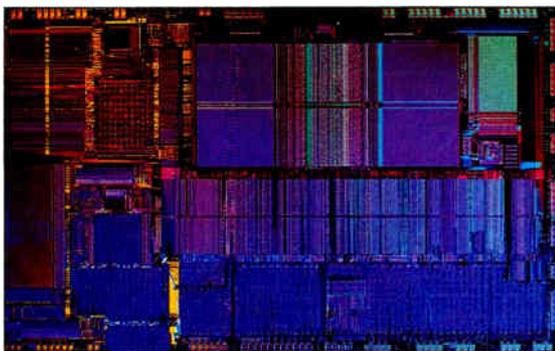
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The State of Chips

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The subject of chips may sound esoteric, but chips provide the very foundation on which our industry is based. Simply put, without chips we have no microprocessors, we have no computers, we have no industry.

The technology behind the chips—the types of substrates and platforms used and the size, speed, and density of the elements on them—enables us to attain faster processing speeds and more capability in less space than ever before. The desktop microcomputer of today easily exceeds the performance of the average mainframe of 20 years ago, as well as that of the average minicomputer of 5 years ago.

This In Depth section explores the state of chips today. It begins with Bob Ryan's "Farewell to Chips?" which examines semiconductors, both technically and historically, in terms of their capabilities and their limitations. It's a fascinating story.

Then, the section provides more detail on three promising technologies. In "The High-Octane Semiconductor," Phillip Robinson discusses the pluses, the minuses, and the possibilities for gallium arsenide, the most prominent current example of Group III-V semiconductor technology.

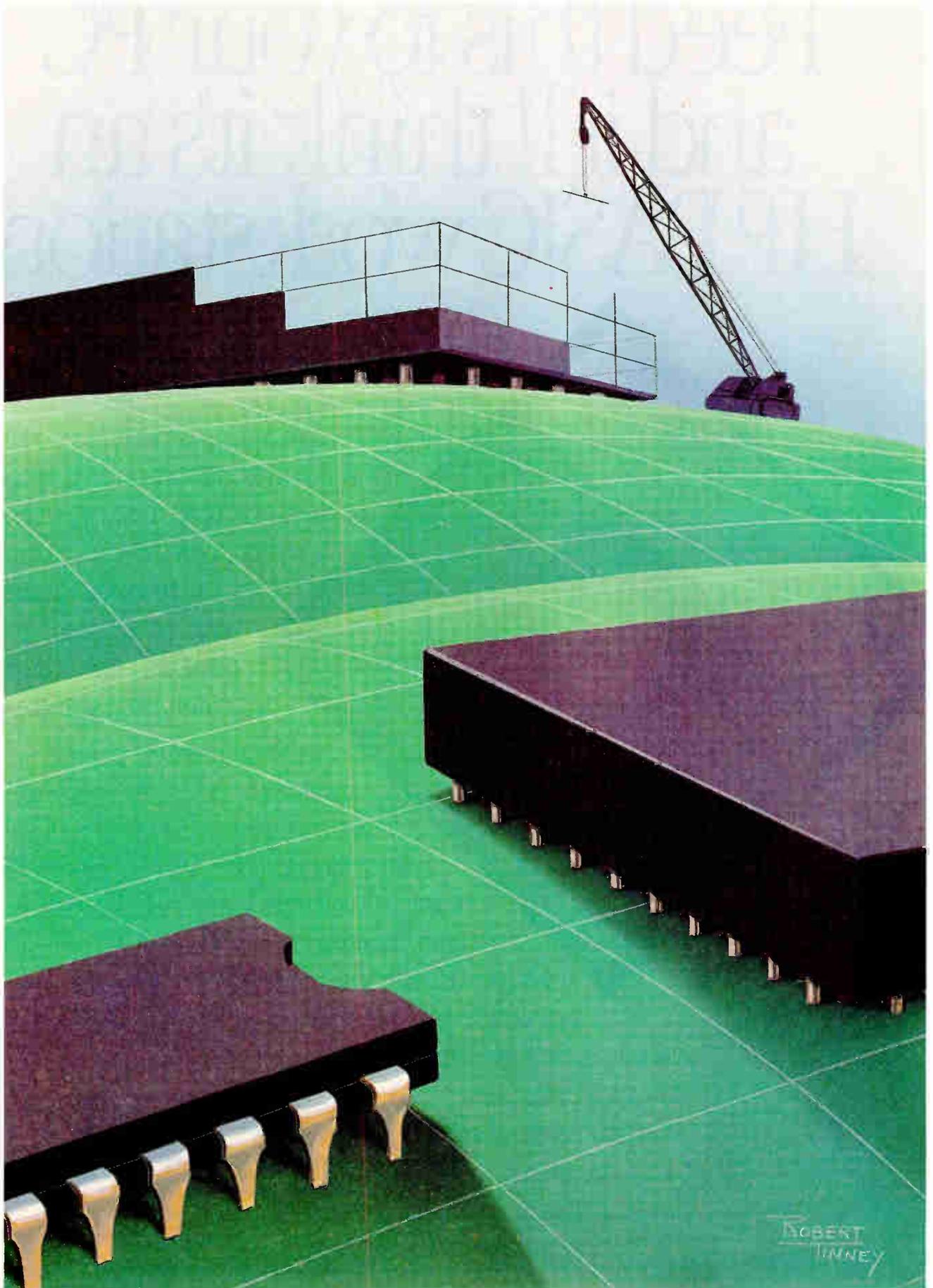
Next, in "A Marriage Made in Silicon," Bob Ryan examines BiCMOS, a technology that combines bipolar and CMOS technologies on the same chip. BiCMOS may well signal the demise of the familiar TTL-interface standard.

Finally, in "Creating Custom Chips," Trevor Marshall looks at electrically

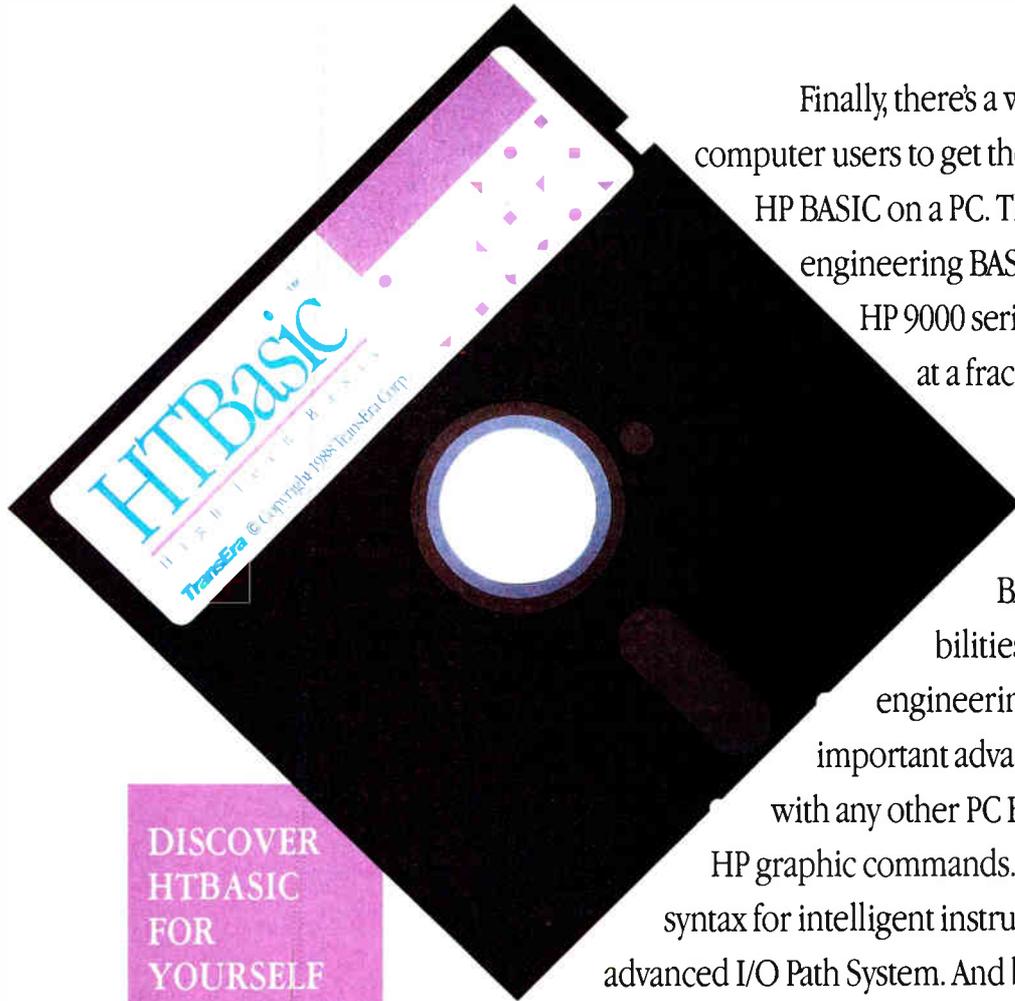
programmable logic devices. The EPLD is a more flexible alternative to the application-specific integrated circuit—if you make a mistake, you simply reprogram it. The capability to do this is built in; it takes only hours to accomplish.

Why should you care about the state of chips today? Because chip technology makes it possible for today's microcomputers to overtake increasingly larger and more expensive machines of yesterday, putting more and more power and performance on your desktop for less and less money. And because chip technology makes it possible to dream about—and possibly even attain—supercomputer performance on your desktop tomorrow.

—Jane Morrill Tazelaar
Senior Technical Editor, In Depth



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Farewell to Chips?

Like a marathoner after 20 miles, semiconductor technology is approaching the wall. What lies beyond?

Bob Ryan

No doubt about it, we are spoiled. We have come to expect ever-faster and more-complex processors and ever-expanding memory as if they were a birthright. The fact is, however, that semiconductor technology is approaching some fundamental limits that will halt semiconductor development in its tracks, and it may reach these limits as early as the year 2000. The good news is that the development of replacement technologies is well under way.

Merry Christmas

Modern electronics began on December 23, 1947, when John Bardeen, Walter Brattain, and William Shockley of Bell Laboratories first produced the *transistor effect*. They discovered that the conductive properties of a semiconductor diode could be controlled by a third electrode. Their first effort was a point-contact transistor.

Transistors form the basis of all digital computers. The fact that you can switch current on and off in a device depending on the state of a second input is the basis of all digital logic. Outside the electronics industry, however, the introduction of



transistors in 1948 elicited very little excitement. By the time Bardeen, Brattain, and Shockley picked up their Nobel Prize in 1956, however, transistors were recognized as the critical component in the nascent electronics revolution.

Integrated Circuits

Throughout the 1950s, transistors were refined in many ways. In particular, they

became smaller and dissipated less power as heat. Semiconductor firms supplied the transistors and other components used by electronics firms to produce everything from hearing aids to radar systems. Everyone inside and outside the industry recognized the importance of miniaturization, but only a few people were able to see the next logical step.

In October of 1958, Jack Kilby of Texas Instruments placed two circuits on a single piece of germanium. The device was crude, and the interconnects on the chip had to be hand-wired, but this device is generally credited with being the first IC.

At about the same time, Fairchild Semiconductor introduced the *planar transistor*. Planar processing created a transistor in which all three

electrical connections reside on one surface of the device. Planar processing involved the etching of components and the diffusion of necessary impurities onto a substrate. It allowed the simultaneous fabrication of many circuits on a single substrate and thus was the forerunner of current fabrication techniques.

Soon afterward, Robert Noyce of

continued

Transistor Refresher

Transistors are the basic building blocks of digital logic devices. The most important function of transistors is to enable you to control the flow of current through them with a third electrical connection. For digital logic devices, this means that you can turn the primary flow of current on and off.

Transistors come in two types: *bipolar* and *field-effect*. Bipolar transistors use both electrons and holes as charge carriers. Field-effect transistors (FETs) are unipolar because only electrons or holes are used as charge carriers. Bipolar devices are harder to fabricate than field-effect devices, but they exhibit a much higher frequency response. In effect, they switch faster.

Two-Way Street

Bipolar transistors are divided into three primary regions: the emitter, the base, and the collector. The primary flow of charged particles in a transistor is from the base to the collector.

The emitter region injects minority-charged carriers into the base. The emitter thus controls the flow of primary-charged particles through the base. If few or no minority carriers are injected, the current flows from the base to the collector. If the emitter injects many minority particles, the current flow from base to collector is stopped. Rectification takes place at the barriers between the emitter and the base (the emitter barrier), and between the collector and the base (the collector barrier).

Conduction by Induction

FETs consist of two regions of one type of conductivity located on a substrate of the opposite conductivity—for example, two n-type regions on a p-type substrate. The flow of current is from one n-type region (the source) to the other (the drain). The p-type region between the two is called the channel. Above the channel is an insulating layer (silicon dioxide—SiO₂—in silicon-based MOS-FET devices); above the insulating layer is a region of metal film called the gate.

Without voltage on the gate, the

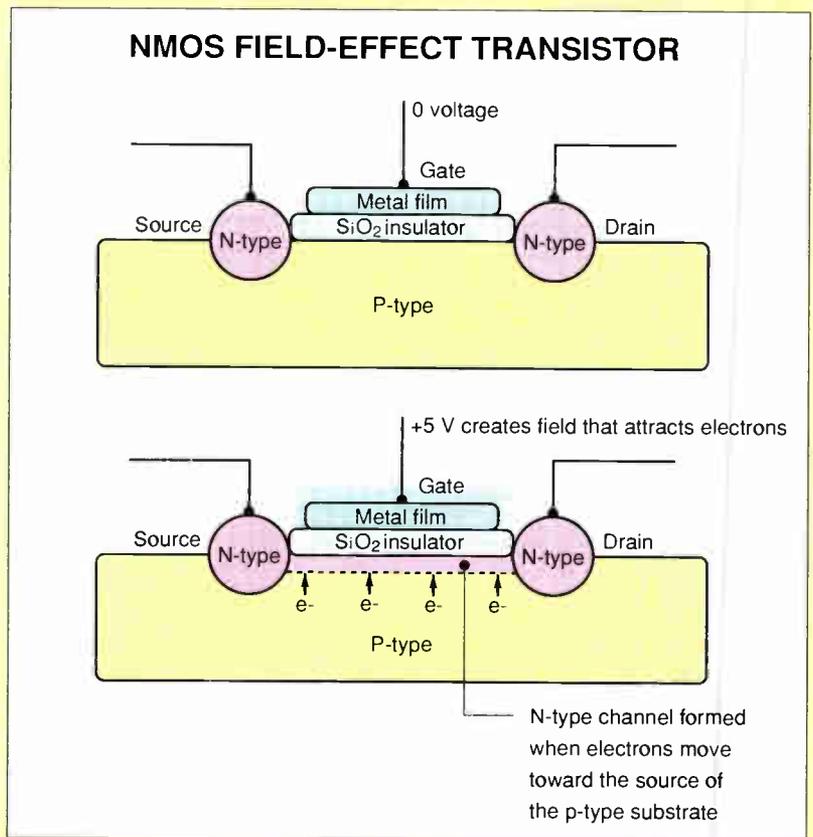


Figure A: *Top: The p-type substrate forms an insulating barrier between the source and the drain, blocking the flow of charged particles. The switch is off. Bottom: When you apply a +5-volt input to the gate, the electromagnetic field created attracts electrons to the surface of the substrate. This creates an n-type channel that allows charged particles to flow between the source and the drain. The switch is on.*

source and the drain are insulated from one another (see figure A, top). When you apply a positive voltage to the gate, you create an electromagnetic field that induces electrons in the substrate to move to the surface. These electrons change the channel between the source and the drain to n-type, thus allowing current to flow between the source and the drain (see figure A, bottom). Note that p-type devices use a negative voltage on the gate in order to induce a p-type channel between the source and the drain.

Logic Circuits

Transistors are the most important elements in logic circuits. By wiring transistors in series, in parallel, or in combinations of the two, you create the NAND and NOR gates that are the basis of digital logic and memory.

It should be obvious that floating-point coprocessors and instruction decoders are incredibly complex devices. But like all digital devices, they owe their existence to the ability to control whether or not current flows through a transistor.

Fairchild Semiconductor used planar techniques to integrate multiple components on a silicon substrate. The commercial devices that followed—the first was a set/reset flip-flop—showed the ad-

vantages of silicon over germanium in the integration of multiple components on a single chip. The ease with which you could control conductivity in different components on a silicon chip and trace

interconnects between components resulted in the final triumph of silicon over germanium as the semiconductor of choice in the electronics industry.

continued



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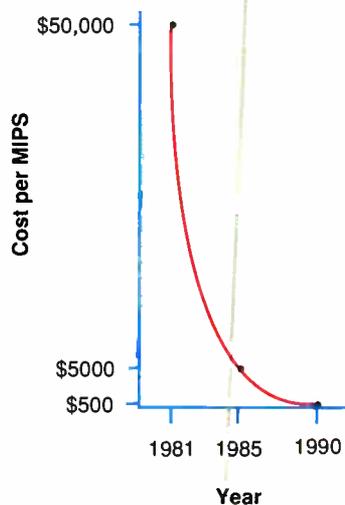


Figure 1: The cost per MIPS for desktop computer systems has declined precipitously since the introduction of the IBM PC in 1981. Costs will continue to decline for the foreseeable future as chip manufacturers fit more and more components into microprocessors.

ICs had a profound effect not only on electronic products but also on how the electronics industry did business. Before the IC, semiconductor companies sold discrete components that electronics firms used to build custom circuits. With the advent of ICs, the basic circuit design function was transferred from the electronics manufacturers to the semiconductor companies. The semiconductor companies now sold basic circuits instead of basic components. Although this gave electronics firms less control over their final products, the advantages of ICs more than made up for any inefficiencies introduced by using standard circuits.

Poles Apart

ICs were first used in a commercial product—a hearing aid—in 1963. By the mid-1960s, ICs had become the primary components in computers and other electronic devices.

Early ICs were based almost exclusively on the *bipolar-junction transistor* and thus were called bipolar ICs. Bipolar-junction transistors use both positive and negative charge carriers and have emitter and collector barriers that are formed by junctions between semicon-

ductor regions of opposite conductivity type (see the text box “Transistor Refresher” on page 238). These devices are noted for their fast switching time. Thus, they were ideal for the TTL circuits that dominated the electronics industry through the 1970s and are still in widespread use today.

The problem with bipolar devices is the large amount of energy they dissipate as heat during operation. This heat limits the number of bipolar transistors you can integrate onto a single chip. Bipolar devices are also very difficult to fabricate. Although the number of bipolar transistors on a chip has increased from single digits in the early 1960s to five digits today, the very large-scale integration (VLSI) of circuits on a single chip was only made possible by metal-oxide semiconductor (MOS) technology.

The MOS Advantage

MOSes are characterized by an interesting property: The insulating layer is the oxide of the substrate material. Thus, for a silicon substrate, the insulating layer is silicon dioxide (SiO₂). MOS technology facilitates relatively easy IC fabrication. Insulating regions can be grown directly on the substrate. This differentiates MOS from a class of compounds known as Group III-V semiconductors. These semiconductors are formed by combining an element from Group III of the periodic table with an element from Group V. Fabricating Group III-V semiconductors is much more difficult than fabricating MOSes. (See “The High-Octane Semiconductor” on page 251 for more information on the most widely used Group III-V semiconductor.)

MOS ICs are based on the *field-effect transistor* (FET); thus, they are called MOSFET devices. (In addition to integrating large numbers of devices into small areas, modern electronics also seems to produce more acronyms per printed page than any other field of study.) In FETs, the conductive properties of a semiconductor are controlled by applying an electric field perpendicular to the flow of the current. MOSFET devices have a slower switching speed than comparable bipolar devices, but they dissipate much less heat and can thus be packed much more closely together. They are also easier to fabricate.

MOS devices are characterized by the type of *channel* that they employ. (The channel is the main path of the current through a transistor.) In NMOS devices, the electrical current is propagated by the movement of electrons. The channel is thus called *n-type* (negative-type). When

current is propagated by the movement of positive electron holes, the channel is called *p-type* and the device PMOS. With silicon, n-type channels are created by doping the channel with substances that donate electrons, such as phosphorus. P-type channels are doped with acceptor substances such as boron. CMOS combines NMOS and PMOS devices in the same circuit.

NMOS devices are faster than PMOS devices and are more compatible with bipolar devices. Thus, although n-type channels are harder to control than p-type ones, NMOS was the dominant MOS technology in the 1970s and early 1980s. CMOS devices are characterized by the fact that significant current flows through them only during switching operations. Thus, they have a much lower average power dissipation than NMOS.

CMOS logic gates use more area in an IC than do NMOS gates. Thus, you would expect that NMOS technology would always allow for a greater packing density than CMOS. This isn't the case, however. As packing density increases, power dissipation and secondary electrical effects become crucial. This is because electronic devices become notoriously unreliable at high temperatures. Because CMOS dissipates less power as heat than NMOS does, you can integrate more of the larger CMOS gates on a chip than you can the smaller NMOS gates.

Coming full circle, the latest CMOS technology is BiCMOS, which combines bipolar and CMOS technology on the same chip. BiCMOS may turn out to be the most significant silicon technology of the 1990s. (For more information on BiCMOS, see “A Marriage Made in Silicon” on page 261.)

Scale and Balance

The most important concept in MOS technology is *scaling*. In the early days of ICs, Robert Dennard and others at IBM came up with the concept of MOS scaling. Essentially, scaling involves reducing the dimensions of a MOS device by a constant factor and lowering input voltages so that potentials in the smaller device are identical to those in the original device. The fact that MOS devices are scalable is the driving force of the microelectronics revolution.

One important aspect of scaling is that when you reduce the dimensions of a component by 2, you decrease the area of the component by a factor of four (thus enabling you to put four components in the space that used to contain only one). Essentially, this is why DRAM density,

continued

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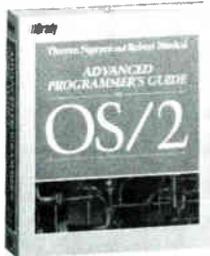
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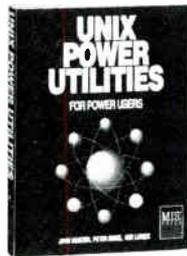
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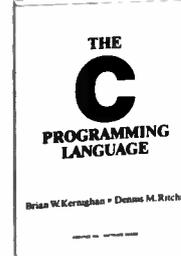
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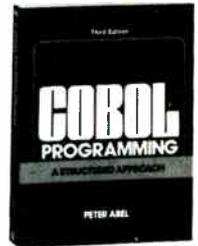
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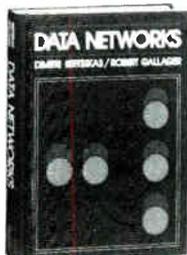
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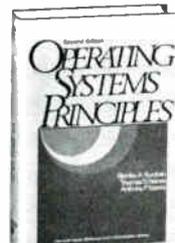
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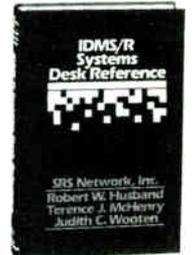
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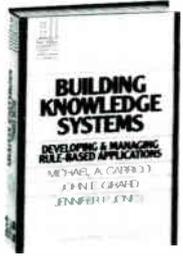
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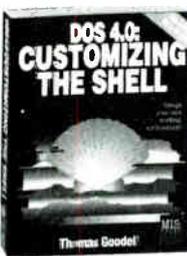
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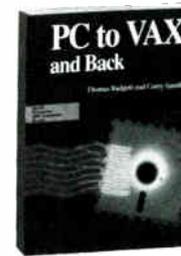
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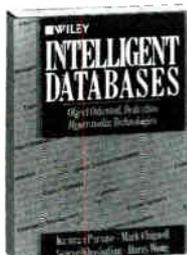
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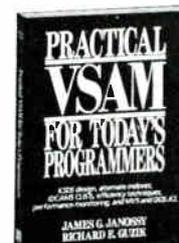
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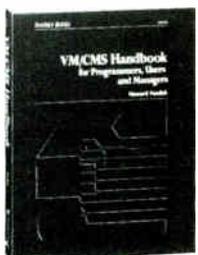
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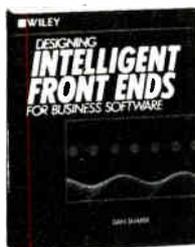


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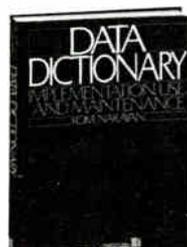


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Architecture Today and Tomorrow

In recent years, one of the more popular topics for panel discussions at computer conferences and trade shows has been the "RISC versus CISC" debate. Besides having a lot of entertainment value (chip designers defending their favorite architectures the way a goose protects her goslings), these debates provide a glimpse into the future of computer design.

Reduced-instruction-set computers and complex-instruction-set computers have differing instruction-set strategies. RISC processors feature a small number of instructions that each execute in one machine cycle. CISC processors use complex instructions that can take several cycles to execute. RISC proponents argue that you get better performance by executing many simple instructions than by executing fewer complex instructions. CISC proponents argue the opposite.

The RISC versus CISC debate won't be decided by panel discussion; it will be won in the marketplace. And the deciding factor may have little to do with numbers of instructions and registers, and more to do with parallelism.

The von Neumann Blues

In 1946, in collaboration with Arthur W. Burks and Herman H. Goldstein, John von Neumann wrote a paper that delineated the concepts on which nearly all computers (both RISC and CISC) have been built since. The paper, "Preliminary Discussion of the Logical Design of an Electronic Computing Instrument," advanced the concept of the stored program and introduced the idea of the program counter (see reference

1). Because it described a processor—the so-called *von Neumann machine*—that had to fetch successive instructions from memory, it also defined the bottleneck between the processor and memory that survives to this day.

Most people would agree that the memory-processor choke point has been a small price to pay for the 40 years of progress based on the von Neumann machine. Computers have grown more powerful every year and will continue to do so for some time. It didn't matter that computers could do just one task at a time as long as they kept doing it faster and faster.

Ever since von Neumann defined the digital computer, however, designers have been investigating ways around the bottleneck. By their natures, RISC and CISC entail different solutions to the problems of parallelism.

Inside, Outside

Since their conception, RISC processors have been evolving toward *micro-parallelism*, incorporating parallel-processing features within the processor. Specifically, RISC processors are becoming *superscalar*; they can execute more than one instruction at a time.

Like other processors, a RISC processor has many components, such as the integer unit and the floating-point unit. And, also like many other processors, RISC processors feature pipelining, whereby many instructions can be decoded while one instruction executes. RISC processors, however, are moving toward pipelines for each unit of the processor. Thus, instructions that use the integer unit are pipelined separately

from instructions that use the floating-point unit. Instructions that use mutually exclusive parts of the processor can also execute at the same time. The result is a processor that can execute two or more instructions per machine cycle.

CISC processors also employ pipelining, and newer processors, such as the 80486 and the 68040, have many integer instructions that execute in one cycle, but the varying execution times of CISC instructions limit the effectiveness of the superscalar approach to parallelism. Instead, CISC processors, with their ever-larger on-chip caches, are better suited to *macroparallelism*, where multiple, identical processors are bound together on a common bus.

Obstacle Course

The problems with superscalar processors involve identifying which instructions are independent and which must be executed in a particular sequence. Superscalar RISC machines will require incredibly complex compilers and instruction-decoding logic. Multiprocessor systems based on identical CISC processors require sophisticated systems software for task scheduling, high-speed buses to limit contention, and workable cache-coherency schemes to ensure data integrity.

In the end, the winner of the RISC versus CISC debate will be the architecture that delivers the best solution to the marketplace. In the future, the quality of the solution delivered by RISC and CISC machines may depend less on the number of clock cycles they use per instruction than on the number of instructions they can execute at one time.

for instance, increases by a factor of four with each generation. The designers essentially halve the dimensions of all components from one generation to the next.

In practice, scaling hasn't always panned out. As you scale down, you increase the relative surface area devoted to interconnections. In addition, scaling can have undesirable electrical effects. When NMOS technology was scaled to 1 micron, for example, problems were encountered that led to increased complexity in the circuits. On the other hand, CMOS has so far been immune to scaling problems.

Scaling yields faster operation as well

as increased integration. In ICs, the distance a signal must travel is often the limiting factor in circuit operation. Thus, CMOS is the technology of choice for today's microprocessor units even though it is inherently slower than NMOS. Because CMOS is easily scaled, CMOS devices gain speed through greater density. The advantages of CMOS for VLSI are exemplified by the Intel 80486, which is a high-speed CMOS device with over 1 million transistors.

Enter the Microprocessor

The emergence of ICs in the mid-1960s resulted in semiconductor companies becoming the designers of basic electronic

circuits. As integration increased and the number of gates on a chip increased to 100 and then 1000 and more, so did the complexity of the circuits supplied by semiconductor companies.

In 1969, Busicom, a Japanese calculator manufacturer, approached Intel with the design for a calculator chip set. Busicom wanted Intel to develop and manufacture the set. Ted Hoff was one of the engineers working on the project for Intel. He proposed that instead of using a dedicated set of chips, you could design a general-purpose programmable chip that would perform the calculator function as well as many other logical functions. In

continued

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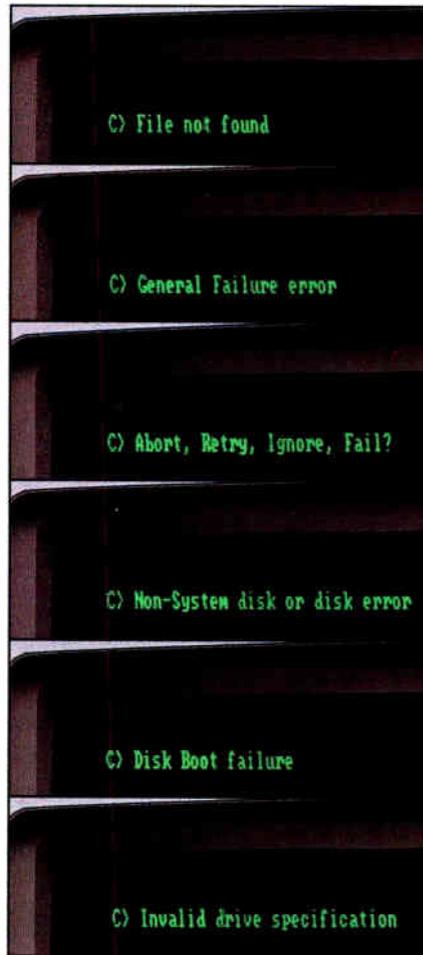
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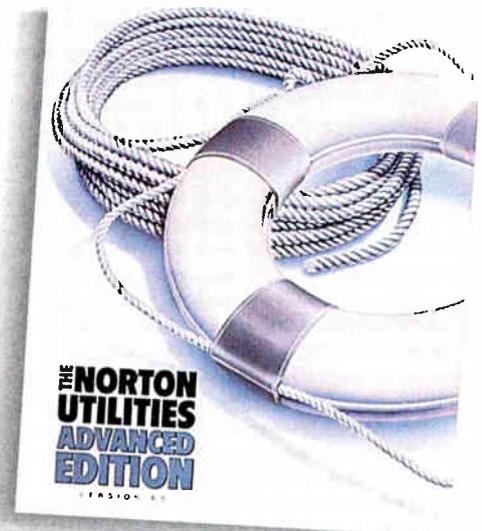
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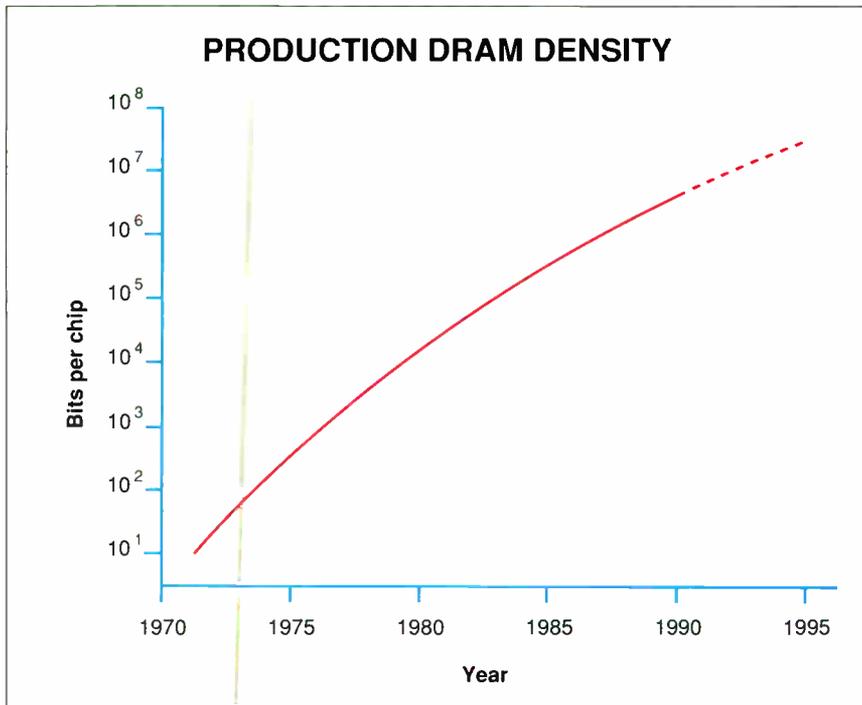


Figure 2: The storage capacity of RAM chips—a direct function of the number of components per chip—doubles every three to four years. Note that the rate of increase slows with time because of the increasing complexity of fabricating near-micron and submicron technologies.

1971, his concept became a reality in the 4004, the first single-chip microprocessor. It also ushered in the era of personal computing. Although the 4004 never appeared in a commercial desktop machine, its direct descendents appeared in the first microcomputers.

The 4004 is not a complete computer. It requires appropriate support chips—shift registers and the like—to perform its function. It didn't take long, however, for the rest of the industry to realize the significance of the 4004. By 1972, Gary Boone and Michael Cochran of Texas Instruments had produced the TMS 1000 which, like the 4004, is a 4-bit chip. The difference is that the TMS 1000 incorporated support functions directly on-chip; it was the first "computer on a chip."

Also in 1972, Intel introduced the 8008, an 8-bit version of the 4004. The 8-bit threshold is important, because it meant that the processor could access one character of information at a time. This and other 8-bit processors—the 8080, Z80, 6800, 6502—formed the basis for the first personal computers.

The microprocessor evolved rapidly after its inception. By 1974, National Semiconductor had introduced a 16-bit microprocessor; by 1981, Intel had a 32-bit microprocessor, the APX432, that in-

corporated over 200,000 transistors on three chips. In 1989, Motorola and Intel announced top-of-the-line 32-bit processors that each have over 1 million transistors on a single chip. The 68040 and 80486 represent the state of the art, but they won't for long. Microprocessors with 4 million transistors will be available in two years, and 16-million-transistor processors by the mid-1990s.

The most amazing aspect of the evolution of microprocessors has been the price/performance curve of desktop systems. In 1981, you could buy an IBM PC that delivered about a tenth of a million instructions per second for about \$5000. By 1985, you could purchase an AT-class computer delivering 1 MIPS for about the same price. In 1990, you will be able to buy an 80486 system delivering about 10 MIPS for about the same amount (see figure 1). This trend will continue. You will see desktop MIPS increase by an order of magnitude every four to five years with no increase in the real (adjusted for inflation) price.

Another interesting aspect of microprocessor evolution has been the effect of these devices on the computer industry. Many computer makers—particularly minicomputer companies—have been unable to compete on a price/perfor-

mance basis with the latest generation of microprocessor-based desktop computers. The assault from below threatens the survival of Data General, Wang, and Prime, and it has already forced DEC to abandon its "one architecture, one operating system" philosophy in favor of one that includes workstations that use non-proprietary processors and operating systems.

As microprocessors continue to increase in power, they will eventually threaten the mainframe and supercomputer industries in turn. Affected companies will either adapt or fail. Semiconductor companies such as Intel and Motorola now control the most important architectures in the computer industry (see the text box "Architecture Today and Tomorrow" on page 244). The role of semiconductor companies has changed from that of component suppliers to that of computer architects.

While semiconductor companies have assumed the design lead in microprocessors, they have also supplied a wealth of products and tools that let computer designers incorporate microprocessors or custom processors into increasingly complex designs without having to resort to custom-chip fabrication. Since the mid-1970s, an entire class of devices has changed the way designers build systems. Instead of using great numbers of standard parts, designers now use customizable devices to build computer systems. (For more information on today's custom chip of choice, the electrically programmable logic device [EPLD], see "Creating Custom Chips" on page 271.)

The March of Memory

Throughout much of the 1960s, silicon memory existed only in research laboratories. The problem was one of integration: You couldn't get enough transistors on a chip to make silicon memory a commercially viable alternative to magnetic-core memory. Texas Instruments created one of the first integrated memory chips in the early 1960s; it contained six transistors and thus could store 1 bit. (Static RAM requires four to six transistors per bit; DRAM requires just one transistor per bit.)

By the late 1960s, however, integration had advanced to the point at which 1K-bit memory chips became practical realities. In fact, Intel started out to manufacture just these chips; later developments moved the company to the forefront of the logic-chip arena. As figure 2 shows, the number of bits you can store on a chip has doubled every three or four

continued

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years since the early 1970s. This year, you will see 4-megabit DRAMs used in desktop computers; 16-megabit chips will be in use before 1995.

The availability of greater and greater amounts of memory will accelerate the trend away from character-based computers and applications and toward graphics-intensive ones. More memory also means bigger, more complex programs and operating systems.

Integration Limits

The personal computer industry is a child of integration. As the designers crammed more transistors onto silicon wafers, you got more power for your desktop. According to Dr. Jonathan Allen of MIT, for the past 25 years or so, memory designers have increased the number of bits per chip by 70 percent per year; logic designers have increased logic density by 25 percent per year; advances in processing technology have increased chip area by 20 percent per year; the power-delay function of ICs has decreased by 200 percent per year; and MIPS have doubled every 12 to 15 months. How long can this continue?

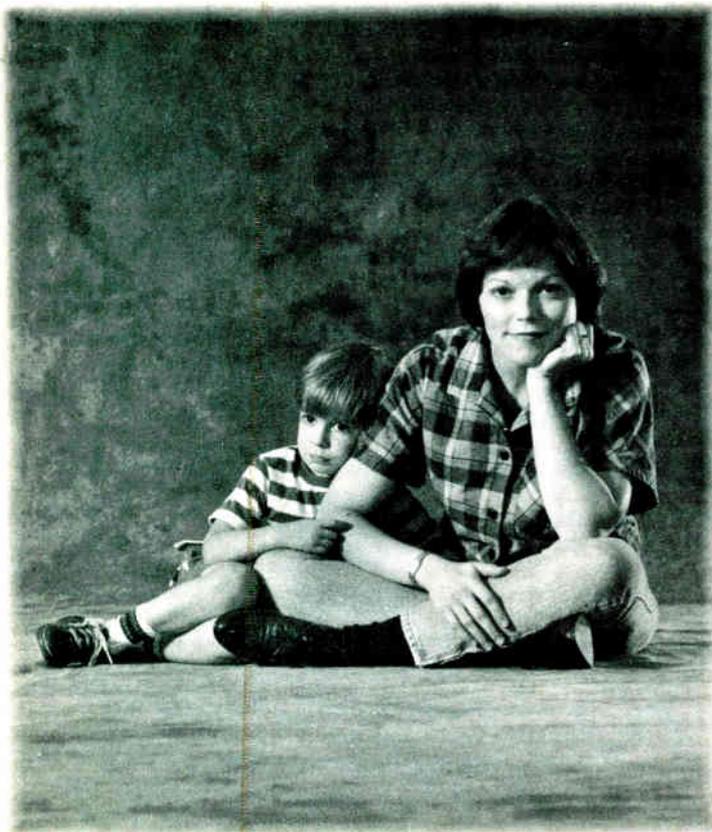
In an ideal world, MOS scaling would continue indefinitely. Designers would continue to halve the dimensions and quarter the area of MOS circuits forever. Unfortunately, the laws of nature (or, more precisely, the best current model of how nature works) preclude infinite scaling. As IC component dimensions go below 0.1 micron, MOS transistors become unreliable because electrons are capable of tunneling through the SiO₂ that insulates parts of the circuit from one another. In effect, at these sizes, the quantum-mechanical nature of the electrons supersedes their electromagnetic nature.

Given a theoretical 0.1-micron feature-size limit, how many transistors will designers eventually cram onto a MOSFET IC, and when will they reach this limit? At the 1989 Semiconductor Outlook Conference, Dr. James Meindl, provost of Rensselaer Polytechnic Institute, made a presentation entitled "The Next Frontier: Opportunities for Giga-scale Integration." Meindl outlined an array of both theoretical and practical limits that bound the maximum number of transistors that you can fit on a single

IC. He discussed fundamental physical limits such as the minimum switching energy and the speed of light, material limits such as the minimum switching time of silicon, and more practical limits such as minimum feature size, packing efficiency, IC area, and heat dissipation.

Meindl brings together these fundamental and practical limits to produce a single metric to measure and predict the integration levels for different materials. He calls this metric the Chip Performance Index (CPI), which he calculates by dividing the number of transistors on a chip by the power-delay product of the underlying technology. For silicon-based MOSFET, he calculates that the current level of integration is 13 orders of magnitude greater than in 1960, when integration began. Based on fundamental and theoretical limits, the CPI for silicon will reach 10¹⁹, meaning that you can expect to see silicon integration increase by a factor of 10⁶. (This doesn't mean that you'll see a million times more transistors on a chip, but that the CPI for silicon will increase by a factor of a million.)

When will the 10¹⁹ limit be reached? Dr. Meindl pointed out some of the prob-



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lems that chip designers and fabricators will encounter at submicron levels. CAD tools have to improve dramatically to keep pace with integration. The switch from photolithographic techniques to more advanced techniques, such as x-ray-based production, will also slow the pace of integration. He concludes that the rate of integration has and will continue to slow, and that while GSI (gigascale integration—more than 1 billion transistors on a chip) will be achieved in silicon, it probably won't happen before the 2010s.

Others are not as confident at the prospect of GSI. As device geometries shrink below 0.5 micron, CMOS designers will have to deal with a host of secondary electrical effects, much as NMOS designers did at 1 micron. Some of these can be ameliorated by moving away from the 5-volt TTL interface standard to a 3.3-V interface, but this will necessitate a major adjustment in the industry. (Note that for compatibility reasons, voltages in ICs have not been scaled as component dimensions have.) The problem of interconnects also grows as geometries shrink. Finding room to connect a billion components on a chip will be an enor-

mous task. Also, the cost of approaching the fundamental limits of MOSFET devices may render geometries much below 0.5 micron economically impractical.

Future Technologies

As MOSFET technology approaches its fundamental limits, researchers are busy investigating replacement technologies. Some are looking at alternative technologies that use FETs. Others are looking at radically different technologies.

Scientists at AT&T, Texas Instruments, and elsewhere are investigating quantum devices that they believe will be practical before the end of the century (see "The Quantum Transistor," May 1989 BYTE). Other researchers are looking into optical technologies (see the Optical Technologies In Depth, October 1989 BYTE), not only for computing devices, but also for interconnects between ICs. The revolution in high-temperature superconductors has spurred research into electronic applications for these devices, such as the recent collaboration between the Microelectronics and Computer Technology Corp. and the University of Houston's Center for Supercon-

ductivity. Superconducting electronics could presage an unprecedented era of speed and power in computing.

What does all this mean to you? Plenty. For at least the next 10 years, you can expect MOSFET technology to continue to provide ever-improving price/performance ratios. The rate of increase will not be as great as in the past, but it will be enough to handle just about any problem you can devise. By the year 2000, one or more of the newer technologies will emerge as a practical alternative to MOSFET. You will still continue to use MOSFET-based computers well into the next century, but at some point, the price/performance ratio of the newer technologies will surpass MOSFET. At that point, the power on your desktop will make available applications limited mainly by your imagination. ■

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Bob Ryan is a BYTE technical editor. He can be reached on BIX as "b.ryan."



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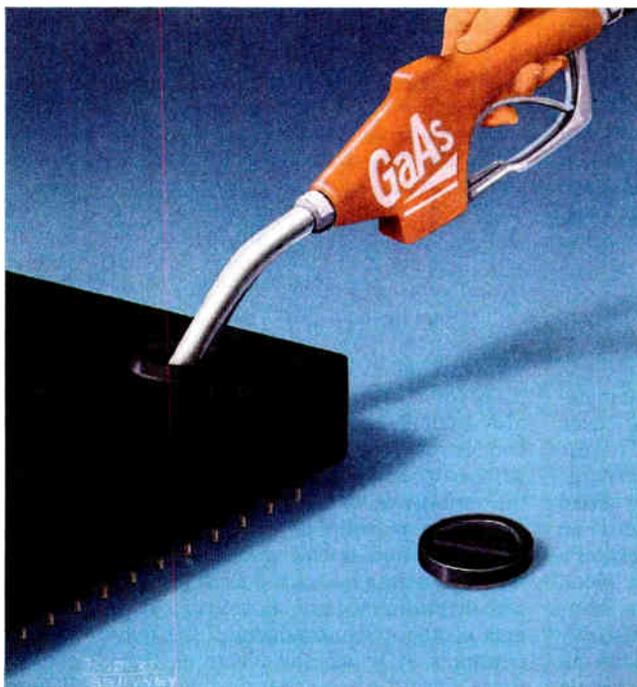
The High-Octane Semiconductor

Although it hasn't lived up to all the hype, gallium arsenide blows the doors off silicon

Phillip Robinson

Five years ago, I wrote an article for BYTE on gallium arsenide, or GaAs ("Gallium Arsenide Chips," November 1984), a semiconducting material that offers higher-frequency operation, lower power consumption, greater radiation hardness, and better temperature resistance than silicon. In the hunt for more computing speed, GaAs (pronounced "gas") promised a foundation material that would be five or six times faster than silicon without requiring any radical change in computer architecture or design.

The same BYTE issue contained other articles on new chips, including RISC chip designs, a string-search coprocessor, the 68020 and 80286 microprocessors, and the Xtar graphics processor. Five years later, the 80286 and 68020 have already passed their peak. They moved through a few years of stardom in the IBM AT and Mac II, only to be replaced by chips that are about to be replaced themselves. RISC is just now moving into its own, grabbing headlines and workstation designs for Sun, IBM, Hewlett-Packard, and others. The Xtar and string-search coprocessors survive



only as footnotes, although graphics coprocessors are becoming a standard component in many systems. In fact, the jury is still out on only one of the technologies described in that issue: GaAs.

Still on Deck

GaAs has solidified its hold on communications, microwave, and optoelectronic work, where high-frequency operation is

paramount. It still provides the highest-efficiency photo-voltaics. GaAs's ability to integrate optical, microwave, and digital circuitry on a single chip are earning it new niches in portable telephones and satellite position finders.

However, except for some military systems where price is distinctly secondary to performance, the market for fully digital GaAs chips has not boomed—but neither has it disappeared. The intrinsic physical properties of GaAs excited some computer designers and visionaries, but poorly understood fabrication processes and the ever-improving specifications of silicon chips relegated digital GaAs largely to prototypes and laboratory experiments. As some wits quipped, "It's the technology of the future—and always will be."

Five years ago, many articles in the general business press raved about the future of GaAs; BYTE, at least, had a cool head. After describing the development work at Fujitsu, Rockwell, Honeywell, Tektronix, and Harris, my BYTE article pointed to Cray Research as the probable first intensive user of GaAs chips, and Gigabit Logic as the

continued

premier independent GaAs chip company. The article concluded that GaAs processing difficulties and the moving-target nature of ever-improving silicon chips would allow GaAs to be, at best, 2 percent or 3 percent of the chip market in 1992. That figure is still holding steady. However, with the entire chip market growing rapidly, even that static market share translates into a much larger world of GaAs.

Five years later, the players and some of the tactics have changed. The key elements today are the use of real GaAs in new computers from Cray and Prisma; higher-density gate arrays from Vitesse, TriQuint, and Gigabit Logic (with Rockwell and Fujitsu still serious contenders); and new drop-in TTL-compatible GaAs logic chips from Gazelle. GaAs may not be here yet for microcomputers, but it has arrived for supercomputers and as bottleneck breakers in everything from mini-supercomputers to workstations.

GaAs Basics

Microelectronics is based on semiconductors. Unlike metals, which always conduct electricity with ease, and insulators, which always block any motion of electrons, semiconductors can conduct or insulate. Their behavior changes dramatically depending on the presence of dopants. Add a couple of parts per billion of one dopant, and a semiconductor becomes a conductor with extra electrons. Add a couple of parts per billion of another dopant, and the same material is a conductor with too few electrons. Keep the crystal pure, or oxidize it, and you have an insulator.

If you dope adjacent regions of a single semiconductor block with the right materials, you can create transistors, resistors, diodes, and capacitors all on the same chunk of material. Microscopic photographic stencils or carefully aimed bombardment by particle beams can dope precise patterns in the surface of a flat semiconductor disk, or *wafer*. Metal lines deposited on the chunk can interconnect these components. That's *integrated circuit* electronics, where an entire circuit is fabricated on a single substrate. (*Discrete* electronics builds a circuit by connecting independent devices to one another.)

Many copies of an IC are made side-by-side on each wafer. The wafer is then cut into individual chips for independent packaging, testing, and soldering onto circuit boards.

Silicon is the premier semiconductor today. The raw materials to make it are inexpensive, and the oxide that forms

easily on the silicon surface is an excellent insulator and protector for circuitry. (By the way, although sand is made up of silicon dioxide [SiO₂], it is not the source for the silicon in chips.)

The processes to print dopant and metal patterns on silicon are well understood, with the lines and patterns getting smaller all the time, squeezing more parts onto each chip. That means more chips per wafer, reducing costs as the same processing cycle yields more cir-

Where
*silicon circuits are
hard-pressed to run at
speeds of 100
or 200 MHz, GaAs can
easily reach
2 GHz or more.*

cuits. It also means better and faster circuit performance, because the largest delays occur when signals move from one chip to the next, not within the chip itself. And most circuit failures come at solder joints and other interconnections rather than inside a chip.

But silicon is not the only semiconductor; germanium was once a popular material for discrete components. There are also a number of III-V compound semiconductors (so called because of the positions of their component elements in the periodic table). These include indium phosphide as well GaAs (a combination of gallium and arsenic in a single crystal). Quantum physics and crystal structure determine the effect of various dopants on these semiconductors, the temperatures at which the electrons from those dopants move under a voltage, and the speed of the electrons through the crystal lattice.

GaAs electrons can move five to seven times faster than silicon electrons. They can also keep moving at much higher temperatures. Silicon chips stop working at around 150°C; GaAs chips work up to about 300°C. GaAs chips can also resist much higher radiation levels, as much as 10,000 times as much radiation as silicon chips can absorb (the radiation bumps

electrons around, giving them energy that normal chip operation wouldn't and so befuddling the chip's logic).

GaAs's basic nature allows higher-frequency operation than silicon does. Where silicon circuits are hard-pressed to run at 100 or 200 MHz, GaAs can easily reach 2 gigahertz (GHz) or more. This makes it ideal for communications circuits that depend on high frequencies, and it also conjures visions of digital operations at 10 or 20 times the speed of today's chips.

Therefore, if you could make the same circuit design on a GaAs wafer as on a silicon wafer, you could have three times the processing speed at half the power consumption, with a circuit that works at higher temperatures and radiation levels (see the figure). However, it's not that simple in practice. GaAs crystals are much harder to grow than silicon crystals, because you must combine two volatile materials in exact proportions rather than dealing with a single element. GaAs wafers are only now reaching 4 inches in diameter, while silicon is already up to 8 inches. That means a single silicon wafer can yield four times as many chips as a GaAs wafer.

The raw materials behind the GaAs crystals cost more (as much as 100 times more than silicon), and the finished wafers are more brittle. The physics of laying down dopant and metal patterns on GaAs are not as well understood as those for silicon. And, as a final blow, the semiconductor equipment industry has focused on building machines to handle, heat, cool, clean, and test silicon wafers, not GaAs wafers, so even the processing equipment is more expensive. Thus, while GaAs has many fundamental advantages over silicon, it has many practical disadvantages.

Center Stage at Cray and Prisma

The premier GaAs machine today is the Cray-3 supercomputer. Cray had admitted to working with GaAs five years ago in the development of its third-generation supercomputer. According to John Swenson, a spokesperson for Cray Research (Chippewa Falls, WI), this effort began in the early 1980s when Cray started its own chip foundry and simultaneously developed relationships with other vendors. Later, Cray chose a Rockwell spin-off company, Gigabit Logic, as its primary source for GaAs chips, and it closed its own foundry. Gigabit makes only GaAs chips.

When the Cray-3 reached the preproduction phase two years ago, the critical

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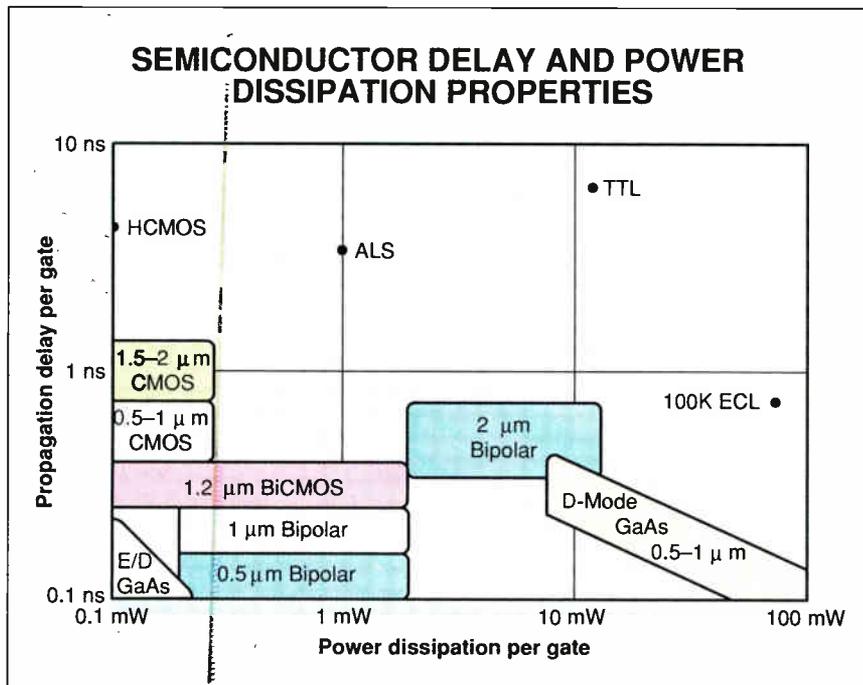
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Comparing the time-delay and power-dissipation characteristics of different types of semiconductor materials and logic types reveals the speed advantages of GaAs over silicon.

packaging and tolerance factors demanded a new robotic technology for module assembly. At the same time, Cray was developing the next-generation silicon-technology C90 supercomputer, a successor to the YMP supercomputer. The company decided it did not have the money to pursue both projects at the same time. Against the backdrop of the shutdown of ETA Systems (a competing Control Data subsidiary) and increased trade-in costs for the previous generation of supercomputers, Cray Research spun off the Cray-3 project.

Today, with government approval in the works, Cray Computer (Colorado Springs, CO), with Seymour Cray as part of the deal, is becoming a separate entity. It will be owned by Cray Research and its stockholders. While working on its silicon supercomputer, Cray Research retains the right to use any GaAs technology developed to date.

That technology has had to overcome a substantial learning curve in working with GaAs. "In particular," according to Swenson, "the brittleness was very awkward, making yields a real problem."

Cray Computer, under the guidance of president Neal Davenport, is still working on the GaAs Cray-3. This computer will have a processor module made up entirely of GaAs. According to Davenport, it is based not on the state of the art

but on "what we could see was likely to be available three or four years ago." That excites Davenport, because it means that the Cray-3 can continue to evolve as GaAs chips reach higher densities and operating speeds.

The current Cray-3 technology uses GaAs gate-array chips of 300 or 400 gates each. That's much less dense than the current YMP, which uses silicon gate arrays of about 2500 gates. The next-generation silicon Cray, the C90, is a 16-gigaFLOP-design computer, like the Cray-3. It will use 10,000 gates per silicon chip. Greater chip density allows tighter packing of circuits and cuts the time lost moving signals between chips—hence increasing system speed. Swenson says the Cray Research developers see "still another generation of improvement we can get out of silicon," especially by focusing on packaging and cooling technology. Davenport says the work on better materials has eliminated the questions about GaAs technology. He sees the Cray-3 as being out in front of the market. He believes, however, that "we're not going to be lonely for long."

Prisma is following Cray, though not to the extent of using GaAs throughout a computer. John Scanlon, Prisma's vice president of marketing, says the company is developing a high-end server-class system in the million-dollar range that uses

GaAs in a SPARC processor to reach a 4-nanosecond clock time. SPARC is the RISC architecture developed at Sun Microsystems and now licensed by a number of computer firms. Prisma has not announced a delivery date for this system, which will use GaAs in the main logic paths of the CPU, though not in the I/O and memory.

GaAs was necessary just for sheer speed. As Scanlon puts it, "I don't think it's possible to get to 4 ns... with a single-processor silicon architecture." SPARC was chosen as one of the architectures that Prisma thinks will be around in the mid- to late-1990s and that already has software support. Prisma designs, but does not make, its own chips. Scanlon proudly describes how "there are a lot of people who talk about GaAs in future-generation machines in 1992, '93, and beyond, but Cray and Prisma are the furthest along at this point. We use GaAs as a core premise, rather than as a sprinkling in key areas."

Gate Arrays and Standard Cells

The traditional technology for high-speed computer systems has been silicon emitter-coupled-logic gate arrays or standard-cell chips. ECL offers great speed, although at the price of high power consumption and heat dissipation. It is much faster than the CMOS or TTL chips used in most microcomputers, but its cooling requirements have restricted it mostly to mainframes and supercomputers. Recently, BiCMOS has been challenging ECL. BiCMOS is a silicon technology that combines bipolar transistors (for speed) and CMOS (for low power consumption) on a single chip (see "A Marriage Made in Silicon," page 261).

Gate arrays are semicustom chips. Most of their layers are set down in advance. The final few layers organize the basic logic gates into the desired pattern or function for a particular task. These final layers are not designed by the semiconductor manufacturer, but by the customer—usually a computer company—using CAD software supplied by the chip company. In small numbers, gate arrays are cheaper than fully custom chips because many different customers can share the same basic chip design. Standard cells are also semicustom chips, but instead of organizing a grid of gates, the CAD software lets you integrate components, such as RAM, ALU, and I/O, that have already been designed. You lay these out and connect them on a single chip, and then the foundry creates that chip as a single circuit. Both gate arrays

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and standard cells fall into the category of application-specific integrated circuits (ASICs).

Back in 1984, GaAs chip processing wasn't sophisticated enough to fit more than a few hundred or maybe 1000 gates on an array, and standard cells just weren't available. Silicon, in contrast, was already packing tens of thousands of gates on a chip. With such a difference in integration density, GaAs just wasn't practical for many systems designers. Even today, when GaAs integration has reached the 4K-byte static RAM level, silicon has moved on to the 1-megabit SRAM level (and 4-megabit DRAM level) with several orders of magnitude more transistors per silicon chip. However, GaAs gate arrays and standard-cell chips have broken through the floor level that is practical for designers.

According to Richard Eden, the senior vice president of R&D at Gigabit Logic, until GaAs technology was ready to support chip complexities of 3000 to 15,000 gates per array, it had trouble being competitive with CMOS and ECL. Gigabit Logic is now turning out standard-cell GaAs chips with 15,000 to 20,000 gates per chip, along with some standard parts such as 4K-byte SRAMs that have a read/write cycle time of 3.5 ns and 4K-byte ROMs that will run in a system with a 1-GHz clock. Learning-curve improvements in fabrication technology, design techniques, and CAD tools have been instrumental in making the new chips, according to Eden. The work on GaAs CAD tools has improved the abilities of silicon CAD tools by demanding features that GaAs needs now and silicon won't need for another chip generation—for example, features to deal with the special physics of VHF operation.

Along with the rest of the industry, Gigabit Logic shifted from its standard-part chips of five years ago to ASICs. Although Cray is the high-profile customer for some Gigabit chips, Eden envisions many applications for GaAs technology, such as "higher-resolution graphics, even in modest machines, where the desired performance improvements are going faster than silicon will be able to support."

Dr. Louis Tomasetta, the president of Vitesse Semiconductor, believes that the 15,000 gate arrays his company has developed have achieved a high-enough level of integration to interest systems designers who work, for the most part, with CMOS. He says that these gate arrays will bring to workstations the kind of speed historically reserved for supercomputers. Tomasetta points out that Vi-

tesse didn't start with fast microwave parts, as did most of the U.S. GaAs makers. Rather, Vitesse developed a process that can keep a 10,000-gate chip running at 200 or 300 MHz with only a few watts of power dissipation, instead of 20 W—the historic heat level that kept the older GaAs and silicon ECLs from having an impact on the design of most systems.

Tomasetta sees register files and RAM caches as the first place for GaAs in air-cooled workstation systems, where GaAs can offer a power-reduction factor of 4 or 5 over ECL. The enormous GaAs market projections of a few years back stemmed from what Tomasetta sees as the mistaken assumption that the computer world wouldn't change from the late 1970s, when most mainframes were built with rack after rack of 50-gate ECL chips. Today's systems need far more integration than that to beat the time delays between chips and boards.

TriQuint, a spin-off from Tektronix, is also in the GaAs ASIC game. It too is a foundry for custom GaAs chips. Al Patz, president of TriQuint, acknowledges that forecasters greatly overestimated the market for GaAs back in the mid-1980s. Patz believes, however, that GaAs has taken no longer to mature in relation to expectations than did CMOS, TTL, or ECL. He sees the cost of today's GaAs—from 3 to 5 cents per gate—as being on a par with the cost of the fastest ECL chips. Five years ago, GaAs was five times as expensive as ECL. Patz points to communications—where the 1-GHz and above frequencies demand GaAs—and to monolithic microwave ICs as the backbone of the GaAs chip industry. Future applications, such as hand-held telephones with both digital and microwave functions on the same low-power chip, are ripe for GaAs.

As for the computer market, Patz acknowledges that it has taken a long time to progress to the point where an entire system would be based on GaAs. He thinks that, in the future, the high-speed graphics of workstations and PCs will cry out for GaAs, as will the glue logic and programmable logic devices (PLDs) that sit between the microprocessor and memory in smaller systems. Silicon versions just aren't keeping pace with today's faster microprocessor and RAM chips—especially since the glue logic must often run twice as fast. That's a bottleneck that Patz believes GaAs could open up.

According to Patz, another market for GaAs will be in connections between systems, such as the processing and mul-

tiplexing chips for LANs and fiber-optic interfaces between items such as mainframes and microcomputers, and TVs and telephones. TriQuint has a new packaging technique for pin-grid-array packages that better enables them to work at the GHz frequencies of GaAs.

Gazelle's Drop-Ins

One of TriQuint's customers is Gazelle MicroCircuits, a spin-off from Gigabit. Robert Gunn, product marketing manager, says that Gazelle was founded on the notion that GaAs was held back because its circuits used different power-supply voltages, different logic levels, and different pin arrangements than do standard silicon chips. Gazelle turned that around by designing GaAs PLD chips that are completely compatible with standard silicon TTL chips, the kind found as glue logic in most systems. In some cases, you can simply pull out a TTL chip and replace it with a faster GaAs successor. The special processing for compatibility does slow down the GaAs a bit, but it also makes it more stable and so improves yields.

Now those chips are providing twice the performance for only 1.7 times the price, according to Gunn. He adds, "As we learn more about GaAs, we'll improve that ratio." Gazelle has TriQuint handle all its fabrication work. Says Gunn, "We saw that over the last seven years about a billion dollars had been spent on GaAs fabs around the world, and only 30 or 40 percent of the capacity is utilized."

According to Gunn, Gazelle chips within systems are just starting to hit the market, with introductions in the fourth quarter of 1989. He envisions them as microprocessor support chips (such as state machines and sequencers), as cache controllers, and for bus arbitration logic. They'll be used wherever there's a critical speed path.

The Next Five Years

Cray, Gazelle, Prisma, Gigabit, Vitesse, and TriQuint: These aren't the only players in digital GaAs today. Many of the large Japanese electronics firms—including Hitachi, Oki, Toshiba, Mitsubishi, Matsushita, Fujitsu, NEC, and others—are developing their own GaAs processes.

Fujitsu is actively selling gate arrays on the commercial market. Rockwell International is still active in GaAs, as well as in high-electron-mobility transistor development and standard gate arrays, and has become a key supplier of chips to

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Cray. Rockwell's Dr. Jai Hakhu is confident that there is a niche market for GaAs—essentially in supercomputers and as links between systems, and in high-definition TV technology. He points to a two-year-old alliance with IBM—"Rockwell is now their sole GaAs manufacturing arm," he says.

Texas Instruments and McDonnell Douglas have demonstrated 32-bit RISC GaAs microprocessors. RISC and GaAs can work symbiotically. RISC is a pro-

cessor-design scheme, like a new, more efficient pattern of highways for a city. GaAs is a new material, like a different road surface that permits faster driving. RISC processors use more simple instructions to accomplish a task than traditional microprocessors do, so they need a faster clock. GaAs can provide that. GaAs chips can't yet hold as many transistors as silicon chips can, but RISC microprocessors use only a fraction as many transistors as a traditional micro-

processor. RISC and GaAs are well matched.

The costs of GaAs may continue to drop even more as the development of new materials cuts the cost of the initial wafers. One possibility comes from work in GaAs on silicon epitaxy. By depositing a thin coating of GaAs crystal on top of a silicon wafer and fabricating the circuits on that coating, the chip maker avoids buying GaAs wafers in the first place. Unfortunately, although this process has been improved in recent years, the 3.7 percent mismatch in crystal-lattice spacing between GaAs and silicon leads to lower-quality crystal coatings with more defects, and therefore to flawed circuits.

Robert Castellano, an analyst with The Information Network (San Francisco, CA), thinks that the initial idea that GaAs was going to be an explosive market because computer makers would replace all their silicon with GaAs has clearly faded in the face of improved silicon technology. However, with more processing experience, better equipment, and a drive to complement silicon rather than compete against it, he believes that GaAs will be successful, with an annual growth rate into the 1990s of 62 percent.

TriQuint's Al Patz echoes that notion, advocating GaAs "not as a replacement for silicon, but to augment it where silicon can't easily solve the problem." Eden of Gigabit admits that GaAs hasn't grown as quickly as some expected, but says the "targets were the hopes and dreams of the venture capitalists and investors—and nothing ever proceeds on that scale."

Tomasetta of Vitesse says, "In a few years GaAs technology will be more widely used and will blur the whole difference between workstations and mainframes and supercomputers—performance will be more equal, and the differences will be in peripherals and memory." He thinks GaAs will no longer be a fantasy, but just another circuit in a designer's catalog. "The user won't really care whether a chip is 0.8-micron CMOS or GaAs, as long as the speed and specifications are right." ■

Phillip Robinson once grew and analyzed silicon crystals as an R&D engineer for Siltec Corp. and supervised hybrid IC design and manufacturing for Modular Engineering. Since those days, he has written articles and books about computer technology and is a consulting editor for BYTE. He can be contacted on BIX as "robinson."

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Error	$\text{erf}(z) = \frac{2}{\sqrt{\pi}} \int_0^z e^{-z^2} dz$
Bessel	$J_0(z) = \frac{1}{\pi} \int_0^{\pi} \cos(z \sin \theta) d\theta$
Zeta	$\zeta(s) = \sum_{k=1}^{\infty} k^{-s} \quad (\Re s > 1)$

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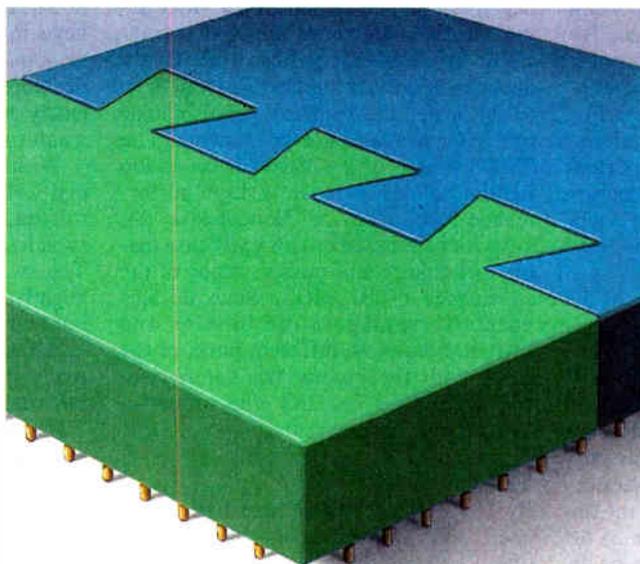
*The combination of bipolar and CMOS devices on a chip
can give you the best of both worlds*

Bob Ryan

For the past two decades, computer designers have faced a difficult choice: Should they design for speed or for efficiency? Bipolar transistors offered speed to burn, but at the price of enormous power consumption and low gate density. Field-effect transistors (FETs) offered low power consumption and high density, but at the cost of slower switching times and low driving current. Now, designers have a third choice: BiCMOS.

BiCMOS combines bipolar and CMOS devices on the same chip—and sometimes in the same gate. It offers the advantages of both technologies: It has faster switching and greater current drive along with lower power dissipation and greater density (see figure 1).

But BiCMOS straddles the middle ground between pure bipolar devices and pure CMOS devices: It is not as fast as the former nor as compact and efficient as the latter. It is also more complex—and therefore more expensive—to produce. It is a compromise, but one that thus far works so well that it may have a major impact on semiconductor technology in the 1990s.



Separate and Unequal

To understand BiCMOS, you need to understand the two technologies on which it stands. Bipolar transistors are as old as solid-state electronics: The first transistor was bipolar. Bipolar transistors get their name from the fact that they allow current to flow in opposite directions at the same time. The flow of primary charge-bearing particles to the col-

lector is controlled by the emitter injecting minority-charged particles. The more minority carriers present, the greater the resistance to the primary particles. Thus, the emitter controls the current flow through the collector. The name *bipolar* comes from this two-way current flow.

CMOS, and other MOS (metal-oxide semiconductor) technologies, are based on FETs. A FET is unipolar: Current flows in one direction at a time. The current flow through a FET is controlled by the absence or the presence of an electromagnetic field above the current-carrying channel.

Bipolar devices formed the basis of all early computers and continue to form the basis of high-speed computers. Rather than give up the speed available with bipolar devices, designers of large computer systems build enormous power supplies and complicated cooling systems to squeeze the most performance out of their designs. On the other hand, desktop computers rely almost exclusively on MOS technology. The logic density and low power consumption of MOS makes it a natural for smaller systems.

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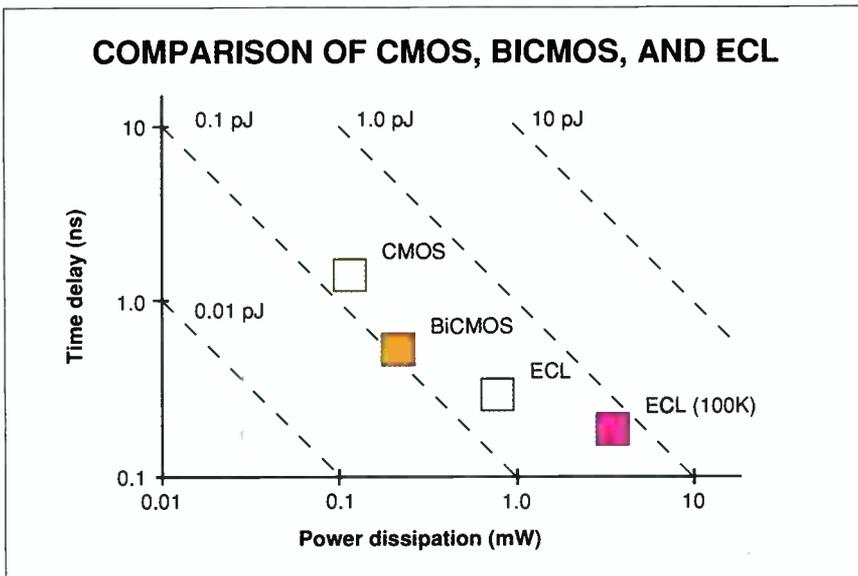


Figure 1: At the same geometry (1.3 microns), BiCMOS gates show their speed advantage over CMOS, as well as a marked power-dissipation advantage over emitter-coupled logic (ECL). (Power dissipations are measured in milliwatts, switching time-delay in nanoseconds, and power-delay product in picoJoules.)

Since size and cost are less important on the high end than performance, BiCMOS is unlikely to replace bipolar emitter-coupled logic (ECL) as the technology of choice for mainframes. For personal computers and workstations, however, BiCMOS offers higher performance than CMOS without the power and density problems of ECL. BiCMOS will have its greatest impact on the desktop computer.

Starting Out

Although purely digital BiCMOS technology is relatively new, research into the integration of bipolar and MOS technologies has been going on for at least 20 years. By the mid-1970s, RCA was producing BiCMOS operational amplifiers. This set the trend in development for the next 10 years: BiCMOS was seen as an analog technology. It continues to be an important technology for analog and A/D applications, such as communications, digital signal processing, display drivers, and voltage regulators.

It wasn't until the early 1980s that researchers began to investigate the combination of bipolar and CMOS technologies for digital applications. Companies such as Motorola and Hitachi developed BiCMOS circuits that interfaced with standard 5-volt digital devices. The early devices usually compromised on the bipolar end of things by using CMOS technology as a starting point and adding the bipolar. They used the PMOS n-well (a

negatively doped region in a PMOS device) as the collector of the bipolar transistor and added a p-base (positively doped) region. Although relatively easy to fabricate, the resultant NPN bipolar transistor was not a great performer. The PMOS n-well of a CMOS circuit is too lightly doped to make a high-performance bipolar device. Nonetheless, devices that are based on this early processing technology still possess many of the advantages of BiCMOS. Such devices normally segregate the bipolar and CMOS circuits on different parts of the chip—with the bipolar transistors usually forming a fast I/O ring around a CMOS logic core.

New Processes

By 1987, many researchers had developed BiCMOS processes that featured little compromise on either bipolar or CMOS performance and that allowed the integration of bipolar and CMOS in the same circuit. BiCMOS gates became a reality, and they allowed designers the flexibility to use bipolar technology to overcome speed bottlenecks anywhere on a chip.

The price you pay for high-performance BiCMOS is processing complexity. CMOS fabrication usually involves 12 masks (shields that protect areas of a silicon wafer as the dopants are being deposited) and doesn't require the use of *epitaxy* (the growth of materials on top of the silicon wafer substrate). High-perfor-

mance BiCMOS uses at least 15 masks and requires epitaxy. This increased complexity is reflected in the higher costs of BiCMOS chips, which can be up to 1.5 times the cost of comparable CMOS. (The increased complexity also has a hidden side benefit: It reduces the chances of CMOS latchup.)

Thus, semiconductor manufacturers have two digital BiCMOS solutions: a lower-performance, lower-cost option, and a higher-performance, higher-cost option. Both solutions have their place in different applications.

Interfacing

One of the more important aspects of BiCMOS technology is that it is relatively simple to fabricate BiCMOS chips that interface at TTL, ECL, and CMOS levels. This is important in maintaining compatibility with current devices, especially in systems that use more than one type of interconnect. Also, as clock speeds, fan-outs, and CMOS density increase, overall performance of TTL- and CMOS-compatible systems can be limited by problems such as switching noise and clock skew. Such problems have many systems designers looking seriously at ECL I/O for high-speed desktop systems. The fact that BiCMOS easily generates ECL I/O levels makes it a natural for such systems.

Within the next few years, as commercial CMOS devices are scaled below 0.5 micron, chip designers are expected to switch to a 3.3-V power supply standard. The switch is necessary to forestall the negative effects of the current 5-V standard on such tiny geometries.

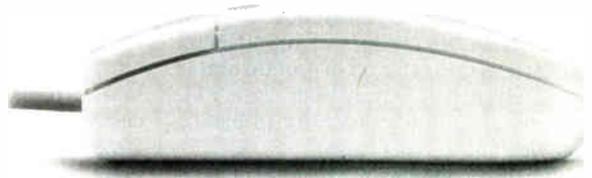
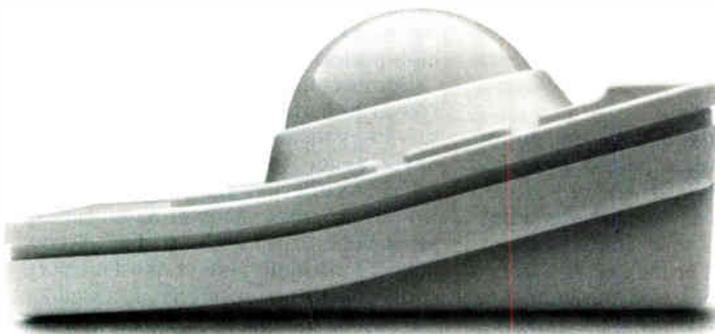
Although BiCMOS has worked effectively at 3.3 V, the performance of bipolar transistors suffers and, of course, TTL and ECL don't function at all. A voltage drop could adversely affect the acceptance of BiCMOS until a bipolar logic capable of working at 3.3 V is developed, or it could hasten the acceptance of BiCMOS as a mainstream technology. By providing on-chip voltage regulation that operates the CMOS circuits at 3.3 V and the bipolar I/O at 5 V, BiCMOS can provide a vehicle that realizes sub-0.5-micron geometries without sacrificing compatibility with the current interface standards.

Real-World BiCMOS

Although BiCMOS remains the focus of much R&D effort, it has already shown up in the parts catalogs of many semiconductor companies. In addition to analog applications, BiCMOS has established

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itself as a viable alternative in application-specific integrated circuits (ASICs) and static RAMs (SRAMs). It has also been demonstrated in other chip types, including DRAMs and a CPU. Obviously, many designers think the advantages of BiCMOS outweigh the added cost.

The area where BiCMOS is best represented today is in ASICs. These semi-customizable chips are supplanting TTL devices as the glue logic in many new computer designs. They provide a flexibility unheard of in standard logic parts.

The first BiCMOS ASICs were gate arrays that featured CMOS cores and bipolar I/O rings. They thus provide CMOS logic density with high-speed interfacing. As gate-array fan-outs increase, BiCMOS provides both the drive and logic density needed without resorting to power-hungry bipolar parts.

An interesting example of this type is LSI's Direct Drive Array line of products. The series consists of six different gate arrays that offer up to 45,000 usable gates. The arrays feature high-drive TTL I/O and enough logic density to handle complex bus-driving tasks.

Recently, companies have also begun

integrating bipolar devices within the core of gate arrays to perform specific functions. Texas Instruments expects to have BiCMOS arrays with integrated cores available in 1990 in densities exceeding 100,000 gates. Hitachi already offers integrated arrays with up to 2500 gates. The lower gate count is a function not only of the larger geometry used in the fabrication of the arrays, but of the fact that Hitachi has a higher percentage of bipolar devices in the core than does TI. Hitachi expects to have high-density BiCMOS gate arrays available next year.

Besides LSI, TI, and Hitachi, other companies involved in BiCMOS ASIC development include Motorola, NEC, Fujitsu, National Semiconductor, Toshiba, and Applied MicroCircuits.

BiCMOS Memories

The classic bottleneck in any digital computer is between the processor and the memory. All instructions and data must flow from memory to the processor before they can be executed or processed. This wasn't a major constraint on system performance when desktop computers ran at 1 MHz or 4.77 MHz be-

cause memory could keep up easily. However, the advent of desktop systems with much higher clock speeds (up to 33 MHz, currently) has exacerbated the processor/memory bottleneck. Commonly available DRAM chips simply can't keep up with the faster processors, resulting in wait states wherein the processor twiddles its thumbs waiting for data to be deposited on the bus.

Consider a system with a 33-MHz processor and fast (80-ns) DRAMs. While each processor cycle takes 30.3 ns ($1/(33 \times 10^6)$), the memory takes 80 ns to load its contents onto the data bus. Thus, the processor sits through two machine cycles waiting for the data to show up on the bus. These wait states are the bane of high-performance systems designers.

Because of the enormous expense involved in outfitting entire systems with sub-30-ns memory, computer designers have turned to high-speed memory caches to alleviate the wait-state problem. A memory cache is based on the proposition that processors don't access memory randomly; rather, most memory accesses are to previously accessed or

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nearby locations. The caching principle is borne out in practice. For example, a 64K-byte cache will eliminate over 95 percent of the wait states incurred when accessing 4 megabytes of DRAM.

So where does BiCMOS fit into this picture? Fast processors need fast RAM for memory caches, and the fastest RAM is SRAM. And it just so happens that, this side of pure bipolar technology, the fastest SRAMs are BiCMOS.

The evolving interest in BiCMOS SRAMs is demonstrated by the last three International Solid State Circuits Conferences (ISSCCs). At the 1987 conference, all the high-speed SRAMs presented were CMOS devices. At the 1988 conference, three different BiCMOS SRAMs were presented—one with 12-ns access and two featuring 8-ns access. By 1989, BiCMOS dominated the high-speed SRAM section of the conference, with reports on multiple 1-megabit, 8-ns devices; a 16K-bit, 3.5-ns chip; and a 512K-bit, 5-ns RAM. The fastest CMOS SRAM described was rated at 9 ns. The papers represented the latest developments in BiCMOS SRAM made by Hitachi, TI, and Toshiba. Other companies shipping production BiCMOS SRAMs include Aspen, IDT, Saratoga, and National Semiconductor. Clearly, as processors—especially RISC processors—employ ever-increasing clock speeds, BiCMOS SRAM has what it takes to keep up.

The situation with DRAMs is quite different. Unlike with SRAMs, DRAM technology is not driven by speed; it is driven by density and cost. Because bipolar transistors are bigger than FETs, they reduce the number of bits you can store on a DRAM chip. So, although DRAMs can certainly use the output drive and fast I/O made available by BiCMOS, it is unclear whether the market is willing to bear the added cost of BiCMOS DRAM production.

BiCMOS CPU

Perhaps the most interesting BiCMOS announcement at the 1989 ISSCC was the announcement by Hitachi of the world's first BiCMOS microprocessor. The 32-bit processor uses 521,000 MOS transistors and 8000 bipolar transistors. It runs at an amazing 70 MHz by employing TTL I/O and bipolar sense circuits in the ROM, register files, and look-ahead circuits in the ALU.

The processor was fabricated from a BiCMOS macrocell library. The 1-micron process used a die that measured 12.98 mm². No details of the architecture were given.

The Hitachi processor is the first of what could be many processors realized in BiCMOS. BiCMOS appears to be a natural for RISC, which relies less on density and more on high-speed clocks. BiCMOS also provides the high-speed interface needed to link RISC chips with fast memory.

Challenges

Although BiCMOS is slower than bipolar and has a lower logic density than CMOS, it is already filling some important niches in ASICs and SRAMs. Whether it evolves into a mainstream solution depends on many factors, not the least of which is how easily and inexpensively CMOS can be scaled below 0.5 micron.

Although BiCMOS processing is more complex than CMOS at comparable geometries (1 micron, for instance), it is not more complex to produce at comparable speeds. CMOS must be scaled aggressively to produce faster speeds. Aggressive scaling is costly and introduces complexity into CMOS fabrication. Because it is inherently faster, BiCMOS doesn't have to scale as aggressively as CMOS. Thus, you may get the same performance from a 1.2-micron BiCMOS process that you get from a 0.8-micron CMOS process.

Regardless of the success of BiCMOS as a mainstream technology, it is already providing important solutions in some critical areas. It proves that you can have your cake and eat it, too; you just have to pay for it. ■

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Bob Ryan is a BYTE technical editor. He can be reached on BIX as "b.ryan."

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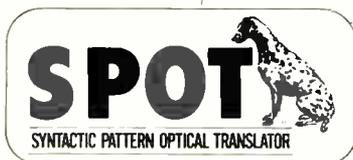
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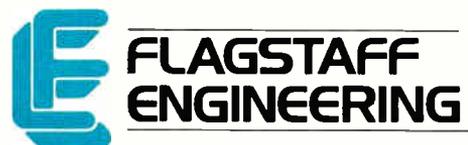
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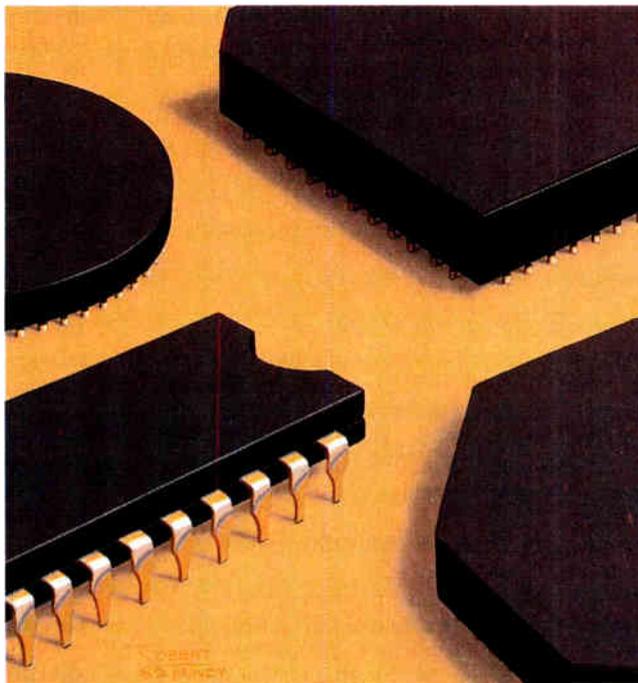
The EPLD is fast becoming the device of choice for quick turnaround or rapidly changing design tasks

Trevor Marshall

Application-specific integrated circuits are all the rage these days. Sun Microsystems advertises that it used only seven ASICs in the SPARCStation 1. These alone covered memory-management-unit, DMA, caching, clock, DRAM, control, and general-buffer functions!

Although the level of integration achieved in circuits such as these is beyond the reach of many developers, the growth in technology that led to the ASIC has also spawned the electrically programmable logic device. The EPLD is smaller, slower, and more expensive than the ASIC, but it has one big advantage: It doesn't require nonrecurring engineering costs that can easily exceed \$40,000 per part. Also, if you make a mistake in an ASIC design, much of the time spent designing the chip and most of the money spent manufacturing it have been wasted, and you have to start all over again. However, if you make a mistake in your EPLD design, you can erase it and program a new pattern within a matter of hours, not months.

Another benefit of EPLDs is that you can program them in the lab and run the design tools for them on a PC. (For more



information on programmable hardware, see "PALs Simplify Complex Circuits," January 1987 BYTE.)

Has Anybody Seen My GAL?

The simplest and fastest of the EPLD devices are the generic array logic (GAL) devices first marketed by Lattice Semiconductor and now second-sourced from National Semiconductor, SGS-Thomp-

son, Advanced Micro Devices, and others. The four basic devices in this family are the GAL16V8, the GAL20V8, the GAL22V10, and the GAL6001.

The 16V8 can emulate all the standard 20-pin programmable array logic devices discussed in "PALs Simplify Complex Circuits." The 20V8 emulates all the 24-pin PAL devices. In addition, using software tools that can take advantage of a GAL's special features, such as the PLAQ assembler from Qwerty (see the text box "The Lone Ranger Rides Again" on page 272), you can create nonstandard PAL devices such as a 16R1 or 16R5. The outputs can be either active high or active low, and each logic term can be clocked or combinatorial.

Since the more complex EPLD devices use many of the features of the 16V8, I'll take a close look at this device. Figure 1 shows a simplified logic diagram of the 16V8 (the 20V8 is similar but has more input terms). At first glance, the architectural similarities to the 20-pin PALs are striking: There is a large array of AND-gate fuses leading to eight input OR gates.

continued

The Lone Ranger Rides Again

Qwerty is a small company in San Diego that offers a unique set of design tools for generic array logic devices from Lattice Semiconductor, SGS-Thompson, and National Semiconductor. For under \$1500, the company sells both a stand-alone programmer, the Lone Ranger (which connects via an RS-232C serial link to any computer), and a software GAL assembler, PLAQ (which is designed specifically to support the features of the GAL16V8, GAL20V8, and GAL6001 devices). The Lone Ranger also supports the GAL22V10, but PLAQ does not.

Qwerty worked closely with Lattice in the early days of GAL technology and offers a number of unique product features. For example, the Lone Ranger not only stores the fuse pattern of the GAL, but also displays information such as the number of times the device has been programmed and a special 8-byte electronic signature. This enables you to "name" the GAL.

When you load a device created with the Qwerty tools into the Lone Ranger, it tells you the name of the GAL (designated by PLAQ at assembly time)—for instance, BREQ. The name is displayed even if the security fuse has been set and the fuse data isn't readable. This feature is extremely useful, especially during long debugging sessions. With named GALs, it's easy to insert revision

data (such as "BREQ-2am") and catch production errors before they become real problems. The signature feature is unique to the Qwerty tools.

You also can designate a GAL as a master, in which case it cannot be reprogrammed without a special query to the operator. This considerably reduces the number of times you wipe out a master GAL by pressing Program Device instead of Load Device. The Lone Ranger also accepts Joint Electronic Device Engineering Council test vectors from PLAQ (or any other JEDEC-compatible software) and electrically tests the GALs with these vectors after setting the fuses.

PLAQ software supports all the above features. In addition, it is transparent to input syntax, enabling you to select the symbols you wish to use for the logic functions, such as AND, OR, and XOR. Thus, you can configure it so that the logic equations look the same as they would in PALASM or many of the other major PAL programming languages. PLAQ also supports state-table design and automatic logic reduction.

PLAQ supports the GAL6001 by enabling the buried-logic macrocell to appear as "virtual pins" in the logic equations. The logic-reduction software is specially optimized to shoehorn complex equations into the architectural constraints of the 6001.

But the true advantages of a GAL become clear only when you look more closely at the output logic macrocell (OLMC) detail shown in figure 2. The two basic features of a PAL device, registered and tristate outputs, are present. However, so are some extended features, such as the product-term and tristate multiplexers, which steer the eighth input from the AND array either to the OR gate or to the tristate enable function.

Feedback multiplexers are provided to steer the feedback signal to the AND array from the cell's output, the register, or the output of the adjacent stage. In addition, a programmable-XOR stage is used to invert the output signal.

Thus, you can configure a GAL I/O pin to function as a registered PAL output, a tristate combinatorial PAL output, or the active-high version of either of these. Unfortunately, the clock signal for the register still can come only from pin 1 of the device and not from the

array. The necessity for total compatibility with PAL devices dictates this rule.

The GAL22V10 is the EPLD analog version of the PAL22V10 device. It is essentially a 20V8, but with the following enhancements:

- There are 10 possible outputs instead of 8.
- The number of product terms is greater with two cells having 16 product terms each, and two each having 14, 12, 10, and 8 terms.
- The pin-1 clock signal is fed as a term to the array.
- Pin 13 is a general-purpose input, instead of being dedicated as the output enable for the registered terms.
- Asynchronous SET and PRESET terms from the array can control the state of the registered terms.

The GAL6001 is an interesting device. Although powerful, it isn't used much

because of its sheer complexity and the dearth of design tools available that can really use all its features.

Figure 3 shows a functional diagram of the 6001, where you can see another characteristic of the more complex EPLD devices: the buried logic macrocell. BLMCs are output cells that don't connect to any output pins, but act as additional terms in the AND array. Typically, you use them as state machines or as complex feedback terms.

There are also input logic macrocells on each input, providing latched, registered, or combinatorial input capabilities. While there are separate clocks for the input and output macrocells, each is dedicated and must control every like cell in the device. It's not possible to use an array logic term to clock either inputs or outputs without dedicating two pins, the input clock and the output clock.

Indeed, if I can level any criticism at the 6001, it must be that there are not enough pins in a 24-pin package to use its power effectively.

At this point, I can make several generalizations. The 16V8 and 20V8 GALs are currently available with maximum delays as short as 10 nanoseconds combinatorial (input to output) and 6 ns clock to output. The 22V10 can be as fast as 15 ns combinatorial and 6 ns when clocked. The delay through the 6001, however, depends on the path that the signal has to take through the device. When you use BLMCs, the propagation delays can be as long as 40 ns, and the fastest path through the device still takes 30 ns.

In general, as the complexity of an EPLD increases, the propagation delays through it also increase. In addition, as a component becomes more complex, the design tools that are needed to use it effectively become more complex and more expensive. It's also much easier to use up the 22 available signal pins on a 22V10 than to use all the terms in its arrays. Thus, the more complex an EPLD becomes, the greater the requirements for special packaging with more pins than the GALs' 24-pin package.

To summarize, the most useful complex EPLD devices will have the following characteristics:

- The design tools will be affordable yet powerful.
- There will be enough pins on the package to enable you to use most of the internal logic.
- The device needs to retain speeds commensurate with discrete circuitry.

continued

GAL16V8 LOGIC BLOCK DIAGRAM

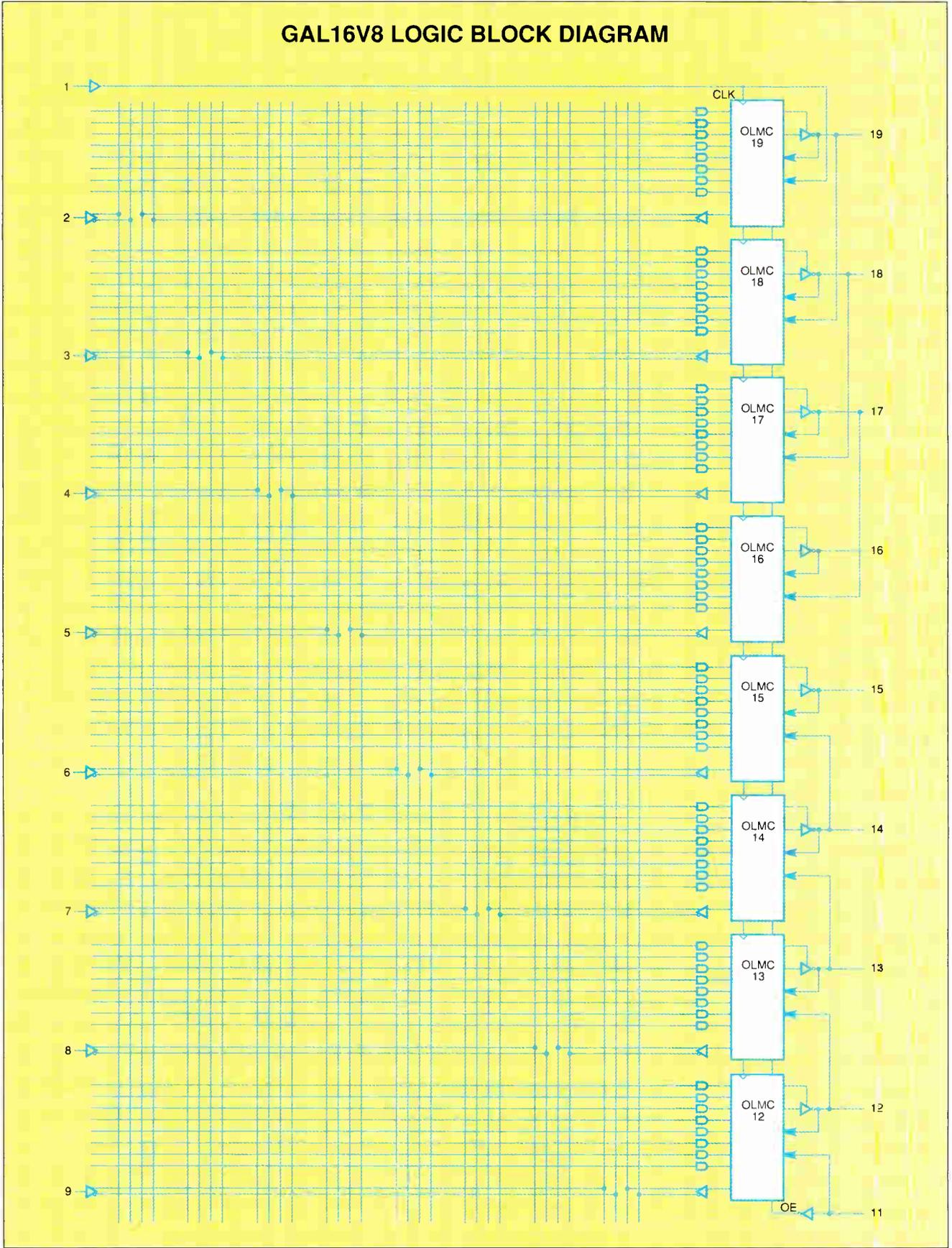
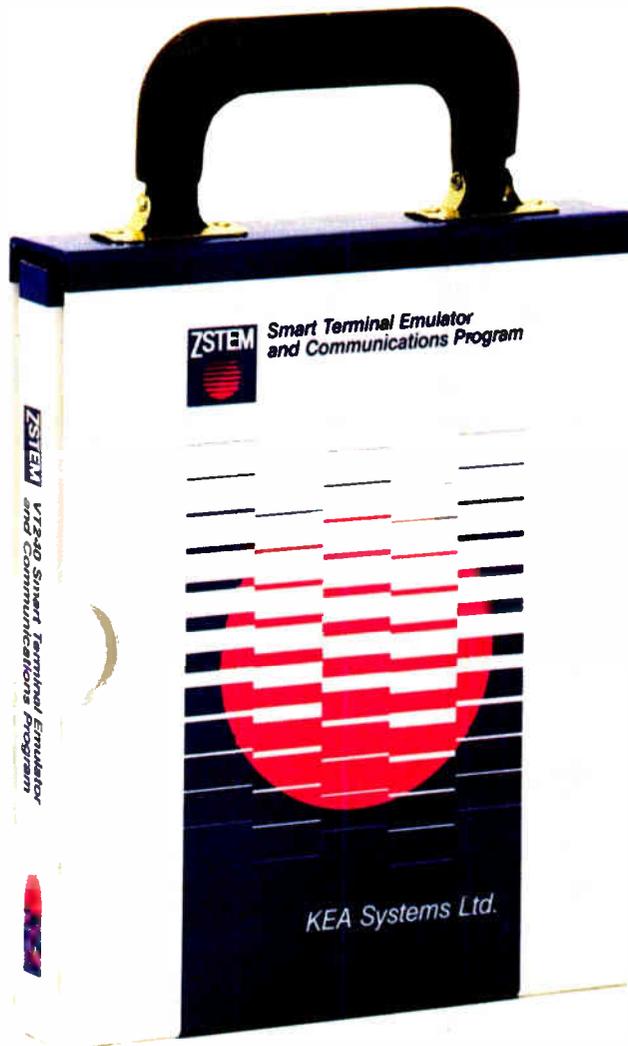


Figure 1: Simplified logic diagram of the GAL16V8 electrically programmable logic device. At this level, the EPLD strongly resembles a 20-pin programmable array logic device.

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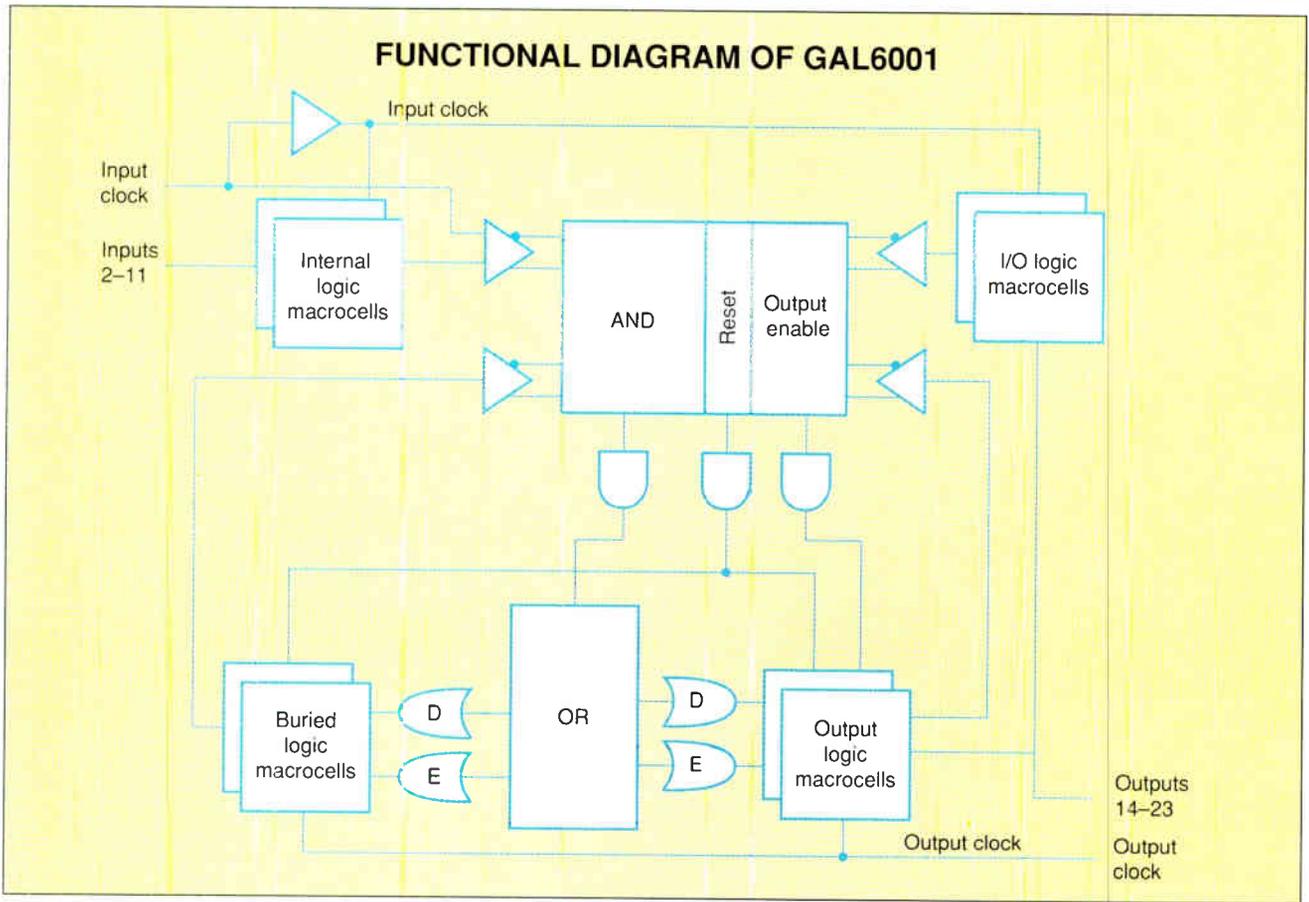


Figure 3: Functional block diagram of the GAL6001. This device offers such complexity that it's easy to run out of pins.

delay would be 5 to 10 ns total. Only the router can advise you on the most efficient interconnect, and only after you have completed the design.

An evaluation version of the CAD software is not available, and so you must purchase the software before beginning a design. The software includes several hardware security keys, each for a different level of capability. [Editor's note: A demonstration is available on disk and on BIX as XILINX.ARC. It can be viewed on an IBM PC compatible with EGA or VGA capabilities. See page 5 for details.]

Having said all that, the Xilinx EPLD arrays offer the greatest density (in terms of the number of equivalent gates), and the Xact software tools provide answers to the design dilemmas. The remaining trade-off is between functional complexity and speed. As the logic becomes more complex, the propagation delay through the device generally increases.

An Excellent Compromise

Altera was another pioneer of complex EPLDs. With Altera's EPLD, you pro-

gram devices electrically and erase them under ultraviolet light. They span the spectrum from low-density PAL-like devices to 128 macrocell MAX-series (MAX stands for multiple-array matrix) parts with 256 internal latches.

The most notable of the simpler Altera parts is the EP610/EP910/EP1810 series. The EP610 is the fastest of these parts, and the EP910 is the fastest EPLD available in the 44-pin plastic leadless chip carrier (PLCC) package. The current price for the EP910 is under \$20, and you can obtain one with delays as low as 25 ns. It represents an excellent compromise between the complexity of the internal logic and the number of device pins.

The EP910 contains 24 macrocells and 72 AND-gate terms resulting from the inputs and product-term feedback paths. Each macrocell is connected directly to an I/O pin. And each one has the conventional AND/OR structure of the GAL, except that the register clock can be derived from the array or from a dedicated pin.

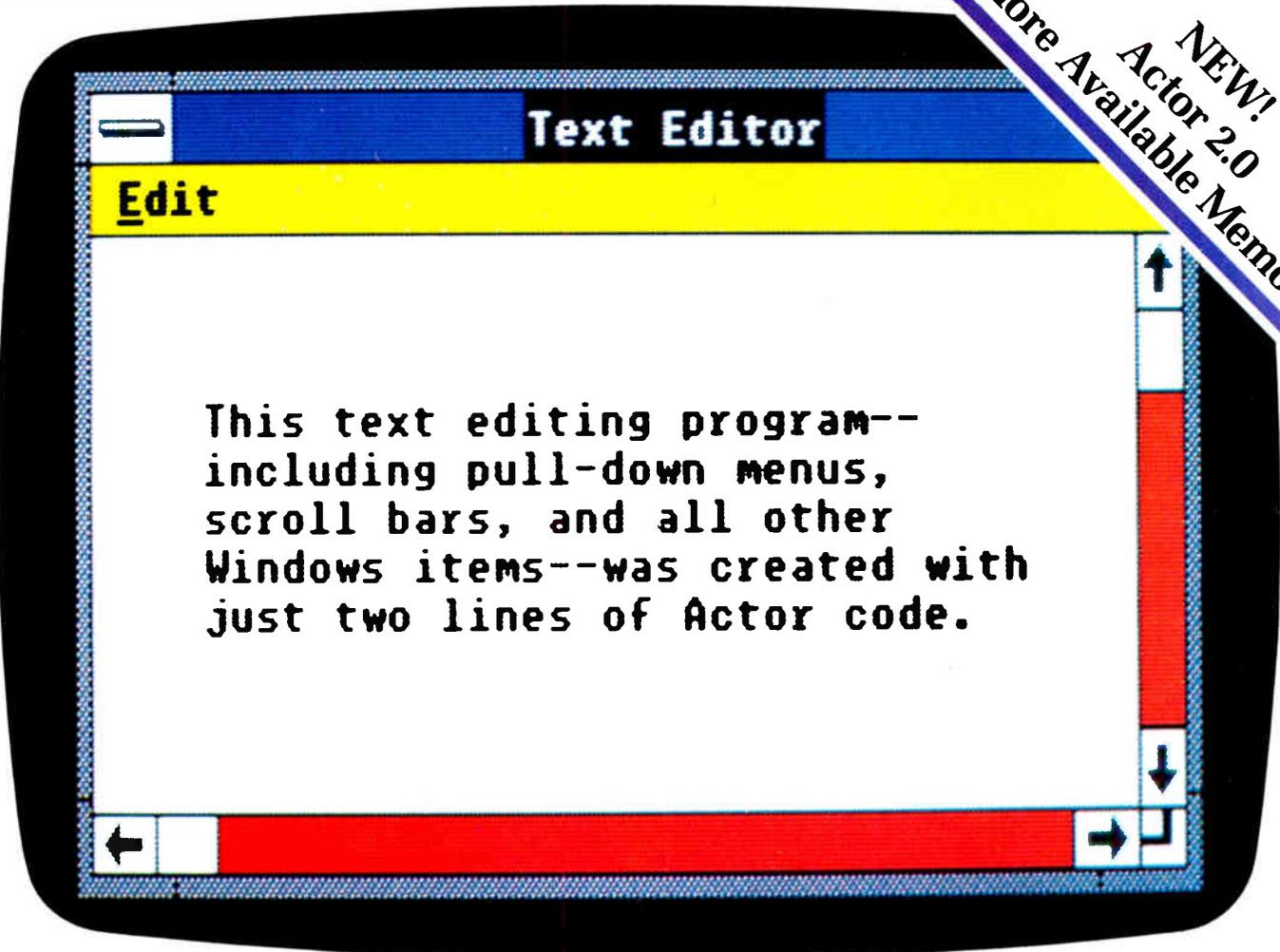
A CLEAR input is also provided to the I/O cell, which can be configured as a combinatorial stage or as various types of flip-flops. Many of the programmable logic design programs, such as ABEL, CUPL, ISDATA, and MINC, also support these parts. [Editor's note: A demonstration is available on disk and on BIX as ALTERA1.ARC. It operates on an IBM PC and provides an overview of the EP610/910/1810-series components, as well as a quick guide to the capabilities of Altera's design software. See page 5 for details.]

The MAX from the Minimum

Altera recently introduced its MAX architecture for complex EPLDs. This family ranges from 16 to 128 macrocells in packages of from 20 to 68 pins. The MAX logic-control macrocell retains many of the features of the GAL devices, except that the number of product terms has diminished to three. However, the XOR control now comes from the logic array, considerably increasing the way in

continued

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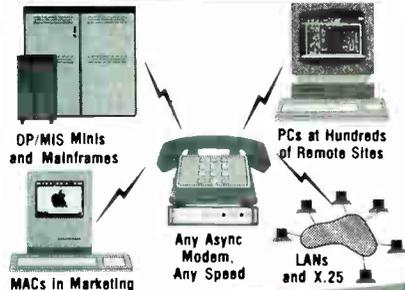
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LOGIC IMPLEMENTATION FOR THE PA7040 EPLD

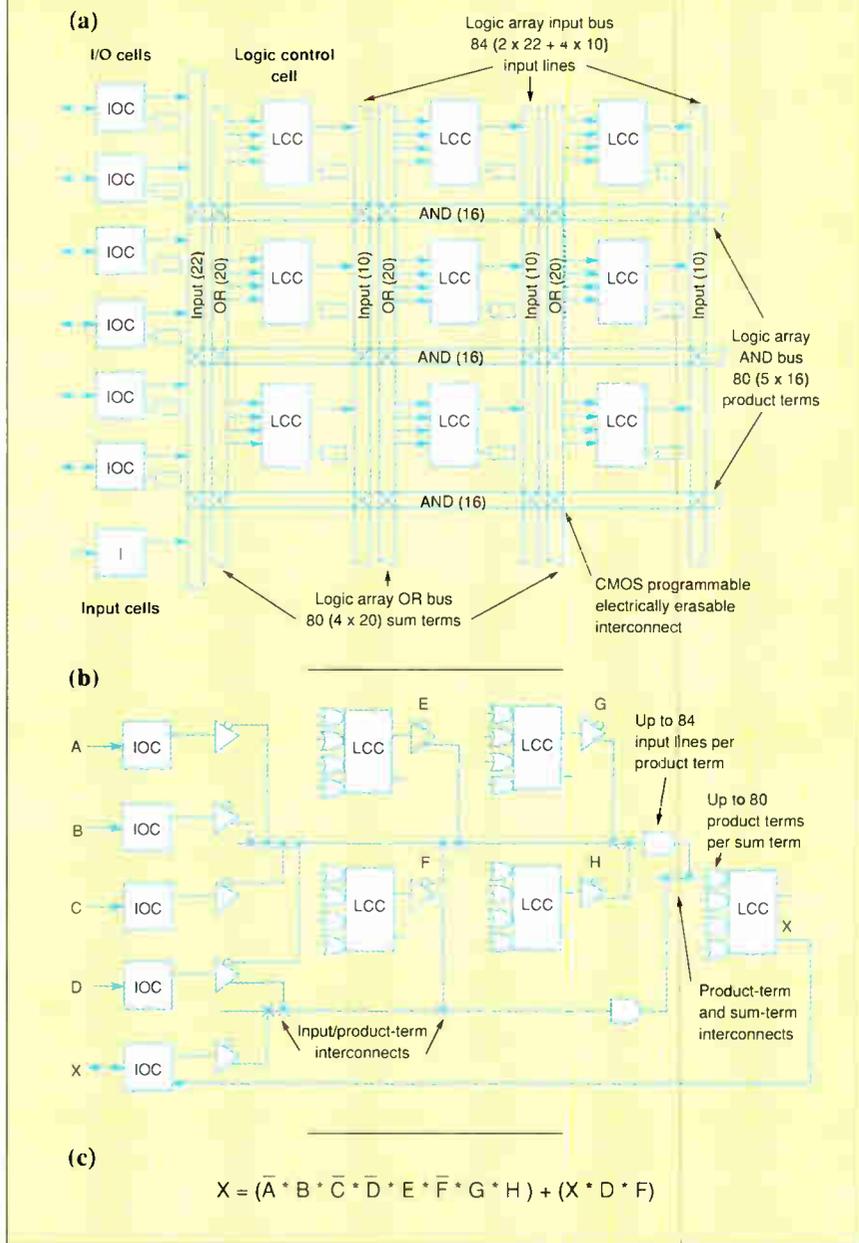


Figure 4: (a) A section of the distributed logic array matrix for the PA7040 EPLD; (b) a sample logic diagram; and (c) the Boolean expression that produced it.

which these three can manipulate the logic functions.

The register clock can come from either the dedicated pin or the array. PRESET, CLEAR, and I/O OUTPUT ENABLES are also derived from the AND array. This AND array is massive, encompassing all the input, I/O, feedback, expander, and programmable interconnect array signals. The MAX technology really has bridged the gap be-

tween the functions of an ASIC and the convenience of an EPLD. In fact, Altera claims that a 74161 counter uses only 3 percent of the available 128 logic cells on its largest (EPM5128) part. [Editor's note: A MAX demonstration clearly showing the capabilities that can be programmed into complex EPLDs such as these is available on disk and on BIX as ALTERA2.ARC. You will need an EGA or continued

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VGA monitor to view this demonstration. See page 5 for details.] MAX+ includes a graphics editor, a design processor (router), and a timing simulator. There is a large library of common 74-series TTL parts that you can enter into the graphics editor to describe what you want the EPLD to emulate.

PEEL Back the Prices

ICT is a relative newcomer to the EPLD field. This company makes a version of the GAL16V8, a 20CG10 24-pin part, and the GAL22V10. Using programmable electrically erasable logic architecture, you can program ICT's devices using the company's relatively low-cost PC-based tools. ICT PEEL devices are slightly slower than the fastest of their GAL equivalents, but are price-competitive at any given performance level. Recently, ICT announced higher-density PA7024 and PA7040 devices. The PA7040 is available in the 44-pin PLCC package and offers twice the number of pins in about the same space required by a 24-pin DIP.

The PA7040 contains 24 logic-control cells, in addition to a unique interconnect scheme. Although the cells provide just a few simple functions of the input variables, the interconnect array is much like the AND array in PALs. This arrangement provides symmetrical and easily analyzed delays through the device, and it significantly increases the complexity of available interconnects. Figure 4 shows how this interconnect array can take terms from either inputs or other cells and, with only one level of delay,

EPLDs are now complex enough to replace most standard TTL functions.

feed them to the output cell.

In other FPGA architectures, it's common to have to route signals through three or four levels of interconnects just to get between the input and output pins. Actel has a series of FPGA devices with higher levels of complexity and slightly faster operation than the EPLDs that I have been discussing. The Actel system is aimed at the high end of the FPGA market. Signetics has bipolar-fuse FPGA devices (the PLHS502 series). These devices have 24 input-only pins, 16 output-only pins, and eight I/O pins. And Intel has the 5AC324 CMOS EPLD devices. These devices have 24 macrocells, 34 flip-flops, 24 I/O pins, and 12 input-only pins.

The Device of Choice

Modern EPLDs are now complex enough to replace most standard TTL functions. The less complex GALs are as fast as bipolar PALs, consume less power, are far more flexible, and are available from several manufacturers. A number of low-

cost programmer and software tools are also available for GALs.

When the speed of operation is less critical, you can use the more complex EPLD components. While you aren't likely to see an EPLD implementation of the high-speed cache controller in your 33-MHz 80386 PC at any time in the near future, you will see EPLDs in bus controllers, peripheral logic, and industrial automation.

A single complex EPLD can replace as many as 20 medium-scale-integration functions. Altera, Xilinx, and ICT provide large TTL function libraries to ease the transition for users who are familiar with TTL circuits to systems design using these EPLDs.

Unfortunately, this ease of use comes with a relatively high price tag. The ICT package is the only one that costs under \$1000. A full set of software from Altera or Xilinx will run nearly \$5000. The entry-level costs, however, are mostly one-time. Once you decide which EPLD family suits your purposes best and have purchased the design tools, the cost of the reusable IC devices is relatively low.

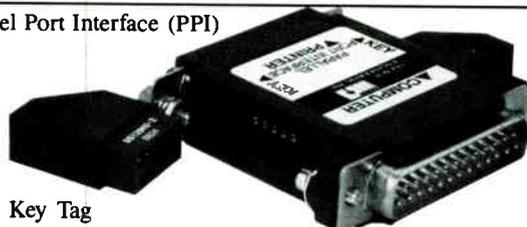
Although ASICs should still be chosen for projects that involve large-volume production, require high levels of integration, or are speed-critical, EPLDs are fast becoming the device of choice for quick turnaround or rapidly changing design tasks. ■

Trevor Marshall is president of YARC Systems (Thousand Oaks, CA) and is a BYTE consulting editor. He can be contacted on BIX as "tmarshall."

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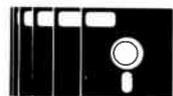
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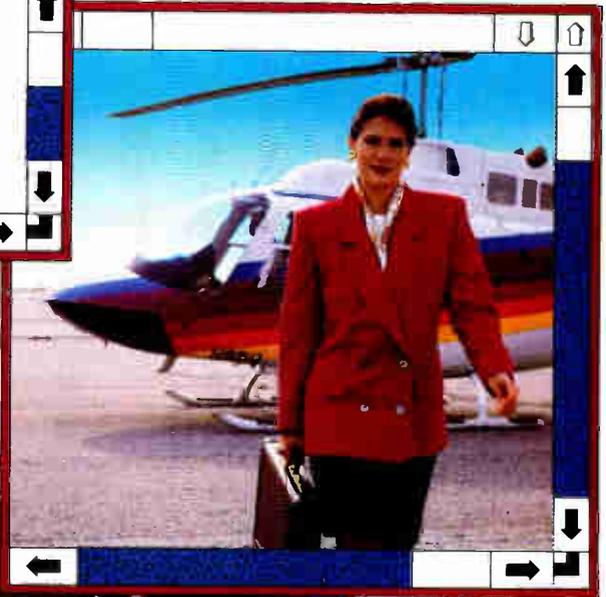
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Semiconductor Sources

BiCMOS, electrically programmable logic devices (EPLDs) and gallium arsenide (GaAs) are all exciting, fast-growing semiconductor technologies. They provide levels of function or performance that "push the envelope" of IC design. For the latest information on companies, products, and processes mentioned in this In Depth, contact the companies listed below.

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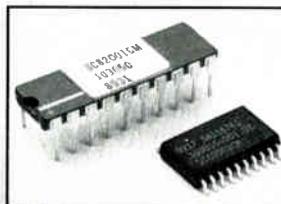
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Our Users Report:

Milt Capsimolis of Ithaca Software in Ithaca, NY, developer of HOOPS, the highly regarded 3D, object-oriented graphics library, reports, "We ported a huge library — well over 100,000 lines — without a hitch, in less than a day! ... We also liked the enormous advantage it offers through its support of the Weitek coprocessor."

Fred Ziegler of AspenTech in Cambridge, Mass. reports, "I ported 900,000 lines of FORTRAN source in two weeks without a single problem!" AspenTech's Chemical Modeling System is in use on mainframes worldwide and is probably the largest application to ever run on an Intel processor.

Please call (508) 746-7341 for more information.

NDP C is also the language of choice if you are combining C with FORTRAN or Pascal, are planning to use any one of four coprocessors that run with the 80386, or require the highest globally optimized code attainable. MicroWay's C, FORTRAN and Pascal compilers come with a 70 function, device-independent graphics library that automatically supports Monochrome, Hercules, CGA, EGA, and VGA adapters and makes it easy to interface memory-mapped peripherals such as digitizers or serial devices such as mice. We make it possible for you to write your own numeric exception handler and include examples written in C, FORTRAN and Pascal. Finally, our C is not only one of the easiest to use, but supports two dialects: ANSI and UNIX. In fact, our UNIX implementation is so close to the standard, that our best customer has become AT&T!

386 Compilers and Tools

NDP Fortran-386™, NDP C-386™, and NDP Pascal-386™ compilers generate globally optimized, mainframe quality code that runs on the 386 or 486 in protected mode under UNIX, XENIX or Phar Lap extended DOS. The compilers address 4 gigabytes of memory while supporting the 80287, 80387 and Weitek coprocessors. They all come with a library of over 70 device-independent graphics, keyboard and sound routines. Applications can mix code from all three compilers and assembly language. The DOS versions allow the user to write his own numeric error handlers and interface 386 real mode programs from protected mode. The VM versions use Phar Lap's Virtual Memory Manager to run programs which exceed the size of your system memory. NDP Fortran-386 is a full FORTRAN 77 with FORTRAN 66, BSD 4.2, DOD and VMS extensions. NDP C-386 is a full K&R C with both MS and ANSI extensions. It is 100% compatible with UNIX C and is substantially faster than the C which comes with UNIX. NDP Pascal-386 is a full ANSI/IEEE Pascal, with extensions from C and BSD 4.2 Pascal.

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THE BYTE AWARDS



Second Annual BYTE Award Winners



he year 1989 may go down in the books as the one in which personal computing rose from the ashes. As the 1980s drew to a close, it seemed as though the industry had hit a plateau: Exciting new technologies were few and far between. Most of the new products announced were only marginally better than their forebears.

Then, interesting things started happening. IBM's dominance of the microcomputer field, once deemed absolute and unshakable, seemed to be faltering. Unix, the sleeping giant, awoke from a decade-long slumber and began to make new strides, as high-powered hardware became available. The promises of megamemory, networking, object-oriented programming, and advanced graphics began to bear fruit. And Apple Computer proved that it was still capable of coming up with technological surprises.

Once again, we polled our entire staff of editors to ask them which products and technologies of 1989 proved to be the most innovative, advanced the state of the art, or provided the best price-to-performance ratio. Dozens of products were nominated. We then voted on which of these were the most significant. We've presented an Award of Excellence to the top vote recipients. These are products and technologies that we believe are especially worthy of recognition. The others that made the final cut are recipients of a BYTE Award of Distinction. Among the hundreds, and perhaps thousands, of products that we saw last year, these are the ones that deserve your special attention.



EISA

The Extended Industry Standard Architecture (EISA) is now officially in place. Hewlett-Packard was first to put

its stamp of approval on the bus by unveiling its Vectra 486 PC; by the time you read this, most of the other members of the "Gang of Nine" will also have announced EISA machines.

BYTE's editors have voted the EISA an Award of Excellence in part because of its direct descent from the generic PC AT bus, the so-called Industry Standard Architecture. As a result, users can install cards designed for ISA machines now, while waiting

for fast EISA cards to appear. Contrast this with IBM's Micro Channel Architecture (MCA), whose cards are incompatible with ISA cards, and, because of their small form factor, have the reputation of being difficult to manufacture.

In addition, while both MCA and EISA systems can do full 32-bit transfers and can configure themselves automatically, the EISA bus is fully synchronous and has a faster maximum burst-trans-

fer rate. Also, since EISA boards have about twice as much surface area as MCA cards (obviating the need for expensive surface-mount technology), peripherals such as on-the-card hard disks, relay boards, and intelligent I/O boards with a large amount of RAM are simpler and less expensive to implement.

Lastly, EISA is another crack in Big Blue's hold on the user, and it will enable the proliferation of AT clones with no holds barred.



EXCELLENCE

Mac IIci, Apple Computer

The Mac IIci is a winner this year for many reasons. First, it's the biggest jump in processing performance for a Mac since the Mac II was announced. A 25-MHz 68030 CPU running in burst mode, faster 80-nanosecond RAM, and cleverly arranged ROM code squeeze maximum performance out of the system.

Second, the Mac IIci uses innovative technology that packs built-in 8-bit video and a memory cache slot (for an additional performance boost if you need it) within the same Mac IIcx housing. Third, the future is built into the system. With 4-megabit-density single in-line memory module (SIMM)-mounted RAM, you can expand the Mac IIci's memory to 32 megabytes. The last addressing problems with the Mac ROM code have been fixed as well, which allows Mac applications to fully utilize the 68030's 32-bit address space.

EXCELLENCE

Motif, Open Software Foundation

Some time ago, the Open Software Foundation (OSF) asked major software developers to submit graphical user interface (GUI) technologies for consideration as a standard Unix operating environment. After due consideration, the OSF chose pieces from three companies.

By combining the technologies of these firms—Hewlett-Packard, Microsoft, and Digital Equipment—the OSF came up with a GUI that has some of each company's contributions to user interfaces. Motif is attractive and useful,



and it runs on any X Window base. It furnishes a consistent user interface across operating systems by offering a Presentation Manager look and the Macintosh intuitive way of operating on Unix and VMS machines.

Motif has been released to OSF members, and at least one, The Santa Cruz Operation, is now shipping a product for consumers. Given the increased interest in Unix as an operating system for high-performance computing, we consider Motif an achievement worthy of recognition.

EXCELLENCE

32-Bit QuickDraw, Apple Computer

An upgrade of the Macintosh's color graphics primitives, 32-Bit QuickDraw extends imaging technology for microcomputers. It allows any 68020- or 68030-based Macintosh to produce photo-quality images using a virtually unlimited palette of colors. This advantage makes the Mac a serious image-processing engine that is capable of handling complex graphics simulations once routinely processed only on high-end workstations and mainframes.

32-Bit QuickDraw's technology makes possible a host of new applications, such as high-quality color desktop publishing and image manipulation. It maintains compatibility with existing Mac graphics applications. Not only do existing applications still work, but in some cases they can actually use these



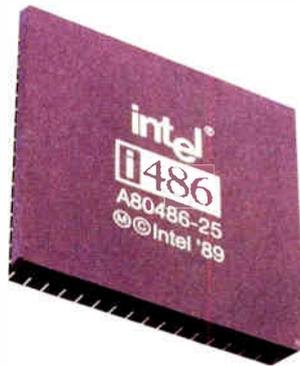
new color extensions without modification. Finally, installation is a snap.

32-Bit QuickDraw requires lots of RAM, a large hard disk drive, and a special video board to display the millions of possible colors. However, since both RAM and some of the now-expensive video boards are coming down in price, the powerful color capabilities of 32-Bit QuickDraw are coming within reach for many Mac users.

EXCELLENCE

80486 microprocessor, Intel

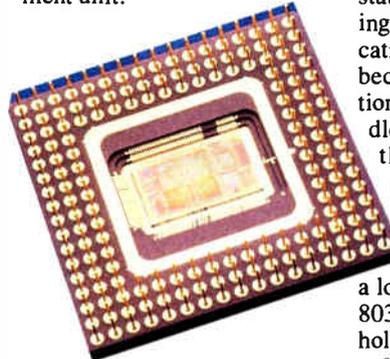
When 80486 chips become feasible and plentiful, users will see an increase in performance that will make systems made with Intel's chip not only cost-effective, but also fast and capable of running applications that take advantage of the extra features of the chip. Right now, the 80486 is in the midst of its shakeout cruise. But if it lives up to its expectations, we see great potential for the micro-



processor and systems built with it.

The architecture is well defined. The major advantages that users will experience with the 80486 are the result of streamlining the chip's

pipelining and the fact that Intel has incorporated into the chip a floating-point coprocessor and a memory management unit.



The 80486 is fully compatible, both upward and downward, with its predecessor, the 80386, thus providing a stationary target for operating-system vendors and applications developers alike. And because it contains the functionality that once was handled by support chips such as the 80387 numeric data processor and the 82385 cache controller, the availability of the 80486 will eventually provide a lower cost per user than the 80386. The 80486's potential holds out the promise that our software may one day be as good as our hardware.

EXCELLENCE

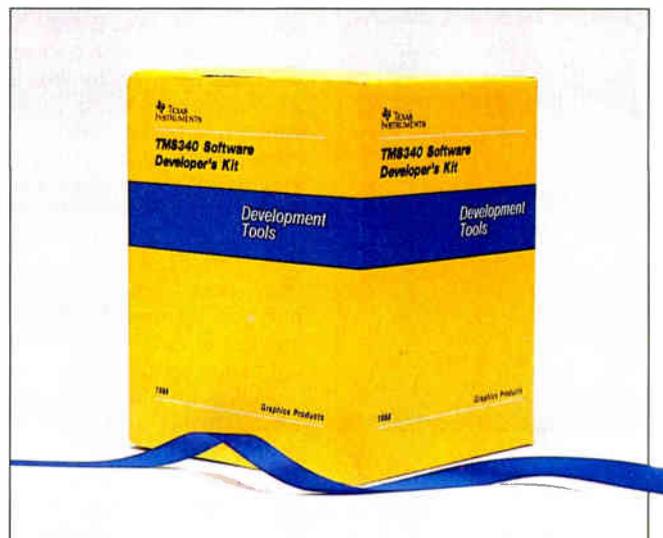
TIGA-340, Texas Instruments

Short for the Texas Instruments Graphics Architecture, TIGA is a high-resolution (beyond the 1024 by 768 pixels of extended VGA) graphics coprocessor card that is well on its way to establishment as a standard application interface.

TI supports TIGA as a standard interface between computers using Intel microprocessors and graphics boards using its 34010 and 34020 graphics coprocessors. (Another approach is IBM's 8514/A, a quasi-standard created to provide another path to high-resolution graphics. IBM designed it to be a closed hardware product but has never published the hardware specifications. TIGA is designed as an open software standard.)

The TIGA-340 board has been shipping since the summer of 1989. We recognize TIGA for being an attempt to bring order to the situation by standardizing the software application interface so that software developers can write to a single driver. TIGA promises to reduce the nightmare of applications development in the wild and woolly world of resolutions beyond VGA.

continued



1989
BYTE
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**VCPI,
Phar Lap Software**

With OS/2 still an unfulfilled promise, frustrated users increasingly have become more and more insistent in their demands for the features that it promises—specifically, large programs and multitasking. Consequently, a number of companies set out to agree on a standard that they hoped would create some order out of all the confusion. One of the results of the clamor has been the emergence of the

Virtual Control Program Interface.

The name is something of a misnomer. VCPI isn't a program, but a specification for how a VCPI-compatible program should behave.

VCPI is designed to solve two problems that arise when several 80386-aware programs run at the same time: conflicts over the use of extended memory, and conflicts over which one of several pro-

grams is in charge.

We recognize VCPI because it could be the perfect answer for users who already have an 80386-based PC and need to tap more of its power but can't afford OS/2. VCPI should also help address the needs of users who have lost patience with the wait for applications software that will turn the current 80286-based OS/2 from a great idea into a great operating system.

EXCELLENCE

**Pocket Ethernet Adapter,
Xircom**

The Pocket Ethernet Adapter offers an innovative solution to the problems of integrating portable computers and computers without available expansion slots into a LAN.

The concept is so simple, it's a wonder no one thought of it before. Just plug it into a PC's parallel port, load the drivers (once), and you're up on the network. This means that one adapter can be used



on AT-bus, MCA, and laptop systems. It's ideal for temporary LAN connections, such as plugging in your laptop when you return from a trip. It's also a good choice for systems whose slots are already full.

The Pocket Ethernet comes in versions for both thick and thin Ethernet. At present, the only drivers available are those for NetWare, but others are coming. It's the perfect way to test new systems, to bring occasional LAN users on-line, and, most of all, to link portables to a LAN.

EXCELLENCE

Studio/1, Electronic Arts



Studio/1 is a simplified but powerful black-and-white version (for the Mac Plus) of Electronic Arts's full-color

paint program Studio/8 (for the Mac II). Amazingly enough, Studio/1 runs with only 1 megabyte of RAM.

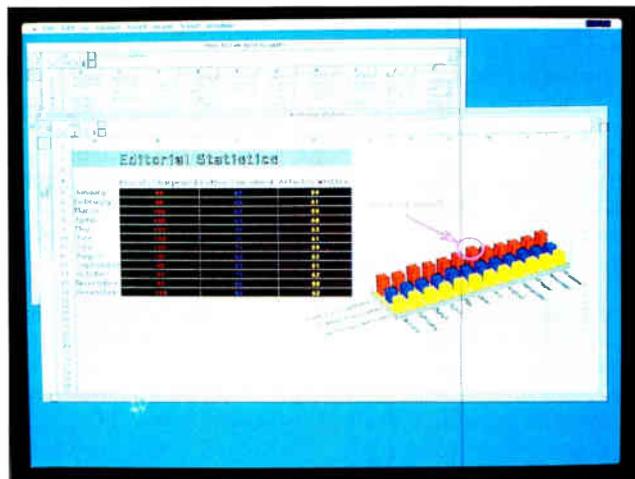
This monochrome package has the same hefty toolbox as its colorized sibling. It includes freehand pencil, paintbrush, airbrush, text typer, magnifier, 40 background/foreground patterns (including gradient fills), as well as tools for drawing straight lines, bent lines, rectangles, polygons, freestyle shapes, and Bézier curves. It also has animation capabilities.

Kudos to Electronic Arts for producing a program for people who prefer to work in black and white and for those of us who can't afford the luxury of investing in equipment for color graphics.

EXCELLENCE

WingZ, Informix

After all the advance hype by Informix, a lot of folks were surprised when the Mac spreadsheet WingZ arrived and lived up to its billing. It offers performance that, in many cases, beats the old leader, Microsoft Excel. And when you consider the addition of fancy graphics and HyperTalk-style programmability, it's hard not to be impressed by WingZ.



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Secret #3:

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Secret #4:

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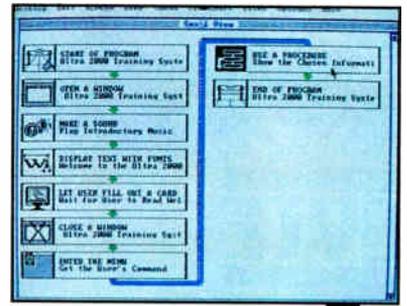
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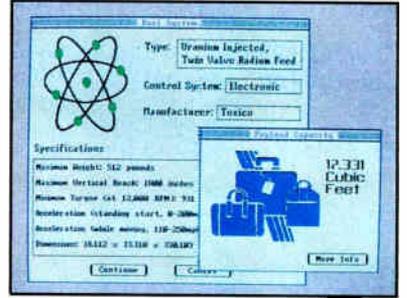
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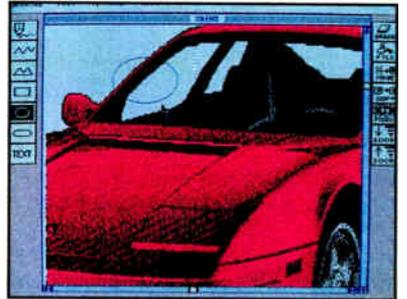
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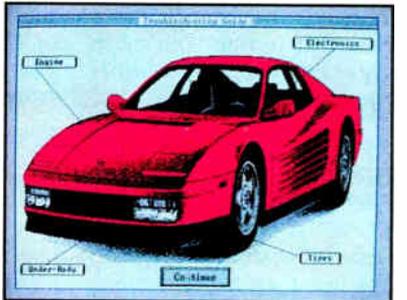
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Cheetah Gold, Cheetah International



When the 80486 was announced at Spring Comdex last year, Cheetah's president promised to keep prices as low as possible on the company's upcoming products. Cheetah Gold keeps that promise. A 25-MHz 80486 tower computer that, in its basic form, sells for \$4995, the system comes standard with 4 megabytes of 1-megabyte by 1-bit SIMM RAM, a 1.2-megabyte 5¼-inch floppy disk drive, a 60-megabyte hard disk drive, a VGA controller, one serial and one parallel port, and a monochrome VGA monitor.

The Cheetah Gold system is rugged, and its price/performance is outstanding in a class that is ripe with much higher-priced, less well-equipped machines.

GRiDPad, GRiD Systems

The GRiDPad could be the first real notebook computer. You use it just as you would a notebook—hold it in one hand, and write on it with the other. No mouse or keyboard is needed. The GRiDPad has a special display, a metal stylus, and software that can rec-

ognize hand-printed text. If you really want any of the other input devices, however, the GRiDPad can give you a "virtual" keyboard on the screen.

This electronic slate also runs DOS software (MS-DOS 3.3 lives in its ROM), and it comes with a megabyte of RAM, memory-card ports for adding more memory, and options such as a 20-megabyte hard disk drive and a 2400-bps modem.

The GRiDPad isn't the sort of machine that everyone will want or need. In fact, its appeal might be rather limited. But this device wins points for its design and its innovative engineering.

HOOPS, Ithaca Software

The Hierarchical Object-Oriented Picture System, or HOOPS, provides platform-independent three-dimensional graphics. The HOOPS library, available for use with C and FORTRAN and Unix, VMS, Phar Lap-extended DOS, and Macintosh systems, supports a declarative style of programming. You tell this system what to draw, not how to draw it.

HOOPS transparently maintains a database of three-dimensional geometry, renders it on the available display hardware, and monitors the user's interaction with the database. It's a clean and powerful implementation that's already being used in several CAD products and should spur the development of database products that employ three-dimensional graphical interfaces.



Magellan, Lotus Development

Magellan isn't the ultimate DOS shell, but it offers two powerful capabilities in which it excels: indexing with fast, fuzzy, natural-language searching, and file viewing.

When you use these functions in tandem, you can locate, examine, group, and launch files on a hard disk drive more flexibly and intuitively than by using some of the other, more well-known products.



MinisPort, Zenith Data Systems

A remarkable achievement in miniaturization, the Zenith MinisPort offers a legible VGA screen, a comfortable 80-key keyboard, and a 4.77- or 8-MHz CPU in a 6½-pound package the size of a notebook.

Zenith is the first company to use the new 2-inch floppy disk drives in a laptop—a controversial but forward-looking decision utilizing an interesting alternative to smart cards. The MinisPort is a product worth using and worth watching.

MultiScope Debugger, Logitech

Until recently, if you wanted to debug an event-driven, multitasking programming environment such as the OS/2 Presentation Manager (PM), you had only one choice: Microsoft's CVP, a protected-mode version of the CodeView symbolic debugger. But now there's an alternative, and Logitech's MultiScope could very well be the debugging toolkit of choice

for professional OS/2 programmers.

MultiScope is more comprehensive than its rival in that the package comprises four debuggers: the PM Runtime Debugger, the PM Postmortem Debugger, the Text Mode Run-time Debugger, and the Text Mode Post-mortem Debugger.

Although CodeView is supplied free with Microsoft C, serious OS/2 programmers can use MultiScope to increase their productivity (e.g., by using MED and postmortem debugging to identify a bug that happens only at a customer's site) and easily justify its \$299 price.

NetWare 386, Novell

This is the first LAN operating system that takes full advantage of the capabilities of the Intel 80386 processor. The result is that Novell NetWare 386 (version 3.0) permits vastly greater numbers of users on a server, improves performance and security, and is significantly easier to use and install.

More important, NetWare 386 is the first network operating system designed to be protocol-independent.

NetWare for Macintosh, Novell

While the first release of Novell's NetWare for Macintosh was buggy and imperfect, it was also the first product to let Macs and PCs coexist on a LAN while both continued to view the world the way each of them wanted to see it.

From the Mac side, the server looks just like any AppleShare server. From the PC side, you see the standard DOS directories. NetWare doesn't force either kind of user to learn the other's way, and that's a step forward.

When Novell has cleaned up this product, it will be great. Even now, NetWare for Macintosh is a product that deserves notice.

continued

Our tools are not exciting. Life without them can be.

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I don't see my changes.

I thought we had everyone's.

What does the documentation say?

What documentation?

Hello, POLYTRON.

POLYTRON

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World Radio History



OED on CD-ROM, Oxford University Press

The computerization of the Oxford English Dictionary (OED) was a gigantic effort that involved more than converting the text into machine-readable form. The dictionary data had to be structured and stored in a database format suitable for the various functions that would be performed, including data integration, entry updating, consistency checking, and general searching.

Researchers at the Centre for the New Oxford English Dictionary developed the theoretical framework for the computerized OED, including several new methods for modeling and searching text data. These theories were then used to create the various software tools needed for the project.

The Centre was very careful to ensure that the software and theories developed for the project are not OED-specific but can be applied to a wide variety of text-dominated databases. Software is written portably in C, using the X Window System whenever complex display capabilities are needed.

The end result is CD-ROM technology put to work in a very successful manner.

PacificPage, Pacific Data Products

PacificPage is a cartridge for the Hewlett-Packard Series II printer, and it's chock full of PostScript-emulation software. When you install the cartridge, the software takes over the printer's internal firmware and makes it behave just like a stand-alone PostScript printer. PacificPage makes it easy for people who

already own LaserJets to get PostScript functionality without buying a new printer or relying on hokey software solutions. It's not fast, but it's elegant, and it appears to be very compatible. Instead of telling users to "throw out your old device and buy this one," Pacific has come up with something that breathes life into old equipment.

PhotoMac, Data Translation

PhotoMac lets you manipulate 24-bit-deep scanned images on a Mac II, and it accomplishes this feat without requiring you to obtain an expensive 24-bit color video board or extra memory. Its special effects are outstanding and easy to use. Although you're working with 24-bit colors, PhotoMac renders the image as best it can on an 8-bit-deep screen by continuously modifying the Mac's color palette as you view or zoom in on parts of the image. It also uses its own virtual memory system, so you can operate within 2 megabytes of RAM, although you'll get better performance with additional memory.



Poquet PC, Poquet Computer

The Poquet PC has all the power of an IBM PC—including a full-screen display—and this computer really is small enough to fit in your coat pocket. Folded, its dimensions run about 1 by 8¼ by 4½ inches. It weighs 1 pound, has a 77-key QWERTY keyboard (with 12 function keys and an

embedded numeric keypad), a 25-row by 80-column display, as well as CGA-compatible graphics.

Built around an Intel 80C88 microprocessor running at a clock speed of 7 MHz, the Poquet PC uses credit-card-size memory cards as its storage medium. The ROM is one of the key features of the Poquet PC because it includes MS-DOS 3.3, GW-BASIC, and a set of simple software applications, including a calculator, a simple text editor, a scheduler with calendar and alarm functions, a communications program for accessing data by modem, an address book, and a file manager and file transfer program.

The drawbacks to this machine are its relatively high price (\$2000) and the high cost of the memory cards (about \$1 per 1000 bytes of storage capacity).



PowerFlex, Advanced Logic Research

The PowerFlex AT is significant for a number of reasons. It represents a price-to-performance breakthrough (it's priced at under \$1500 for a system with 1 megabyte of RAM and a 40-megabyte hard disk drive), and it provides a simple, inexpensive upgrade path through the use of a special slot.

You can go from the base 80286 CPU to an 80386SX to an 80486 (when available). For growth-minded companies, the PowerFlex is a smart choice.

Quattro Pro, Borland International

The new Quattro, like the original version, is essentially a cross between Lotus 1-2-3 and Excel. It provides 1-2-3 compatibility and superior printing and graph-making capabilities. Other features include Undo, a transcript of user actions, the ability to edit menus, good mouse support, and the ability to read and write a large number of file formats without translation.

Quattro Pro has a couple of minor drawbacks. Users can't signify different fonts on the screen, and the program's object-swapping mechanism is a bit slow. Still, the program is great if you want the advantages of Excel (and then some) but don't want to sacrifice compatibility with 1-2-3.

SmartCache PM3011, Distributed Processing Technology

Several of the machines that we've benchmarked this year showed really amazing disk speed. What they had in common was Distributed Processing Technology's caching controller. The 68000-based controller, with 512K bytes of RAM standard, surpassed every uncached disk design.

What makes the SmartCache even more attractive is that it's not part of a proprietary design included with a high-end machine; it's available through most clone manufacturers and even direct to end users.

SmartLabel Printer, Seiko Instruments U.S.A.

A small, lightweight thermal label printer has caught the fancy of those who have until now gone crazy trying to print out names and addresses for envelopes and labels. The 1¼-pound, 3½- by 6¼-inch SmartLabel Printer connects directly to an RS-232C serial port (for IBM PCs and compatibles) or to a modem port or printer (on Macs).

continued

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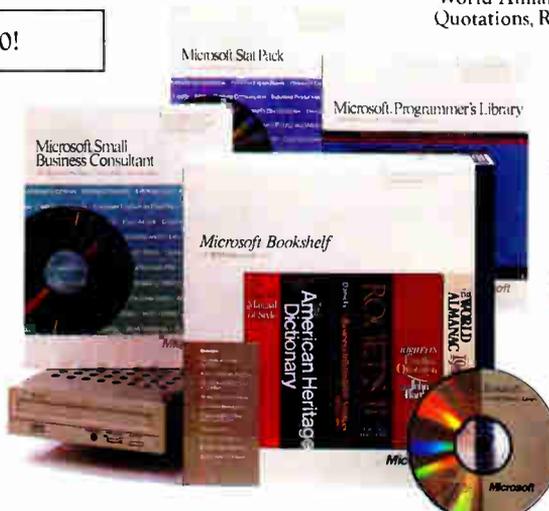
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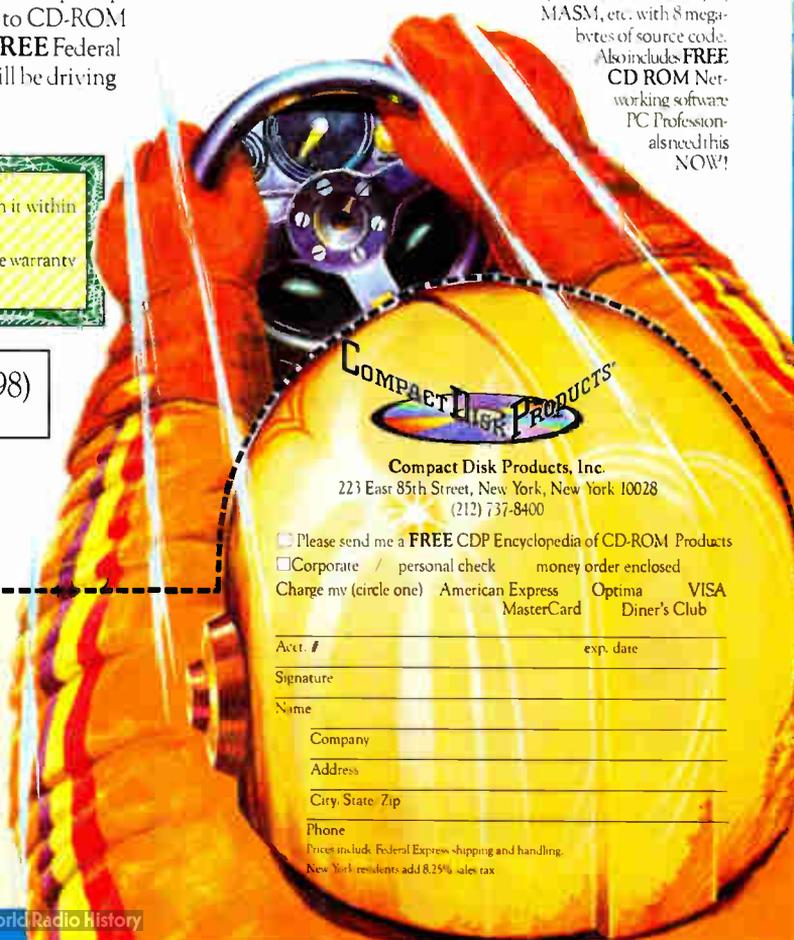
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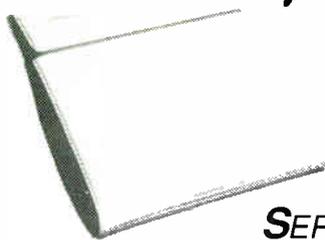
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The printer's software includes a database, a bar code generator, and a text editor. It works as a desk accessory on Macs and as a TSR program on PC compatibles. With the printer, software, cable, and a roll of 130 labels, you can press a key or click a mouse to capture the text on the screen, format the information, and send it to the printer. You'll then see output in about 15 seconds.

Since there still aren't any simple ways to print addresses on envelopes, this is an interim answer that will help until one comes along.

Think C 4.0, Symantec

Symantec's Think Technologies division has always produced quality developer tools for the Mac. Its Pascal and C compilers don't hog machine resources, produce tight code, and have source-language debuggers that help you write code that works. And you can get your hands on these products without having to pay an exorbitant price.

This year Symantec upgraded Think C and Think Pascal to provide object-oriented programming support, extensive class libraries, and source-level debugger's support. It's nice to see these languages keep pace with the times as we go into the 1990s.

Turbo Pascal 5.5, Borland International

With Turbo Pascal 5.5, Borland enters the object-oriented programming era. Using Object Pascal and C++ concepts, Turbo Pascal 5.5 implements all the crucial ingredients of OOP: encapsulation, inheritance, and polymorphism. Yet without sacri-

ficing true object-oriented capability, Turbo Pascal 5.5 is extremely easy to use. It will likely introduce more people to object-oriented techniques than either of its predecessors. And, while it's a great educational product, Turbo Pascal 5.5 is also a tool for serious developers. Now, separately compiled Turbo Pascal units can implement extensible class libraries. That's the real story this year.

Virtual, Connectix

While Apple's System 7.0 promises virtual memory for 68030-based Macs and Mac IIs equipped with a paged-memory-management-unit chip, Connectix has been providing this capability for nearly a year. Its Virtual INIT provides 8 megabytes of virtual memory by swapping unused portions of memory to and from a file of the same size on your hard disk. For Mac users caught in the RAM crunch earlier in 1989, Virtual meant the difference between being able to do some work, or none at all.

XVT, Advanced Programming Institute

XVT (for Extensible Virtual Toolkit) by Advanced Programming Institute is a platform-independent GUI library that enables developers to write a single C program and then compile and link it for Windows or the Macintosh (and soon, PM and the X Window System). With XVT, as with Windows and the Mac, your program must detect and respond to "events" such as mouse-clicks and menu selections. Thus, the learning curve is steep for programmers new to GUI development. But you only have to learn one set of rules, not two (or three or four). And XVT programs are somewhat simpler than their Windows or Mac counterparts. This approach is clearly the right way to bring order to the chaos of competing GUI systems. ■



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World Radio History

STATE OF THE BBS NATION

*Behold the lowly bulletin board,
now encompassing the globe*

Lamont Wood and Dana Blankenhorn

Ten years ago, it was a hobby—the modem version of ham radio. As soon as technically savvy computer hobbyists managed to acquire dual floppy disk drives, they were likely to put their machines on-line, making them bulletin board systems (BBSes). They would appoint themselves the *sysops* (system operators) and invite their friends to dial in with 300-bps modems and exchange files and messages. Today, the word *hobby* hardly applies. BBSes are a way of life for thousands of people. For some, it's a business, perhaps even a career.

Forget dual floppy disk drives. Nowadays, it's common to find sysops with several gigabytes of storage. Free files? You'll find BBSes with thousands of files, even tens of thousands. BBSes with multiple phone lines are common, often with one personal computer per line, networked together (some have dozens). As for modems, 9600 bps is seen everywhere. In fact, it's common for a BBS to support multiple 9600-bps modem standards by using both a USRobotics dual-standard HST modem and a Hayes V-Series modem.

Now, there are global hierarchical networks of BBSes that consolidate and retransmit hundreds of thousands of kilobytes of messages daily—with personal computers. Many corporations unflinchingly pay millions for mainframes, staffs, and special networks to accomplish the same result.

Demographics

The falling price and rising sophistication of computers and modems has brought sysop status within reach of everyone. This ubiquity, however, makes a head count of current BBSes difficult to come by.

David Burke of Hartford, Connecticut, heads the nascent North American Association of Bulletin Board Operators (NAABBO). He believes that 16,000 public BBSes exist in the U.S. alone, or about 100,000 if you count those in the private and corporate sectors. (Unfortunately, the sysops resist organization—only three joined NAABBO in the first seven months of its existence.) Tim Stryker, president of Galacticomm, a maker

of multiuser BBS software in Fort Lauderdale, Florida, says that most of his customers are companies or agencies that use BBSes to send information or software to remote locations.

USRobotics, meanwhile, admits that it has sold high-speed modems to "more than 5000" sysops. Hayes also claims sales in the thousands. Still, there remains an enormous turnover among BBSes. A list of 9600-bps BBSes given out by Hayes was surveyed recently; most of the lines were either changed, busy, or disconnected. Mark Leff, a Cable News Network reporter who tracks BBSes in the broadcast industry, estimates the annual turnover on his list alone at over 25 percent. Extrapolating Leff's experience nationwide, it's clear that all BBS population figures are only estimates.

But it's also clear that thousands of people have chosen to become sysops. Why? Money isn't the answer. About half of the BBSes don't charge their callers. The rest either charge about \$50 per year or a few cents per hour. A handful have acquired staffs and appear to have become profitable ventures. The rest are probably lucky to break even.

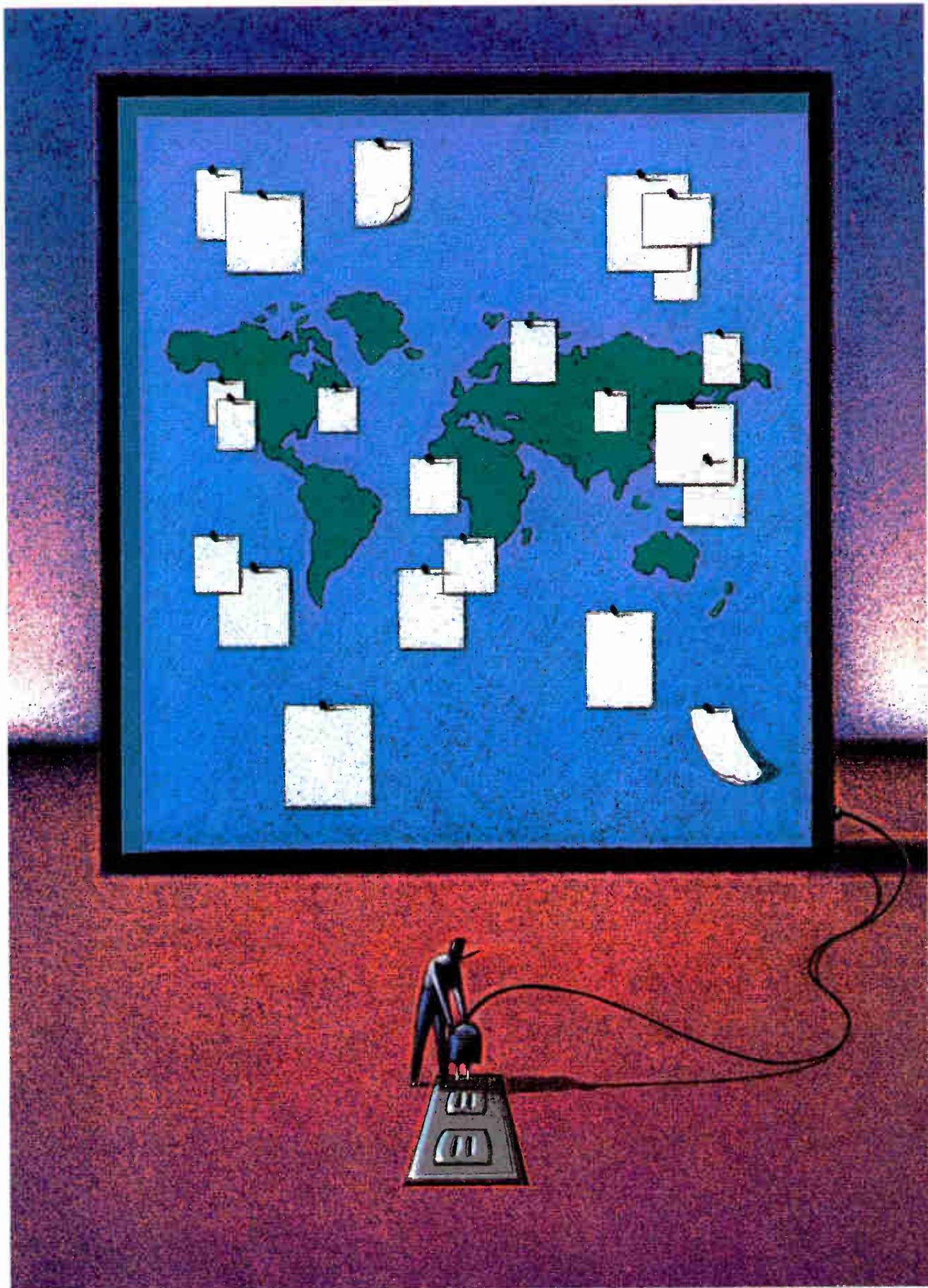
The act of being essentially in the publishing business attracts many people, and they aim their BBS at a particular profession or interest. Indeed, whatever your interest, you will probably find a BBS dedicated to that subject. There are even BBSes where you can trade broadcast-quality graphics files.

For others, BBSes have replaced public socializing. Sysops inevitably talk about the thrill of meeting people from all over the nation and the world, on-line. "I met my wife through the BBS and got a condo for the honeymoon from another sysop in Florida," says Chicago sysop Loren D. Jones.

Turning a Profit

Such motivations may become obsolete as the BBS movement turns into the BBS business. Some sysops, who run new-wave BBSes with multiuser BBS software, are up-front in saying that they plan to make money. Today, anyone can put up a 16-line, real-time chat BBS for an initial investment of about \$10,000.

continued



Meanwhile, the spread of old-breed, single-line BBSes has slowed; membership in the International FidoNet Association grew by only 500 last year, half the previous year's figure.

And the regulatory environment may begin to scare off amateurs. The FCC could crack down on a BBS at any time. In Broken Arrow, Oklahoma, police arrested Jeff Jirka when he offered graphics files they deemed too graphic. (He drew a \$500 fine and two years' probation on obscenity charges.)

But probably the most unsettling threat comes from phone companies that want to classify potentially profitable BBSes as businesses. In Houston, Southwestern Bell has attempted to classify all Texas BBSes as businesses and thus subject to business rates of \$35 per month per line. (Residential rates are \$16 per month.) Southwestern Bell officials have been meeting with the Coalition Of Sysops and Users Against Rate Discrimination (COSUARD).

Action on a similar tariff in Oklahoma awaits the outcome of the Texas case. COSUARD argues that even multiline BBSes that request donations are usually run by amateurs, while Southwestern Bell says that charging a subscription makes a BBS a business. Merely asking for a donation may be acceptable, but all multiline BBSes must pay business rates, says Bell's lawyers. The dispute continues.

A Closer Look at BBSes

Plenty of BBSes look like they're here to stay. The Exec PC Board in Shoreham, Wisconsin, is probably the world's biggest public BBS. Sysop Bob Mahoney says he gets 3000 calls per day, averaging 25 minutes each, on 90 lines in the basement of his home. By the time you read this, however, he'll have 150 lines in a new office. Wisconsin Bell had to dig a quarter-mile-long trench to bring in the new lines.

Mahoney charges \$20 for three months' membership, or \$60 a year. For this fee, you receive 7 hours on-line weekly and 4 megabytes of downloads, with a 4-to-1 time and byte credit for uploads. Mahoney has his own BBS software written in Microsoft C that can scan 20,000 files by keyword in 2 seconds. He uses 80386-based IBM PC ATs with Industry Standard Architecture buses, connected by a LAN under Xenix. He favors US-Robotics and the V.32 standard modems.

By day, the BBS is busy with Fortune 1000 executives looking for good shareware. By night, it's busy with entrepreneurs and hobbyists. Mahoney advises other sysops to "put together a business plan. Computer people tend not to do that."

In Denver, meanwhile, Jack Rickard runs *Boardwatch*, a newsletter about BBSes. He also "publishes" *USA Today DecisionLine* and the *Newsbytes News Service*, which are special-interest electronic news services to other BBSes. "Most of the systems I know of are trying to break out of the hobby mode and become paying propositions," he says. He agrees that the bulletin-board movement is finally becoming a business, reminiscent of newsletter publishing: "In another three years, it will be common for people to make money. There's a market for

people who can sell information at \$35 to \$50 a year."

In Toronto, Ron Sachse runs Metropolis Online using the Galaticomm Major BBS software. He has been working with 36 lines but has plans to go to 44. The BBS is incorporated as a Canadian business. "The word that would summarize our board is *info-tainment*," he says. "We're providing a sort of local version of CompuServe" at \$1 (Canadian) per hour. He offers the usual free files and a multiplayer adventure game called Infinity Complex. He gets about 1000 calls per day. The BBS is adding on-line shopping and will rent space to vendors.

Chatting is the most popular service on Metropolis.

"We have a lot of handicapped people on our system—people who are legally blind and deaf," Sachse says. "They tell us that for the first time they feel normal—they're on a par with non-handicapped people."

For the younger audience, there's the Celebration Station, a small BBS—326 users and five lines—in Bluehill Falls, Maine. Paul Stookey may be one of the more idealistic sysops in America, and he's probably the most famous, as the "Paul" of the folk group Peter, Paul, and Mary. Stookey says that when he was growing up in Dorsey, Maryland, in the early 1940s, "one of the neatest things you could have was a clubhouse. Maybe you had a password. There you saw friends who shared the same interests and made the same discoveries." Stookey calls his BBS "an electronic clubhouse." He hopes to add software that will make signing-on analogous to visiting a spacestation.

"I started a young person's board because I see an opportunity to turn a technological threat into a comfortable form of world communication," he says. Stookey is moving from Galaticomm software into a custom time-slicing system. He's looking for a company to underwrite his costs and provide his BBS with a toll-free line.

BBS Networks

A sign of the sophistication of the BBS movement is the advent of "echo networks." Echo networks are associated BBSes that systematically and regularly share files and conference messages with each other. Daily, thousands of hobbyists upload and download hundreds of kilobytes of information to each other—information that was itself gathered and consolidated from scores or hundreds of individual sources.

Each network has public "echo conferences," often a hundred or more, in which users can post messages about the conference topic, be it WordPerfect or the weather. An echo conference is a conference whose contents are shared among the participating BBSes in an echo network. Somewhere in echoland there is a moderator for each conference, who edits the discussion to keep it civil and on-topic. Conferences devoted to a particular computer product are often moderated by the vendor's customer support staff.

A sysop can subscribe to one or more echo networks and choose which conferences within the network he or she wants to carry. Every day (usually) the sysop uploads the latest messages in

continued

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those conferences to a regional hub, and, during the same call, downloads any new traffic for his or her conferences from the hub—consolidated material that the other sysops uploaded that day. Then, at least once a day, the regional hub calls the national hub and makes its own uploads and downloads, but on a bigger scale. Thus, by being part of an echo network, your local BBS can have conference postings from all around the continent (and the globe), current within two days. There are at least five major echo networks: FidoNet, Relaynet, Interlink, SmartNet, and Canada Remote Systems.

Like the other relay networks, FidoNet is not a legal entity but simply the sum total of the BBSes who subscribe to its practices. It is, however, the oldest and biggest. The International FidoNet Association estimates it has about 6000 members—mostly in the U.S., but a lot now in Europe and elsewhere. “If there is an executive director of FidoNet, I am it,” says Ken Kaplan of St. Louis. Originally founded in 1984 as an inter-BBS point-to-point mail network, it soon acquired a sophisticated routing system, with global zones, regional networks, and local nodes. Kaplan now refers to himself as Net 100, Node 22, Zone 1.

Echo conferencing was added in 1986. “Basically, what happened then was that usage quadrupled overnight—people started finding tremendous applications for it,” Kaplan says. He estimates that FidoNet now carries about 500 echo conferences. Sysops use every kind of hardware imaginable, from dual-floppy systems to VAX minicomputers. Each regional network has its own procedures for certifying sysops.

Interlink is run by Andy Keeves in Mt. Vernon, New York, where he is also the 40-year-old head of Cyllon Systems. He counts about 100 BBSes and about 100 conferences. Communications use QMail running on PC Board BBS software.

Approximately a year ago, Interlink and SmartNet came into existence as a result of the breakup of Memphis-based PCB Echo. Keeves says that Interlink differs from other networks in that it works hard to be professional: Moderators quell the chatter in the technical conferences. “We’re trying to attract top-caliber callers,” says Keeves. To join Interlink, a sysop has to have been running a BBS for a year or more, developing what Keeves calls a “serious tone.”

At the center of the network is Keeves’ own eight-line BBS, each line supported by a workstation attached to a Novell LAN. He uses mostly USRobotics HST modems. The network has about 1 gigabyte of storage. He describes his hub BBS as being “close to self-supporting.”

SmartNet was also born about a year ago during the fission of the PCB Echo system. Paul Waldinger runs the national hub out of Oceanside, New York. The BBS is called Sound of Music. Waldinger runs both general-interest conferences and product-oriented conferences moderated by vendors. SmartNet now has about 250 subscribing BBSes and carries about 100 conferences. It also exchanges material with Canada Remote Systems and Relaynet.

Waldinger says that he sees 2 to 3 megabytes of traffic each night, relayed through eight regional hubs, using QMail and PC Board software. To handle it, Sound of Music has 2.3 gigabytes of storage on nine workstations connected by a 10NET Ethernet. The system connects to nine phone lines through various brands of 9600-bps modems. Backed by a staff of three, Wal-

dingler edits all traffic for objectionable material. Users pay \$75 per year, but echoing sysops are charged nothing. The board also maintains 15,000 free software program files.

Waldinger, a 39-year-old computer consultant, says he hopes to eventually turn a profit and make the board his career. “It’s

Commercialization *is inevitable, as the BBS nation seems to have reached critical mass.*

electronic publishing—the electronic version of a magazine. A lot of sysops think along those lines,” he says.

Meanwhile, the second largest BBS in North America—the 74-line Canada Remote Systems (CRS) in Toronto—is also the hub of a Canadian echo network called Canada Conference Mail. Jud Newell, vice president of CRS, says Canada

Conference Mail has ties to about 100 Canadian BBSes and carries 127 conferences. It also has a gateway to SmartNet and echoes selected conferences from FidoNet. Like SmartNet, it relies on QMail and PC Board software.

Newell and his wife started CRS in 1981. It is now a money-making concern with a staff of eight. CRS has about 7500 subscribers paying \$65 to \$175 (Canadian) yearly, depending on the amount of access each receives. The users have access to the system’s 60,000 programs, clip-art files and macros, plus various news services. CRS gets 4000 calls a day; daily echo traffic to SmartNet alone runs to 700K bytes. The traffic is supported by 74 workstations connected with a Novell LAN. The file servers on the CRS LAN have a total storage capacity of 4 gigabytes.

Newell reports no regulatory problems within Canada, but adds, “Although about the time we told the phone company that we needed seven phone lines because we had seven kids, it started getting suspicious.” He now pays business rates as a matter of course. He has no qualms about carrying personal mail—unlike many U.S. sysops, whose concern over privacy leads them to defer such mail to the commercial networks.

And then there’s Relaynet, operated out of Bethesda, Maryland, by psychiatrist Dr. Bonnie Anthony. Relaynet counts about 260 BBSes in the U.S. and Europe and about 138 conferences. Instead of PC Board software, the system is based on a package called PC Relay, noted for adding reference numbers to all messages and for having been written by a 15-year-old boy during his 1988 spring break.

As you would expect from Anthony’s background, Relaynet has more social-oriented material, including an on-line version of Alcoholics Anonymous. “Our entrance requirements differ from most—we’ll take anyone,” she says. “We can support boards with a wide variety of software, and we’re not afraid to take on teenage sysops.” The Bethesda hub gets up to 800K bytes of material a day from 24 regional hubs and from selected conferences on SmartNet, Interlink, and FidoNet. At her hub, Anthony uses a LANtastic network with three workstations and six phone lines. She has 320 megabytes of storage.

The Commercial Side

With so much going on in the BBS nation, it’s no surprise that the commercial world has taken notice. For instance, Tymnet and Telenet, the two main national data networks, now offer services designed to link users to distant BBSes. Users dial into the network through a local phone number, the service routes their calls to a network port near the BBS they want, and the

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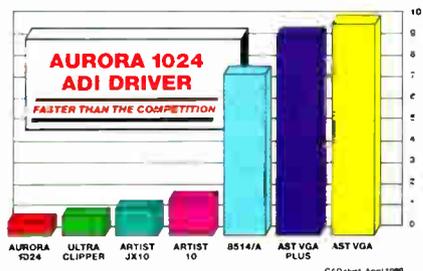
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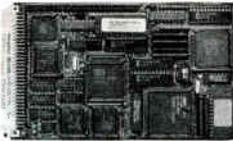
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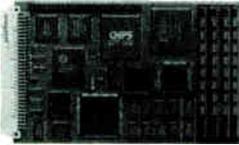
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Tymnet is re-marketed through a service called StarLink by Galaxy Telecomm International in Albuquerque, New Mexico. After a sign-up fee, users are charged \$14 an hour during business hours and \$1.50 per hour for nights and weekends, plus one cent per kilobyte over 200K bytes per hour. The head of Galaxy Telecomm, who asked that his name not be used, claims to have "thousands" of StarLink users, who are on-line an average of 40 hours a month, some well over 100 hours a month. He has seen multiline BBSes network their chat lines from one BBS to another, so that a couple hundred people are on-line together.

Dominick DeAngelo is marketing vice president at Telenet Communications Corp. in Reston, Virginia. Telenet's service, a data packet service for BBS users, is called PC Pursuit. DeAngelo notes that after Telenet found people using PC Pursuit 300 hours a month—leaving them just enough time for eating and sleeping—it raised the rates from \$25 per month for unlimited use. Now, after the sign-up fee, users pay \$30 per month for 30 hours of non-prime-time use, and \$3 per hour over that. DeAngelo's service also has thousands of users who pretty well fill the network's evening capacity of the 34 cities where it's offered.

Into the Future

When services such as PC Pursuit began, there were those who objected to the implied commercialization of the BBS movement. Most BBS software had simply appeared, written by someone in the ranks in response to a need. A good example is QMail, written by Mark Herring in Memphis in 1987 to help a friend reduce his phone bills when calling Tennessee BBSes from his new home in Texas. QMail allows you to download new conference messages, read them and write replies off-line, and then upload the replies to the appropriate conferences. It circulates as shareware, but Herring sends you a "better version" if you pay the \$25 registration fee.

Further commercialization is inevitable, as the BBS nation seems to have reached the critical mass required to become a serious hardware and software market. "Today, more and more firms are writing software for BBSes, and we're seeing more and more features at a tremendous rate all because of the money that's in it now," says the head of StarLink.

As examples, sources point to the multiuser boards from DigiBoard in Minneapolis, which have up to 16 serial ports on a personal computer plug-in board, using software that circumvents DOS by talking directly to universal asynchronous receiver/transmitters on the board. In addition, there is multiuser telecomm BBS software based on "distributed demand scheduling" from eSoft in Aurora, Colorado. It has a module that can compile ordinary dBASE programs into multiuser programs, with automatic file locking, sharing, and updating.

So, aside from a few regulatory harassments, the BBS nation has passed its infancy and is blooming into an unknown factor—certainly at least a grass-roots community based on high technology. Perhaps it will end up as a new information medium as hard for us to imagine now as the current publishing industry would have been for Gutenberg to imagine in 1450. ■

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THE MAC STATE OF MIND

A revealing look at some expert-system shells and AI languages for your Macintosh

Daniel W. Rasmus



he interface of human need and computer programming is no stranger to the Macintosh. The windows and menus that make up the Mac OS are refinements of its Lisp and Smalltalk ancestors.

But the Mac has evolved past its interface, thanks to a platoon of expert systems, hypertext applications, and programming languages. With the Texas Instruments microExplorer and the Symbolics MacIvory, the dying symbolic processor has found new life on the connectivity bandwagon. A stand-alone Lisp chip that shivered nakedly in futuristic scenarios now resides warmly within the friendly case of the Mac II.

Moreover, the Mac is becoming a contributor to the information revolution. The massive data of the 1980s will be the selectively distributed information of the 1990s. Knowledge-based systems technology is transforming the once avant-garde Mac into a knowledge machine. Tools available for the Mac are improving in functionality almost weekly, and well-established AI companies are now bringing their wares to this exciting platform.

In this article, I'll evaluate some expert-system shells and discuss their inherent strengths and weaknesses. I'll also provide a text box ("Speaking Macintosh AI" on page 306) and a resource

listing that includes most of the Mac expert-system software available today.

Shell and Shell Alike

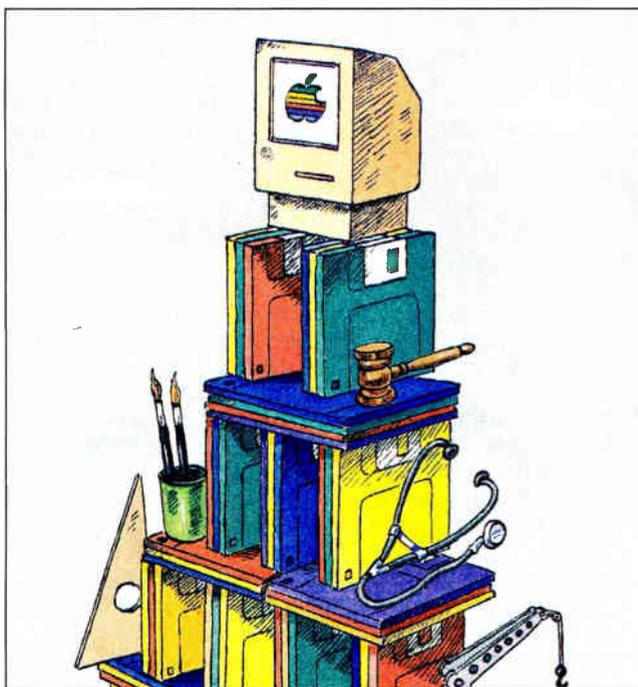
The most commonly recognized piece of AI software is the expert-system shell. These high-level-language systems enable experts and people called "knowledge engineers" to develop computer programs that emulate the capabilities of a human expert. Unlike traditional programming that can take on repetitive tasks with a fury, expert systems tackle problems that are

ill-defined.

The language of expert systems is the IF... THEN statement. This logical form is interpreted by the shell through the use of modus ponens and other reasoning techniques. Most expert systems incorporate a certainty factor as a way to express fuzzy knowledge and best guesses.

Expert systems use the tools of logic to capture experience that skilled people have accumulated on the job. Although the capability exists to encode the knowledge of textbooks and first principles, few expert systems try to be that ambitious. A human expert can tell you how to fix a drainpipe with a few dozen rules of thumb, while reasoning from first principles would require a theory on pipes, gravity, the viscosity of

continued



Speaking Macintosh AI

The joint venture between Apple and Texas Instruments that resulted in the microExplorer transformed the Macintosh II into a platform that hard-core AI insiders could pay attention to. But bringing Lisp to the Macintosh happened long before TI forged the gates of silicon that make up its Lisp chip. Many firms believed that the Mac was an AI computer and developed major implementations of languages like Lisp, Prolog, and Logo that needed little more than the Mac Plus and its now-aging 68000 processor. With the introduction of the 25-MHz 68030-based Macintosh IIfx and its access to many megabytes of RAM, AI vendors should be breaking a lot of fingernails porting their wares to this new environment.

Lisp

Lisp is the underpinning of most AI research. Even its chief rival, Prolog, began life as a Lisp program. On the Mac, Lisp comes in two very extensive and forceful products, Apple Common Lisp and Procyon Common Lisp, as well as several lesser implementations.

Apple Common Lisp is the result of R&D by Coral Software and Franz, Inc. Apple purchased Coral in 1989 and now sells the product through its normal development channels. What Apple has brought to the Mac is a programming language that is both fast and elegant. Every page of Guy L. Steele Jr.'s *Common Lisp: The Language* (Digital Press) has found a home in this product.

The editor, called FRED (which stands for the cheeky recursion "Fred resembles EMACS deliberately"), is a full EMACS-style editor with many Macintosh features built in. FRED is completely extensible through Apple

Common Lisp, and several new menu items and dialog boxes are included as examples. I like working with Apple's smooth editing environment and easy access to the Mac Toolbox.

Apple Common Lisp's only close competitor is Procyon Common Lisp. Apple Common Lisp attempted to bring the Lisp machine to the native Mac. Procyon Development of Great Britain has put the Mac into Lisp. Procyon is a completely implemented Common Lisp with an interface that dazzles the developer with pop-up menus and clear, intuitive commands. Lisp hackers who see this program may not want to return to their costly Symbolics workstations. The latest version of Procyon includes a complete implementation of the Common Lisp Object Systems. Procyon Common Lisp may be the best Lisp running on any microcomputer at this time.

Apple also distributes a stripped-down version of Apple Common Lisp called Pearl Lisp. This now public domain product is an excellent introduction to symbolic languages. Expertelligence rounds out its Mac arsenal with Expert-Common Lisp, a unique version of Common Lisp that is not so careful to follow the guidelines set out by Guy Steele. Also from Expertelligence comes ExpertLisp, a small Mac-specific product. Expert-Common Lisp options include a nice interface development package and the OPS5 expert-system-building language for both Expert-Common Lisp and ExpertLisp.

Lisp on the native Mac is turning the Mac into a strong contender for AI development system of the year. With Lisp boards from TI and Symbolics, the Mac may have found yet another hole in Big Blue's corporate armor.

Prolog was Japan's choice for the Fifth Generation computer project. In the U.S., it has fallen on hard times, as AI leaders continue to tout Lisp as the premier AI development language. But as this ballyhoo rages on AI BBSes and behind ivy-covered walls, the Mac has been showing itself to be not only a machine for Lisping AI developers, but a friend to their logical rivals as well.

Prolog

Prolog, which stands for "programming in logic," brings the fine art of logical inference to the computer world in the form of predicate logic. If you program in C, FORTRAN, or any other language, Prolog will probably look like Greek. Prolog programs are entered as rules and database statements that are processed by the language's built-in backward-chaining inference engine. Although Prolog is optimized for AI, it can be manipulated to form general-purpose programs. Prolog is often used as a front end for complex database inquiries and natural-language systems.

Most Mac Prologs implement the Edinburgh syntax. My favorite Prolog implementation on the Mac is AAIS Prolog M-2.0 from Advanced A.I. Systems, which offends neither my Mac nor my VAX sensibilities. All those things that I learned in C Prolog on the VAX can be translated directly (with some I/O modifications) to the Mac. The program's interface is clean and straightforward. Advanced A.I. Systems has produced a complete implementation of Prolog in a fast, easy-to-use system.

If you insist on Prolog with a Mac twist (perhaps even a backflip), look at LPA MacProlog from Programming

various substances, and other deep chunks of knowledge. Expert systems are ideal for representing that part of a person that makes her or him an expert, but estimates for the development of deep knowledge systems run into the decades.

Yet, despite their limited scope, expert systems have strong abilities to solve problems. From intelligent database front ends to "superdiagnosis" machines, expert-system technology is tackling and solving industry problems. Mac AI software is becoming a strong competitor of the serious problem-solving tools that exist on IBM platforms.

Cognate

Peridom's Cognate is more of a language than an expert-system shell. Although you could call all expert-system shells languages, most are expressed in a sufficiently English syntax to

be classified as English-based input systems rather than computer languages. Cognate, however, represents an older phase of the AI business, when the only way to create an expert system was to write it in Lisp. The Lisp-like flavor of Cognate is derived from NASA's CLIPS programming language, which Peridom has translated into a minor shell product and a series of MPW C libraries. The MPW libraries enable Mac software developers to embed the CLIPS inference engine into C, Pascal, and assembly programs.

As an expert-system shell, Cognate is rather weak. Its syntax looks much like Lisp code because CLIPS itself is a derivative of Charles Forgey's OPS5, which is written in Lisp. The language is obscure and difficult to master, but for applications that call for lightning-fast inferences based on pattern matching, Cognate is an excellent product.

Logic Systems. Many commands familiar to Prolog programmers as one-line statements become dialog boxes in LPA MacProlog. The implementation of Prolog is strange at times, and many textbook examples need tweaking to work. Unfortunately for Prolog programmers, there are no international standards like those in the Lisp world, so Prolog developers continue to be creative with syntax and style. As an environment, LPA MacProlog strives hard to make Prolog a real Mac creation. I find many of the features overlaid for a language as austere as Prolog, but those looking for high-level Mac interface features and a neat workplace will find LPA MacProlog the logical choice.

The weakest link in the Mac Prolog market is Applied Logic Systems' Prolog. This simple-to-use system is sometimes too simple for spoiled Mac users. The other Prologs I've discussed have a Load Menu item for evaluating a disk file, but ALS Prolog requires command-line input. The choices made between what to include and what to exclude in the package seem forced. An expert-system shell I wrote that runs in both C Prolog and AAIS Prolog would not run in ALS Prolog because certain primitives (e.g., recorded) are not included in the language. ALS needs to reexamine its product and add a little more pizzazz before I can recommend a program that costs up to \$499.

In addition to these three products, there is ExperProlog II from ExperTelligence, which implements the latest innovations in logic programming. This new language is an evolution of the Edinburgh syntax that would make even experienced Prolog programmers think twice before entering a keystroke. Ex-

perProlog II is reserved for those who really know what they're doing.

ExperProlog II rounds out the Mac Prolog market. None of these products has advanced the Mac/language interaction as well as the Lisp vendors have done, but most of them are good tools for making logic a working state of mind for many Macs.

Smalltalk

Smalltalk is a precursor of the Mac interface. When you enter into Smalltalk, you enter a world of windows, pop-up menus, and dialog boxes. This is where it all began. The object extensions of the Lisp products that I looked at earlier are the direct result of Smalltalk.

Everything in Smalltalk is an object that belongs to a class. Like Prolog, this is a foreign place to many souls who call themselves programmers. The primary implementation of Smalltalk on the Mac is the \$995 Smalltalk-80 from ParcPlace Systems. ParcPlace, as its name implies, is a spin-off of the Xerox Palo Alto Research Center. Since Smalltalk is an interpreted language, it runs too slowly for most common business applications, but its rapid prototyping capabilities have found it a place in the MIS design department. Manufacturing R&D groups use these same prototyping talents for developing simulation systems for factories and warehouses.

Smalltalk/V from Digital is an alternative to the pricey ParcPlace system. The excellent manual could make even a paranoid nonconformist learn the language. Smalltalk/V is not the Smalltalk discussed in Smalltalk texts, and programs from Xerox like Humble and Analyst will not work in the system. But the Digital implementation is much

more intuitive than the ParcPlace system and much easier to master. The object of Smalltalk is to represent the world as a hierarchical place of classes and properties. That puts Smalltalk in a class of its own.

POP-11

If you want a language that mixes the best and worst of these other languages into a hodgepodge, look at AlphaPOP from Computable Functions. POP-11 seems to be an attempt to pull together the important features of an AI language into one system, but it seems too late and too difficult to understand.

Perhaps 10 years from now I'll look at my discouraging words about POP-11 and comment on how wrong I was. My opinion of POP-11 today is that it is a novelty looking for a party.

Looking Ahead

When an IBM hardware engineer looks at a Mac and calls it a toy, he or she is correct only in appearance. Inside the attractive hardware is a processor that can take on the most difficult symbolic processing tasks. Crunching numbers can be done on a hand calculator—it takes a real computer to manipulate lists, text, and natural language.

The language market on the Mac continues to grow. Current indicators like Procyon Common Lisp show that the best language implementations may still be out there as bits of unlinked code or in the minds of programmers now playing with Logo in kindergarten rooms. The Mac is a computer that can speak many tongues well. Now we must sit back and see what Lisp, Prolog, Smalltalk, and POP-11 programmers do with the tools they have at their disposal.

Rule forms, debuggers, and other high-level interface features that experienced knowledge engineers look for are missing from Cognate. Rule input is accomplished using a basic text editor. Rules are then compiled into a form that is executable through its interpreter. The compilation makes knowledge bases execute quickly, but the lack of a true incremental compiler makes playing around with different rules and scenarios more taxing. The inclusion of a more Mac-like development environment would greatly enhance this product and make it more competitive with other shells in its price range (\$150-\$250). Adding buttons and rule forms need not remove the compatibility of the source code with other machines.

However, Cognate is useful as a learning tool for people looking into the Lisp machine market. Because most large Lisp-based expert systems are founded on OPS5, Cognate can

be an inexpensive way to learn the style and syntax of these expensive products.

ExperFacts

As is true of Cognate, ExperFacts from ExperTelligence is a language, not a shell. Its \$495 cost seems reasonable until you have to add the \$495 ExperLisp to it. Because ExperFacts is a set of compiled Lisp functions, it suffers from the obtuseness of the Lisp syntax, but it benefits from being able to call on Lisp for assistance. As an expert-system-building environment, ExperFacts has most of the tools required to do AI work, but because of the Lisp that underlies it, delivery of a finished product becomes a difficult question in the evaluation process.

If you have already chosen the aging ExperLisp as your

continued

expert-system development environment, getting a copy of ExperFacts may make sense, but the lack of source code could be a hindrance to hardened Lisp hackers. The best application for ExperFacts is the corporate R&D lab or the science fiction-peppered bedroom of a well-to-do future AI guru. ExperLisp has been replaced by many new Lisp implementations that have made this Lisp, and ExperFacts, products of the past.

The flex Environment

If Prolog is your language of choice, then flex from Programming Logic Systems (known as LPA in the U.K.) might be the right development environment for you. The world of flex revolves around the powerful logic engine found in all Prologs. LPA MacProlog is one of the most innovative of the Prolog environments. It essentially turns your Mac into a Prolog workstation complete with dialog boxes for initiating queries and complete access to the Mac Toolbox. And in the middle of this rich environment, you can insert the \$495 flex inference engine.

The flex environment supports frames, complete with daemons and inheritance. The inference engine comes equipped with forward- and backward-chaining rules built with LPA's proprietary Knowledge Specification Language. Because much of the Prolog research has concentrated on natural-language representation, flex's rule syntax is very sophisticated. Such common words as *above*, *according*, *because*, *does*, and *requested* help make writing rules simple. But there are many inference concepts and keywords to remember while writing complex programs.

Because flex is inserted into Prolog, any Prolog clause can be used in conjunction with the program. This feature gives flex the ability to communicate with C or Pascal and to have access to the Macintosh Toolbox. But it also means learning Prolog to really take advantage of flex. If you are already a staunch Prolog advocate or, even better, an LPA MacProlog user, flex is a good environment. If you haven't yet tackled serious knowledge-base development, I recommend staying away from flex until you get bitten by the Prolog bug. Most of your knowledge-based systems will be just as successful using one of the stand-alone shells.

Humble

Xerox Special Information Systems brings to the Mac shell game a product of a different flavor. Humble is a Smalltalk-80-based expert system. Like ExperFacts and flex, Humble is designed for the implementation of expert systems by those who already know how to work within a given programming environment. Smalltalk, a precursor of the Mac interface, will be foreign to most Mac aficionados without an extended period of adaptation.

Humble is a full-featured expert-system shell that offers forward and backward chaining and several other features inherited from its Smalltalk-80 motherland. Because of its Smalltalk origins, Humble has excellent support for objects and good connectivity to other Smalltalk applications, such as the Xerox Analyst information center.

As an interpreted shell, Humble reacts more slowly than most stand-alone systems and should be considered primarily for people looking to add intelligence to their Smalltalk applications. The object-oriented structure of Smalltalk is catching fire now as reusable-code fanatics join forces with programming environment proponents.

HyperX

The Mac has become the computer of choice for developing hypermedia programs. This long-theorized approach to informa-

tion management lets people jump around in a computer-based document to find only the information they are looking for. Millennium Software's HyperX is at the forefront of adding expert-system technology to this primarily push-button paradigm. [Editor's note: See "Expert Systems and HyperCard" on page 319 for more information on HyperX.]

Knowledge is represented in HyperX as attribute-value pairs and simple facts. HyperX supports daemons, which are usually reserved for more pricey knowledge-based systems. Daemons are programs within programs that are triggered when certain facts change values or are proven to be true. Because HyperX is written in HyperTalk, daemons can implement HyperTalk commands within rules. HyperX also connects well with the Oracle database to provide links to corporate mainframe databases.

For interface-design novices, the HyperX package includes the Quest expert system. Quest, written in HyperX itself, helps designers get a head start on laying out their user interfaces through "expert advice" on question-card layouts. Question cards, which gather input about attributes during a consultation, can make full use of HyperCard facilities for drawing interactive graphics or adding voice to your expert system.

The most important aspect of HyperX is its HyperCard abilities. It is the first commercially available expert system written and implemented entirely with Apple's HyperTalk scripting language. [Editor's note: A limited version of HyperX is in the public domain. It is available in the "listings" area of the macintosh conference on BIX.]

As a front end to HyperCard stacks, HyperX shows the way toward intelligent searches through the sea of information that is becoming available on HyperCard. As more stacks are developed for videodisks and CD-ROMS, the explosion of HyperInformation will only get worse. HyperX can help HyperCard users place more intelligence in their stacks.

Instant-Expert Plus

I have watched Human Intellect Systems' Instant-Expert grow from an infancy of simple text strings into the highly charged Instant-Expert Plus, which reaches into new areas for Mac AI buffs. What's more, I have seen an unstable product transformed into a graphical interface-building program, where clicks on the screen can link to a fact, a variable, or a series of rules. Human Intellect Systems has worked many months with customers and its French developer, Mindsoft, to create a program that makes the most experienced AI professional take notice.

Many systems at a cost greater than the \$498 Instant-Expert Plus price tag fail to provide the flexibility of forward, backward, and mixed-mode search strategies. This system includes 79 commands that expand basically English syntax into a way to read and write text files, talk to your modem port, and even talk to you with Apple's Macintosh System File. Instant-Expert Plus also connects easily to HyperCard via text-file passing.

The real charm of Instant-Expert Plus is its graphics. Instant-Expert Plus supports MacPaint, PICT, and PICT II file formats. Any region on a graphic can be selected as a button to which facts or rules can be attached.

One demonstration system that accompanies this program shows how a user can be completely locked out of the development environment through clever rule interaction. Pointing and clicking on the screen combined with well-placed dialog boxes makes this a program that could be used for prototyping traditional programs, not just knowledge-based systems.

Instant-Expert Plus is not without its flaws. I would like to

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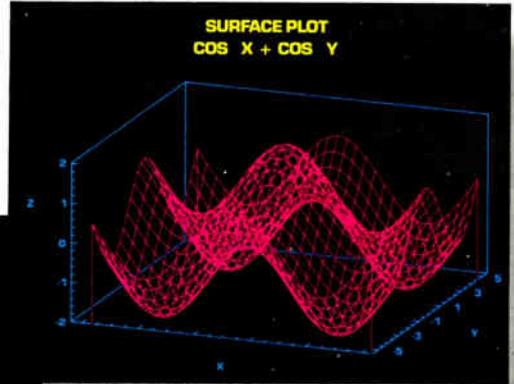
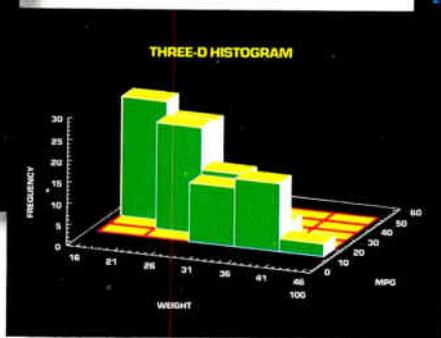
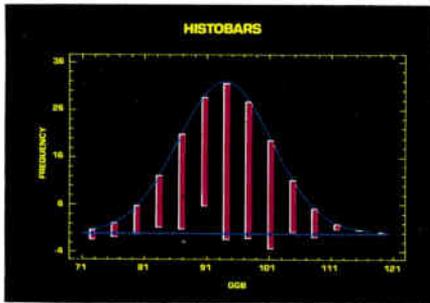
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ITEMS DISCUSSED

Expert-system shells

Cognate\$150
 developer's version.....\$250

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 Bowie, MD 20716
 (301) 390-9570
Inquiry 1110.

ExperFacts\$495

ExperTelligence
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 Goleta, CA 93117
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Xerox Special Information Systems
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Millennium Software
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 (714) 626-8589
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Inquiry 1030.

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Inquiry 1031.

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Lisp

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 APDA—Apple Computer
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 Cupertino, CA 95014
 (800) 282-2732
Inquiry 1033.

see future versions of the program include a graphical knowledge-mapping tool and better integration with HyperCard. Overall, however, Instant-Expert Plus is a solid product.

Human Intellect Systems responds to customer comments. No fewer than five shipping versions and several intermediate versions have been released to correct bugs and add significant improvements to the user interface and general functionality. If you need interactive graphics with numeric, string, and integer variables, Instant-Expert Plus may be your expert system.

Intelligent Developer

One of the most recent entrants into the Mac AI market is Intelligent Developer from HyperPress Publishing. This expert-system shell attempts to bring the strengths of larger systems down to the Mac, and it achieves its goals with restraint. Priced at under \$400, the program needs a bit more intuition in its user interface.

Many of the problems with expert systems come when a product is not powerful enough for a particular job. With Intelligent Developer, power is not a problem. Where many expert

systems must struggle with database access, Intelligent Developer includes its own database within the editing environment. You can write rules to quickly create new items for processing. Intelligent Developer also includes some knowledge-engineering novelties, like "paste a function" and "paste a fact." These conveniences help alleviate the all-too-common "I forgot what it was called" syndrome that occurs with other shells.

Its debugging facilities include tracing and individual rule execution. Generating knowledge-base reports is a feature that certainly differentiates Intelligent Developer from its less capable counterparts. Not only can you print a rule base, you can also generate complete cross-reference reports any way you like to see them. I would, however, like to see improved speed and rule navigation. The product often seems sluggish when executing internal functions and menu items. Completing a rule returns you to a dialog box of rule titles, rather than allowing the creation of, or movement within, the knowledge base from the rule template itself.

Intelligent Developer is accompanied by IntelliCard, a HyperCard-generation program that imports Intelligent Devel-

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oper rules, inference engine and all, to a HyperCard stack. IntelliCard is a good tool for delivering HyperCard-based expert systems, but some of Intelligent Developer's functions, such as database access, fall away during the translation.

IntelliCard stacks are difficult to understand, so much of HyperCard's interactive nature becomes hard to take advantage of. Intelligent Developer needs another generation before it really shines in the AI market, but for developers willing to put up with the program's quirks, its HyperCard delivery system could spread AI evangelism faster than a 9600-bps modem.

Level5

When Information Builders introduced Level5 on the Macintosh, I was excited. Here was one of the established players in the AI game paying attention to my little 9-inch monitor. When I received the product, my enthusiasm quickly waned as I watched a slightly reworked IBM PC product turn function keys into pull-down menus.

Like its older cousins on the PC and the VAX, this is a bug-free place to create backward-chaining expert systems. Its pro-

duction rule language is robust enough to create complex rules and to do fancy tricks with knowledge. But knowledge is not everything, especially on the Mac—the Mac calls for appearance as much as for substance, and Level5 needs an interface face-lift.

With Level5 Macintosh, the only tool for knowledge engineers is a text editor. Most variable types must be declared at the beginning of the listing, and all your typing must be correct before you compile your knowledge base. Unlike Instant-Expert Plus, Intelligent Developer, and many other Mac shells, Level5 doesn't tell you about errors until you have typed in and compiled a completely structured portion of your knowledge base. The incremental compilers in other systems notify you before you enter your next rule if you made a mistake.

Those who want to port products to the now-profitable Mac need to understand the users of these computers, not just how to call ROM routines. I understand that rule templates and incremental compilation are scheduled for Level5, but not before it appears in the PC version. I wish Information Builders had

continued

adopted Microsoft's leapfrog thinking and tried Mac-like features on the new Mac version before they were introduced on the established IBM platform.

Level5's delivery interface also needs work. The outlined data-entry sections tucked tightly against the menu bar should be aggressive dialog boxes, and the graphics display should be awash with button overlays waiting for mouse-clicks, but they are not. You can get through a session with Level5 if you are familiar with its IBM counterpart, but you will long for the intuitive MacPaint kind of thinking you've enjoyed since you first discovered a mouse on your desk.

Level5 is a backward-chaining system that lends itself to well-defined problems with well-defined goals. You can force the system into a pseudoforward chaining, but the headache is often not worth the result. For \$685, I expect more than a bug-

Those who
*want to port products to the Mac
need to understand the users, not just
how to call ROM routines.*

free product on the Mac; I expect an elegant environment that transforms my mouse-clicks into a meaningful dialogue.

Level5 left the smell of DOS in my disk drive and the taste of command lines in my mouth. Even the database-connectivity benefits of the older versions are neglected in the Mac product. The dynamic links to Information Builders' Focus database are replaced by the processing of tab-delimited files. For future versions, the company should consider links to popular databases like Acius's 4th Dimension and Claris's FileMaker IV. VAX and PC users may find Level5 Macintosh a quick way to bring existing knowledge systems to the Mac, but until the program adopts a more Mac-like flavor, I cannot recommend it as a tool for crafting Mac-style knowledge systems.

MacSmarts

Cognition Technology's MacSmarts was one of the first expert-system shells available for the Mac. Even with its slick interface and HyperCard links, the inference engine has changed little and is becoming worn in the ever-escalating battle for features.

There have been rumors of a new version of MacSmarts, called MacSmarts Professional, but it has not yet appeared. It is said to support database connectivity, variables, built-in engineering and financial functions, and links to HyperCard. For small tasks and learning, MacSmarts 3.2 is OK, but its lack of variables and weak explanation facilities make it a poor choice for important knowledge-system development.

Mahogany

The newest entrant in the Macintosh AI wars is Mahogany from Emerald Intelligence. Born and bred on an Amiga, Mahogany supports a simple, and very colorful, user interface. Sometimes it is nauseatingly colorful. But aside from its gaudy exterior, Mahogany is a good entry-level tool.

Mahogany's best feature is its bug-free inference engine.

Knowledge bases are built with easily entered IF...THEN rules and are controlled by forward, backward, or mixed-mode inference procedures. This package is written completely in C, so inferences are fast. Simple strings and object-attribute-value pairs make up Mahogany's knowledge-representation repertoire. There is not much depth to this package, and control of the inference process is impossible. But at \$149, the system can't be expected to be too powerful.

Mahogany's delivery environment is not as intuitive as many Macintosh shells. Double-clicking on an item once should enter it into the base of facts. Double-clicking on it twice should not produce any result. When you answer a Mahogany question, you may find that you unintentionally enter a selection more than once. Although the knowledge-building interface is fairly good, the delivery environment can't even be customized to associate developer-written text with attributes.

Mahogany Professional, which was due out by the end of 1989, promises to fix many of the oversights found in the program's introductory version. The new version was slated to include full object inheritance, the ability to lock rules, database and spreadsheet support, and various environment control operators.

Nexpert Object

Neuron Data's Nexpert Object is sometimes more Mac-like than the Mac itself. Long before most Mac programmers discovered pop-up menus, Nexpert Object was using these handy tools as its primary interface. And if you need power, there is nothing more powerful than Nexpert Object running on a Mac without a Lisp coprocessor.

In fact, much of Nexpert Object is reminiscent of the Lisp environment, without forcing you to put everything inside a pair of parentheses. This object-oriented system enables you to represent your world as symbols rather than text.

In addition to pop-up menus, Nexpert Object also has a highly windowed collection of editing and debugging tools that enable you to edit objects, rules, and classes with minimal keyboard interaction. But the interface is not all that makes this product the shell of choice for those who can afford its \$5000 price tag. The program has forward and backward chaining, the ability to call and be called by MPW programs, and HyperCard links. Through newly released libraries, you can embed Nexpert in HyperCard. HyperBridge, which works with both HyperCard and SuperCard, gives HyperCard developers command of all of Nexpert's callable interface libraries. The HyperBridge product simplifies functions that Nexpert Object handles poorly, such as built-in graphics and text-file concatenation and writing.

A new addition to the Nexpert family is the \$4000 Nextra knowledge-acquisition tool. Neuron Data now provides not only an excellent development and delivery tool but a less painful way to structure certain types of knowledge, such as the classification problem.

Nexpert's documentation is mostly a disconnected series of overviews that keep you distanced from the meat of the product. Third-party training from vendors such as Bechtel AI Institute and Digital Equipment will help fill the training and documentation void fostered by poor, but improving, Neuron Data documentation. Neuron Data also needs to provide certain features found in all Lisp tools but lacking in Nexpert Object: list processing and unification. The lack of these two basic techniques forces developers to create more rules than they should have to.

Those complaints aside, working with Nexpert Object is more fun than effort. It gives me an expressive environment

continued

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where I can concentrate on my problem, not the problems of my shell. If I'm doing heavy-duty knowledge engineering, I want a tool with the prowess and flexibility of Nextpert Object.

SuperExpert

One of the oldest technologies in the AI market is the ID3 algorithm that derives rules from a table of examples. This type of system appeared in the early ExpertEase software, and it has appeared again, with little change, in SuperExpert.

Softsync currently has no plans for further development of SuperExpert for the Mac, but the \$199.95 product continues to ship. As with most ID3-derived products, SuperExpert uses a table of examples for developing rules. To improve the user interface, you can link attributes to English questions. You also can link rule bases to form hierarchies that simulate forward- or backward-chaining inferences.

The main problem with SuperExpert is the lack of a rich representation environment. PC-based ID3 products such as First Class Fusion have been beefed up to include database links, hypertext, and decimal support. SuperExpert has none of these capabilities. If you are developing a simple help desk function that has little more than single-word answers or integers, SuperExpert may work. But for a few dollars more, I recommend a shell with more capabilities and more support from the manufacturer.

Jumping to Conditions

I am encouraged by recent developments on the Mac. With the advent of the Lisp-chip-based microExplorer board, many

major Lisp-based shells are beginning to appear, along with dedicated systems like the ICAD design tool and Gensym's G2 process-control expert system. Even people without the Lisp chip will find workstation expert-system power in the recently announced port of Gold Hill Computers' successful IBM expert system, GoldWorks II, to Apple Common Lisp. The Mac inherited its look and feel from the AI world, and it is now making the esoteric world of expert systems as accessible as bit-mapped drawing and standard program interfaces.

Even the less well-known elements of the AI scene, like neural networks, are appearing on the Mac—and hypermedia products like Owl International's Guide and BrainPower's ArchiText are turning data and information into knowledge.

The Future

The next few years will see lower prices for shell products and more knowledge-processing capabilities added to spreadsheets, databases, and word processors. The Mac II and its 68030-based descendants will make aggressive vehicles for intelligent control of everything from household appliances to factory floors. For now, however, my once-ridiculed Mac and I look forward to working together toward making the knowledge revolution a reality. ■

Daniel W. Rasmus is manager of computer-assisted manufacturing at Western Digital Corp. in Irvine, California. He is a frequent contributor to magazines and a lecturer in manufacturing, AI, and computers. He can be contacted on BIX c/o "editors."



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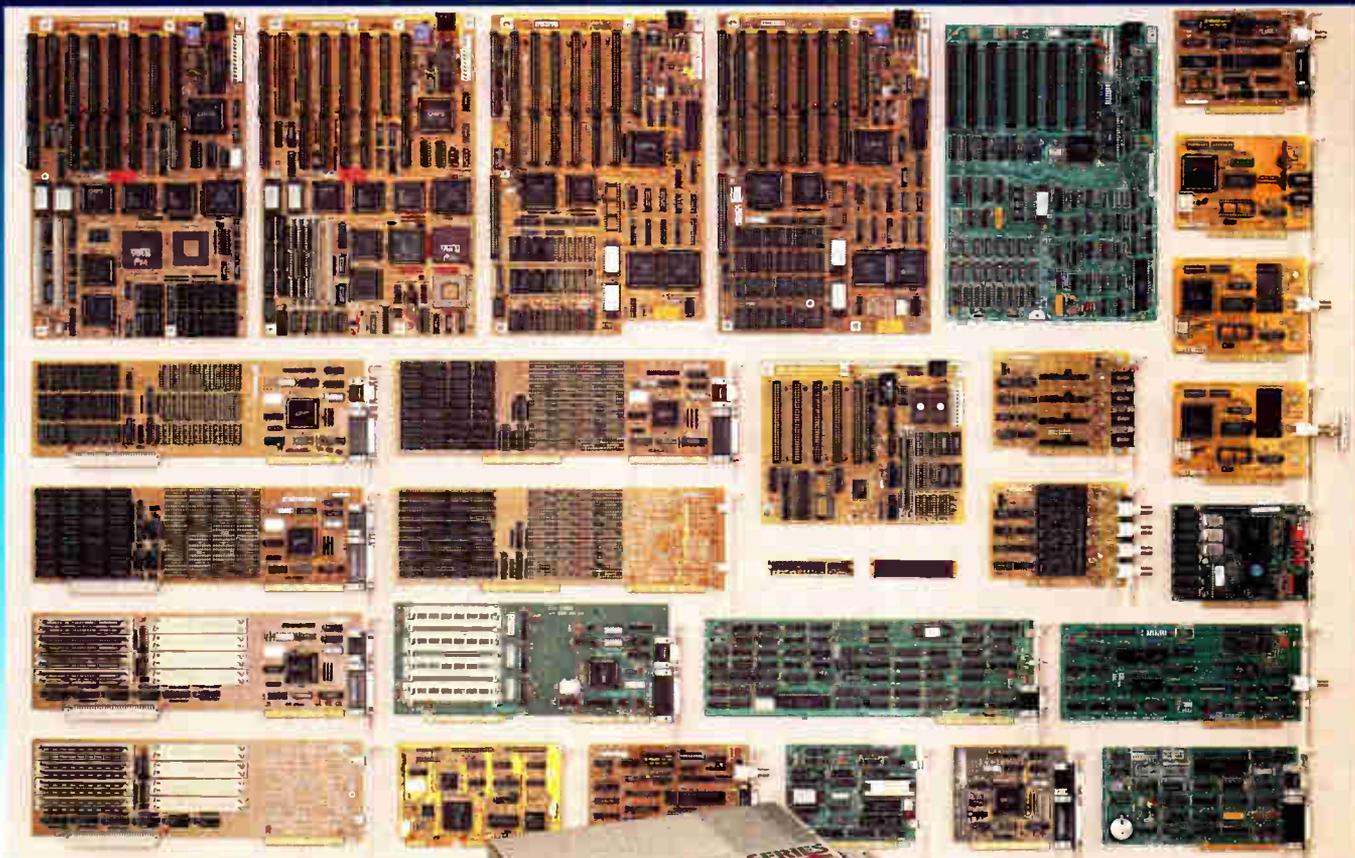
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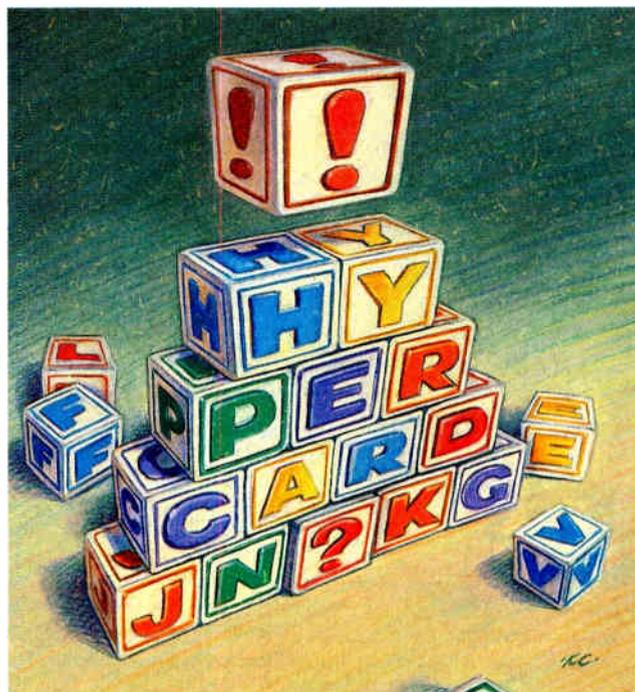


HyperCard has been called everything from database to hypermedia toolkit and from system software to "information erector set." There probably are as many different descriptions as there are public domain stacks. But amid all the fanfare and hyperbole that have surrounded HyperCard since developers first received the "freedom to associate," a powerful and exciting theme for hypermedia development is quietly emerging: HyperCard as an environment for building expert systems.

With its easy integration of text, graphics, and object-oriented programming, HyperCard can be ideal for implementing several types of knowledge-based applications. Many learning, reference, and diagnostic systems already have been created using only the simple associative links that HyperCard provides. Interestingly, this form of knowledge representation is so intuitive that many of the domain experts who authored these stacks did not realize that they were actually creating knowledge-based systems. This is somewhat different from other attempts at automated knowledge acquisition, or "trying to get experts to build their own expert systems," and certainly has had more success.

Millennium Software has developed a number of Hy-

perCard-based expert systems, including the Apple Business Analyzer for ComputerLand, using these simple associative links, along with a healthy serving of HyperTalk scripts and XCMDs (external commands). You can avoid some problems, such as mapping and debugging the logic in large hypertext systems, by maintaining the logic in the system separately from the data. One example of such a production rule-based system is HyperX, an expert-system shell written entirely within the HyperCard environment.



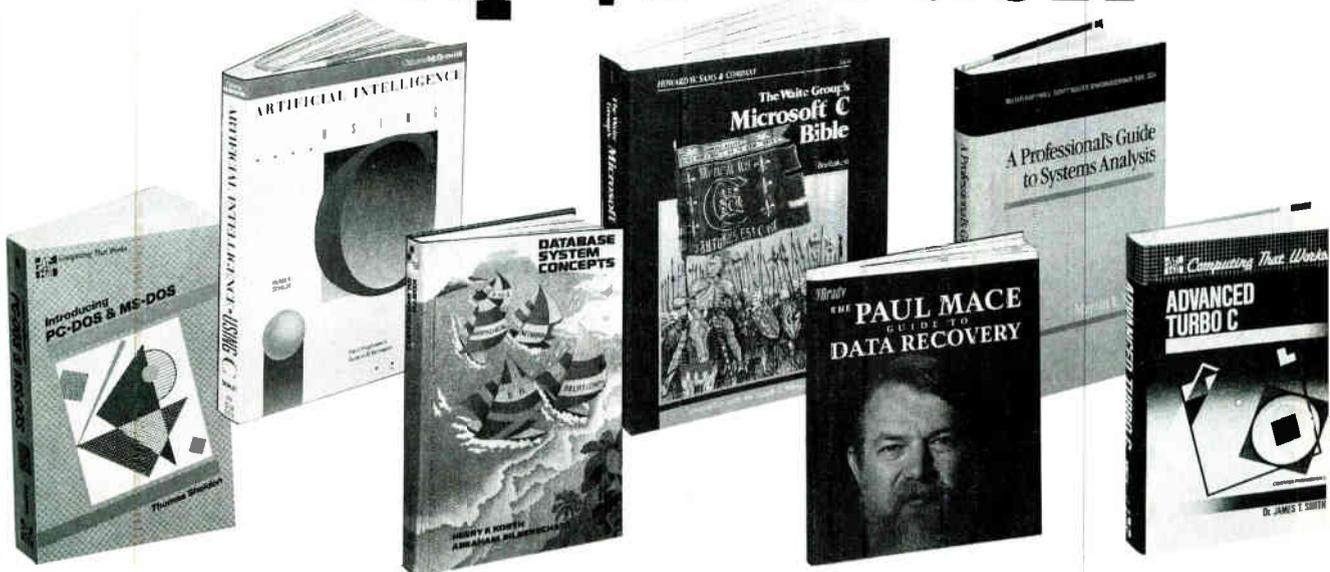
Inference by Hypertext

First, let me provide a brief review of HyperCard. Within HyperCard, the card is the basic receptacle for information, and any card can have its own text fields, graphical images, or buttons. The button is a graphical object that performs certain actions when it is clicked on by the mouse. The author of a stack can create new buttons that are linked to other cards or stacks automatically by responding to simple questions presented by dialog boxes. These actions will create a script for that button that automatically goes to a destination specified by the author of the stack.

The links that HyperCard can create automatically are considerable more limited than other, more powerful

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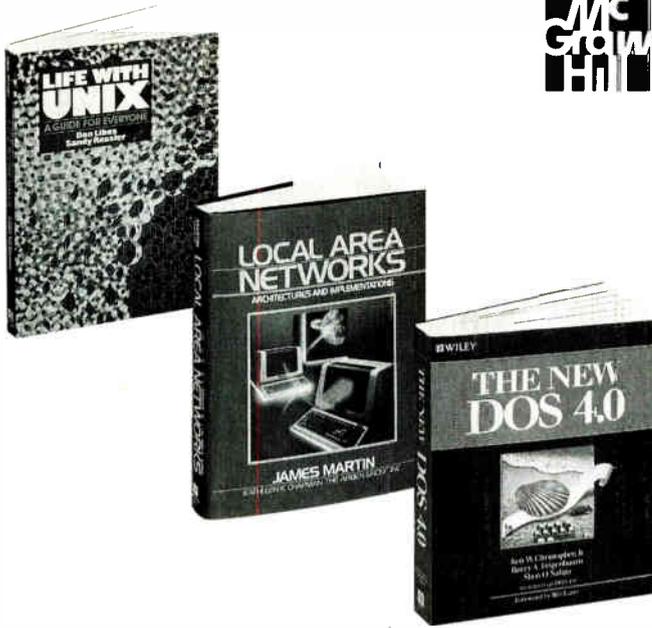
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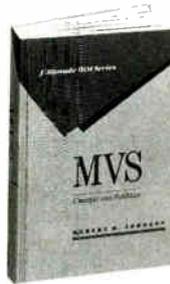
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Listing 1: The proveRule function of the Consultation handler.

```
function proveRule theRule
  repeat with theLine=1 to the number of lines in bkgnrd field
    "Assertions"
    put line theLine of bkgnrd field "Assertions" into theFact
    put testFact(theFact) into theResult
    if theResult is true -- this fact already has a value
      of true
    then next repeat -- so test the next fact in this rule
    if theResult is false -- this fact already has a
      value of false
    then return "fail" -- so fail the rule
    put backChain(theRule,theFact) into theResult -- does
      theFact have a rule that
      determines a value for that fact?
    if theResult is not empty
    then -- add that rule to the "Goal Trail" of rules to be
      tested
      put the number of lines in card field "Goal Trail" of
        card "Smart" into theLine
      put theLine+1 into theLine
      put theResult into line theLine in card field "Goal
        Trail" of card "Smart"
      return "*"
    end if
    push this card
    visual effect barn door close
    go card "Smart"
    put "Looking up Question..." into card field "Status"
    show card field "Status"
    put find(card field "Questions",theFact) into theQuest
    if item 1 of theQuest=0
    then -- ask the generic question
      visual effect wipe up
      go card "Question"
      put theFact into field "Fact"
      return "?"
    else -- ask the question card for this fact
      put item 1 of theQuest into theQuest
      put item 2 of line theQuest of card field "Questions"
        into theQuest
      visual effect wipe up
      go theQuest
      return "?"
    end if
  end repeat
  put "Passing Rule..." into card field "Status" of card
    "Smart"
  put field "Conclusion" into card field "Conclusion" of card
    "Smart"
  put the number of lines in card field "Facts" of card
    "Smart" into numLines
  put numLines+1 into theLine
  put field "Conclusion" into line theLine of card field
    "Facts" of card "Smart"
  put true into item 2 of line theLine of card field "Facts"
    of card "Smart"
  put the number of lines in card field "Rules" of card
    "Smart" into theLine
  put theLine+1 into theLine
  put theRule into line theLine of card field "Rules" of card
    "Smart"
  put "pass" into item 2 of line theLine of card field
    "Rules" of card "Smart"
  return "pass"
end proveRule
```

with a concise and readable syntax, enabling clever script writers to easily create their own high-level dynamic inference engine.

HyperX

As far as I know, the first entirely HyperCard-based expert-system shell is HyperX, a stack that work began on in late 1987. HyperX is now a commercial product from my own company, Millennium Software, but the first published release (version 1.4) may still be available free for noncommercial use through many user groups and electronic services, including BIX.

[Editor's note: *The commercial version of HyperX, version*

3.0, is available for \$99.95 from Millennium Software, 1970 South Coast Hwy., Laguna Beach, CA 92651, (714) 497-7439. A public domain version that includes source code is available on disk and in print from BYTE and on BIX. See page 5 for details.] Although version 1.4 is a demonstration system and does not provide the more sophisticated tools to create your own systems that are included with my latest commercial release, HyperX 1.4 does contain a fully functional inference engine written in HyperTalk.

The HyperX inference engine requires three different backgrounds for operation: Rule Cards, the Smart Card, and Question Cards. Rule Cards, as shown in figure 2, contain the knowledge of the expert stack, in the form of production rules. These rules express the relationships between the different facts that are important to the subject area, or domain, of the expert system. A rule contains a list of assertions (the IF part of the rule) and a list of conclusions (the THEN part of the rule). By proving each of the assertions to be true, you can infer logically that the conclusions are also true.

The Smart Card, shown in figure 3, is a visual display of the internal workings of HyperX. It is an electronic blackboard that holds all the information HyperX has discovered during the current consultation. All the facts that have been tested and their values, which rules have already been tested, and other information needed by the inference engine are stored in different fields there.

HyperX enables you to use Question Cards to determine the value, either true or false, of any fact during a consultation. Each value for that fact is represented by a button on the Question Card for that fact. When you click on a value button, that fact is added to the list of facts that have been tested during this consultation and stored on the Smart Card. Question Cards also can be customized with any special graphics, buttons, or fields that are needed in the expert stack, including associative links to related information.

To begin a consultation with HyperX, you just click on the light bulb icon on the Smart Card. This will begin execution of the Consultation handler. The Consultation handler is the main entry point into the HyperX inference engine, which looks for and evaluates goals. If there are no rules scheduled to be tested in the Goal Trail, the Consultation handler will try to find a new goal for the system, either by working from the last known conclusion or by testing rules in their natural order until all rules have fired. Once HyperX has a goal, it will continue testing the rules in the Goal Trail until there are no more rules left, starting with the bottom.

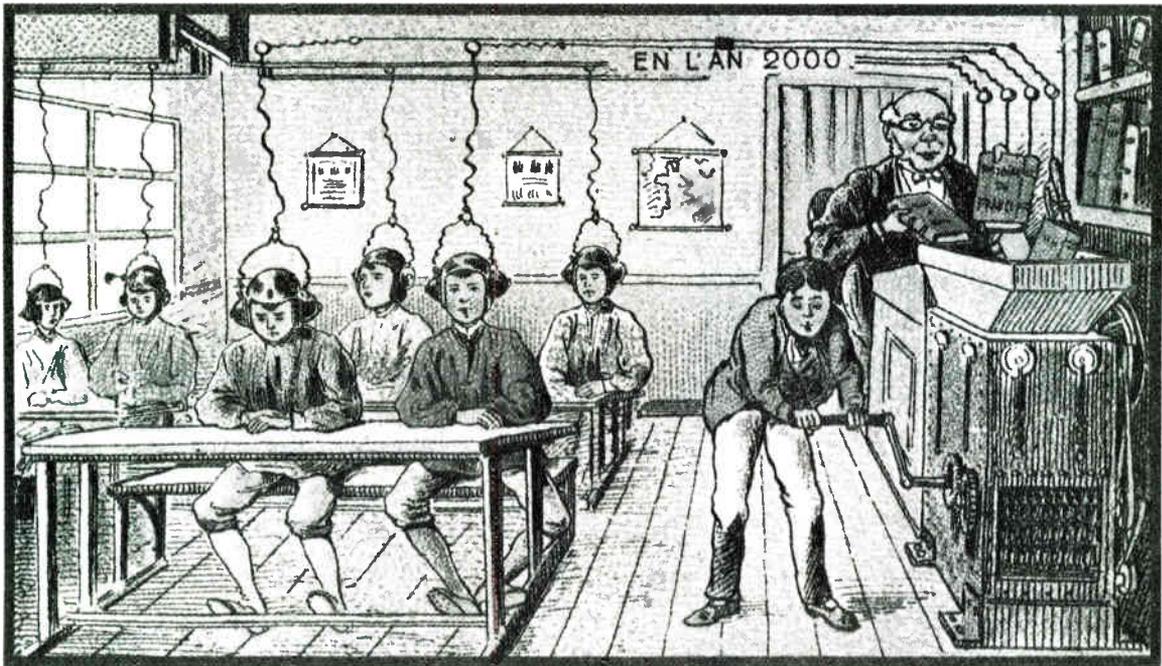
Several other functions are called by the Consultation handler. The proveRule function, shown in listing 1, attempts to "fire" a particular rule by testing each of the facts in the assertions of a rule for validity. If a fact is unknown, proveRule calls the backChain function to try to find rules that determine a value for that fact, otherwise jumping to the Question Card for that fact.

The proveRule function returns one of four possible results to the Consultation handler: "?", "*", "pass," and "fail." The result of "?" indicates that a question card was asked for one fact in that rule. The "*" result indicates one of the facts in the rule being tested backward-chained to another rule. The result of "pass" tells the Consultation handler that the rule being tested has passed, and the "fail" result indicates that the rule being tested has failed.

The backChain function is a special-purpose search mechanism used by the HyperX inference engine. When a particular fact is unknown, HyperX looks for a rule that determines a

continued

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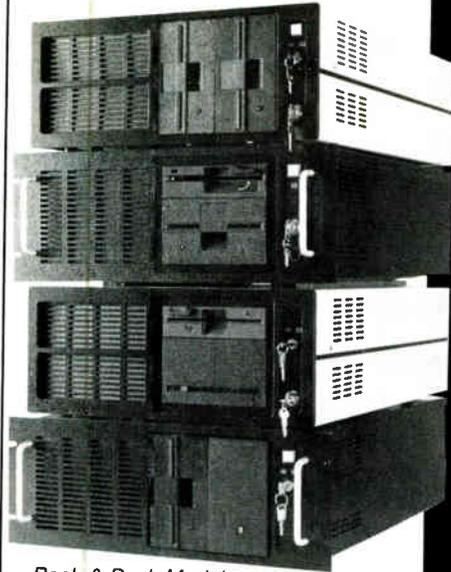
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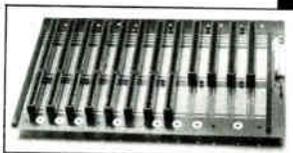
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Listing 2: The forChain function search mechanism.

```
function forChain theFact
  put empty into theResult
  put "Forward Chaining..." into card field "Status" of card
  "Smart:"

  go card "Rule 1"
  visual effect scroll left very fast
  find theFact in bkgnd field "Assertions"
  if the result is empty then
    put field "Rule Number" into firstRule
    repeat forever
      put find(field "Assertions", theFact) into
        onThisCard
      if item 1 of onThisCard <> 0 then
        put testRule(field "Rule Number") into ruleStatus
        if ruleStatus is empty then
          put the number of lines in card field "Goal Trail"
            of card "Smart" into theLine
          put theLine+1 into theLine
          put field "Rule Number" into line theLine of card
            field "Goal Trail" of card "Smart"
          put "found" into theResult
          exit repeat
        end if
        visual effect scroll left very fast
        go to next card
        find theFact in bkgnd field "Assertions"
        if field "Rule Number" = firstRule
          then
            exit repeat
          end if
        else
          exit repeat
        end if
      end repeat
    end if
  return theResult
end forChain
```

value for that fact. The forChain function, shown in listing 2, is another search mechanism. In this case, a rule has already passed, and now HyperX is moving down a chain of inference trying to find another rule to test based on the conclusions. In other words, forChain looks for rules that are proven by a particular fact.

Which Way from Here?

It is easy to get lost in a large hypertext system, so an expert system is like a navigator who leads you in directions suggested either by the goal of the system (backward chaining) or by context (forward chaining). By creating a hybrid system that combines both strategies, novices and experts can utilize the same information source at their own ability levels. Also, by searching out these connections dynamically, it is possible to create adaptive systems that can respond to new information or even "learn" new rules from users.

Powerful extensions also can be added to a HyperCard-based expert system such as HyperX (or any other stack, for that matter). Buttons, scripts, and XCMDs that control devices like videodisks or that access SQL databases like Oracle can easily be cut and pasted into your expert stacks, much like the "Velcro software" concept being espoused by advocates of object-oriented programming.

With the enormous variety of public domain and commercial stackware available, it has become possible to spend less time reinventing the wheel and more time adding intelligence into your application. ■

Ron Evans is president of Millennium Software, a development, consulting, and publishing firm in Laguna Beach, California. He can be contacted on BIX as "hyperx."

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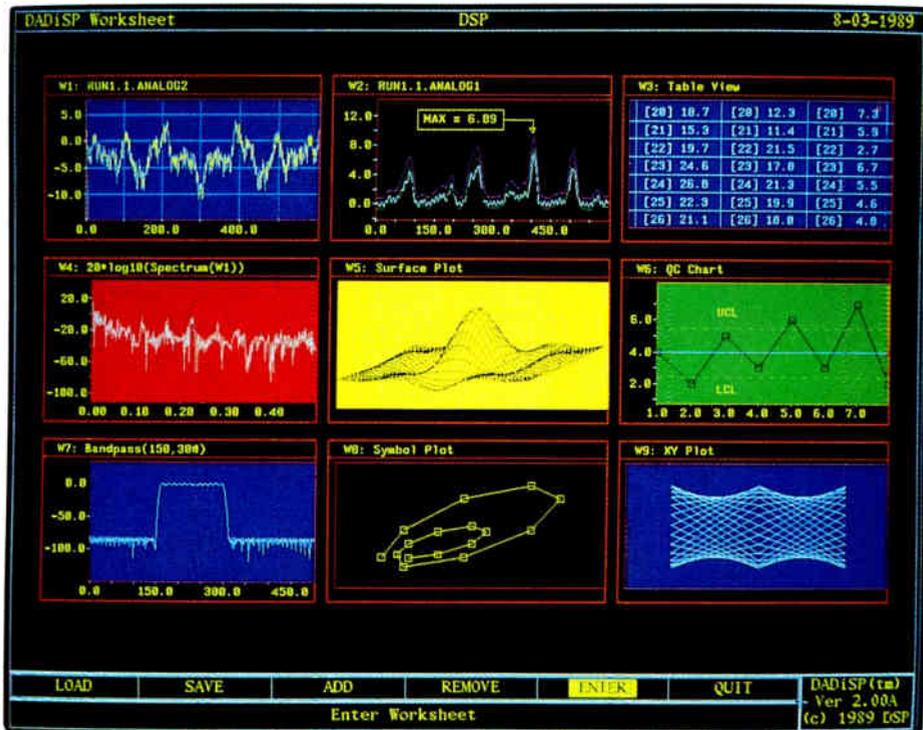
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CONFIGURING PARALLEL PROGRAMS

PART 2

*The Par.C parallel C compiler
simplifies programming for the transputer*

Dick Pountain

Last month, I described a key problem in the world of parallel programming—namely, how to map a network of software processes and message channels onto the available parallel hardware. In its most general form, this problem is intractable, equivalent to the “Traveling Salesman” problem for which there are exact solutions only when there are very small numbers of points for the salesman to visit. I discussed the experimental Occam Transpiler, a compiler that uses a genetic algorithm to map parallel programs onto arbitrary arrays of INMOS transputers. Now, I shall look at a totally different approach to this key problem, the new Par.C (a parallel C) compiler for the transputer.

Configuration Time

A parallel program can be configured at any of the life stages of a computer program: compile time, load time, or run time. Compile-time configuration implies that you must know the exact topology of the target hardware when the program is compiled. The Occam language is an example of compile-time configuration, since configuration statements are built into the language itself and become part of your program (see my article “Occam II,” October 1989 BYTE). In Occam you can develop a program by simulating parallel execution on a single processor, but to produce a version that runs on multiple processors, you must add statements to the source code that assign each parallel process in the program to a particular processor. Then you must recompile. The Transpiler (described in Part 1) performs its own automatic configuration at compile time.

Load-time configuration implies that you can execute the same compiled code on differently shaped processor arrays by supplying information about the array’s topology to the program loader before each run. With this capability, the loader directs the program modules to the correct processors. This information might be provided as a manually created file of process/processor assignments, or it could be supplied by some sort of network analyzer built into the program loader.

The 3L parallel C compiler provides an example of both methods. Programs in 3L C consist of separately compiled and linked task files. A configurator tool takes these modules, along with a text file of task/processor assignments, and produces a loadable application. This system lets you adapt applications to new hardware without recompilation. You merely edit the configuration file. A different 3L configurator tool can perform automatic configuration for a restricted class of applications by using a flood-fill algorithm to load tasks throughout a network. Flood-fill works only for programs that are structured as a single master task and many identical worker tasks, but many numerically intensive math computations fit this description. (I’ll be writing more about the 3L compiler in a future article.)

Run-time configuration implies that while the program is running, it can adapt itself to the topology of the hardware. It can also imply that the program can change its configuration based on variables within the program. One way of performing this feat is illustrated by the Equus operating system, which can migrate both processes and message channels from one processor to another at run time.

None of these three strategies is the “best.” There are, as always, trade-offs. Compile-time configuration is the least flexible but offers the greatest potential efficiency, because optimizations can be performed with full knowledge of the target hardware. Run-time configuration offers greater flexibility but necessarily imposes overheads, both in memory size and execution time. Load-time configuration represents a compromise between these extremes!

Par.C

Par.C is an ANSI-standard C compiler produced by Parsec Developments of Leiden, Holland. It generates code for the INMOS transputer and incorporates Occam-like language extensions to facilitate the writing of concurrent programs. Versions are available for the IBM PC, Sun, or Harris (Unix) computers, and for the transputer itself; I evaluated the PC version.

continued

The Par.C system consists of a pre-processor/compiler that generates assembly source code, an assembler, a linker, and a loader/server, which runs on the host and loads object code into the transputer network and also provides screen and disk I/O through the host.

Par.C tackles the problem of configuring for parallel computing in an unusual way. The loader/server contains a network analyzer that sends out a worm program to investigate the transputer network at load time. Having discovered how many transputers are present, and their type, speed, memory, and interconnections to their neighbors, the worm stores this information in the memory of each processor in the network, where it can be found by the run-time system.

Then Par.C loads an identical copy of the program code into each processor in the system. Each copy can discover the identity of the particular processor it is running on and its neighboring environment by reading the information stored by the worm, and it can choose to execute only certain parts of its code based on this information. Hence, a program can run different code on different processors, determined by the shape and size of the network it encounters at run time. Most efficient use of memory is sacrificed, since large parts of the loaded code may never be executed.

It is difficult to classify Par.C using the three-branched scheme that I adopted above. The topology information is determined and stored at load time, but it gets acted on at run time; however, the selection of which code is to be executed is determined by the source code at compile time. In one sense, configuration has been avoided altogether, since copies of the same code are loaded throughout the system. There is no such thing as a free lunch; the work saved in doing configuration is added into writing the main program. You have to write extra code to specify how the program should choose which parts to execute. This can be a substantial amount of code.

Language Extensions

In Par.C, as in Occam, the configuration language is indistinguishable from the programming language. Par.C extends the C language by adding a channel data type for interprocess communications, the `par` statement to launch parallel processes, and the `select` statement, which waits for an event to occur on a channel.

Channels in Par.C can carry data of any type. Input or output to a channel occurs through ordinary assignment statements. Channel communication can proceed only when both the output and input ends are ready. For example, having declared a channel

```
int jim;
channel fred;
```

you can output a value to it by using it on the left side of an assignment,

```
fred = 3452;
```

and receive a value from it inside a different process by using it on the right side,

```
jim = fred;
```

Par.C tackles configuring for parallel computing in an unusual way.

A channel is intended to be used to connect exactly two processes in one direction, but the compiler does not enforce this. The program is likely to crash if two processes try to output to the same channel. Channels, like other C variables, can be manipulated by pointers. To create a channel to another processor, a channel pointer has to be given the address of a physical transputer link using the `LINKIN()` or `LINKOUT()` functions. Alternatively, you can use the library functions `SendLink()` and `Rec-`

`Link()` for interprocessor communication.

The `par` statement makes the enclosed C statements execute concurrently.

```
par
{
    ProcessA();
    ProcessB();
    ProcessC();
}
printf("Done");
```

This statement causes `ProcessA()`, `ProcessB()`, and `ProcessC()` to be executed simultaneously. The `printf()` statement cannot be executed until the processes have all terminated. Any C code at all can be used in a `par`; therefore, you can use `if` and `switch` to spawn processes conditionally. The exception is that you can't use `return`, `break`, or `continue` statements to leave a `par` process, as these statements are incompatible with concurrent execution. Par.C, unlike Occam, permits global variables to be shared by component processes in a `par`, leaving the programmer with the responsibility of catching any problems caused by the undefined order of assignments to such variables.

Par statements can have a replicator in their head, whose syntax is modeled exactly on the C `for` statement. This causes a number of similar parallel processes to be started. For example,

```
par (i = 0; i < n; i++)
{
    printf("%c", string[i]);
}
```

causes all the characters of `string` to be printed concurrently. Note that, unlike Occam, Par.C permits the upper limit of a replicated `par` to be a variable; the number of parallel processes that will be started is not known until the statement is being executed. Par.C allocates processes using a run-time stack and memory manager (which also enables it to support recursion).

The `select` statement is used rather like C's `switch` to execute just one from a number of clauses, but each clause has a channel attached to it, and the selection is performed according to whose channel delivers a value first; you can think of it as a high-level way of handling interrupts. The syntax for `select` in Par.C is rather complex. Each clause of the `select` starts with the word `alt` (for *alternative*), followed by the word `guard` and a channel pointer

continued

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Listing 1: This program demonstrates the use of the `par` and `select` statements for invoking parallel processing.

```
#include <stddef.h>          /* general definitions */
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

#define MX 6
#define TimeOut 500

unsigned int rand();

void main() {
    int i,j=3,N=MX,Again=1,nC=0;
    channel C[MX];          /* array of channels */
    int NotYet[MX];        /* array of Booleans */

    for (i=0 ; i<MX ; i++)
        NotYet[i] = TRUE ; /* initialize Booleans */
    par
    {{
        /* 1st process level 1 */
        int i;
        par (i=0 ; i<MX ; i++) /* nested replicated par */
        {{
            int r = i * i ;
            wait ( rand()/91625 );
            C[i] = r ;
            printf("Sent %d over channel at %p\n", r, &C[i]) ;
        }}
        printf("Replicated par terminated\n");
    }}
    while (Again)          /* 2nd process level 1 */
    {
        select within (TimeOut * (j+1))
        {
            alt (j=0;j<MX;j++) cond NotYet[j] guard &C[j] :
                printf("Received %d from channel C[%d] at %p\n",
                    C[j], j, &C[j]) ;
                NotYet[j] = FALSE;
                nC++;
                break;
            alt timeout :
                printf("Time Out in Select\n");
                break ;
            alt cond (nC >= MX) :
                printf("All data has been received\n");
                Again=FALSE;
        }
        printf("Selecting process terminating\n");
    }
}
```

and/or a conditional expression and/or a replicator. One form of the `select` statement is

```
select
{
    alt guard &Channel1 :
        Message = Channel1; break;
    alt guard &Channel2 :
        HandleInput( &Channel2); break;
}
```

If `Channel2` is the first to have its input ready, then `HandleInput()` will be executed. A `select` like this will wait forever until one of its channels becomes ready, but you can create a timed `select` by adding the `within` expression:

```
select within 1000
{
    alt guard &Channel1 :
        Message = Channel1; break;
    alt guard &Channel2 :
        HandleInput(&Channel2); break;
    alt timeout :
        printf("Timed out waiting for reply\n");
        break;
}
```

Unless the `select` is triggered within 1000 clock ticks, it will terminate by executing the time-out code.

The program in listing 1 illustrates the way `par` and `select` are used. Many other functions, required in `Par.C` to handle the transputer hardware at a lower level, are implemented as library routines rather than language extensions—for example, `Run()`. This routine loads and runs a program down a specified link to another transputer.

Program Loading

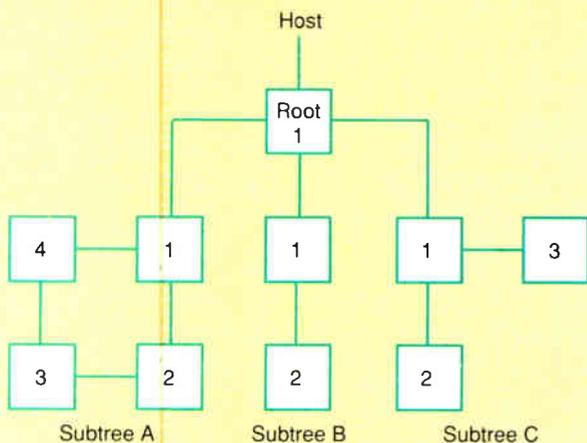
`Par.C` is limited in the network topologies that it can program, but these limitations are shared by most other transputer programming systems. The first limitation is that only one transputer (the *root* transputer) can communicate with the host computer, and this by a single link. The root transputer is the only one that can perform disk and screen I/O, but it can have multiple processes for concurrent file I/O. `Parsec` is working toward multiprocessor I/O (i.e., allowing I/O from any transputer in the network) in a future version of the system. The development of this enhancement is not a trivial undertaking. Another limitation is that the `Run()` function can execute only on the root transputer; therefore, the whole network must be booted from the root.

Booting multiprocessor programs under `Par.C` is largely automatic. If you link your compiled program with the `A.LIB` library, it will be loaded and run on a single transputer; however, if you link it with `B.LIB`, then identical copies of the program will be loaded and run on every processor in the system. In either case, all you have to do is type `RUN <myprog>`.

By using the `Run()` function inside your program, you can partition the network to some extent. Since the root transputer must have three links that are not connected to the host, you can configure the processor network to have up to three branches or subtrees (see the figure), each of which you can load with a different subprogram using `Run()`. Each subprogram thinks it has been booted by the host, so you can again use `A.LIB` or `B.LIB` to load one or all of the subtree processors.

continued

TRANSPUTER TREE



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The System Structure

RUN.EXE, the Par.C loader/server, stores the information that it gleans about the network at boot time in a structure of type SYSTEM (see listing 2). The information in this structure will be different for each processor and includes the number, type, and status of the processor and its immediate neighbors, as well as the location of the links that lead to and from the host (HostLinkIn, HostLinkOut).

Programs should not read the system structure directly, but should obtain a copy using GetSysInfo(), ensuring compatibility if future versions of Par.C have added items in the structure. The most important information in the structure, the total number of transputers and the processor number and type, is available without using the system structure in the global variables _Tn, _nT, and _ttype (in the header file STDDEF.H). This information is all that is necessary for many applications. As an example, for a math program using one controller and many identical calculator processes (e.g., matrix multiplication), you might configure using this sort of construct:

```
main()
{
  if (_Tn == 1) Controller();
  else par
  {
    Calculator();
    MessagePasser();
  }
}
```

More complex programs could take the form

```
switch (_Tn)
{
  case 1 : some code... ;
  case 2 : more code... ;
  case 3 : more code... ;
  etc....
}
```

Listing 3 is an example of how to use the system structure. The example is part of a simple network analyzer program that

continued

Listing 2: Par.C creates this structure in the memory space of each transputer in the network. Your program can read the structure at run time.

```
typedef struct _system
{
  _Word HostLinkno; /* Number [0-3] of the bootlink */
  channel *HostLinkOut; /* Send uptree */
  channel *HostLinkIn; /* Input from uptree */
  _Byte *MemStart; /* Lowest available address */
  _Byte *MemTop; /* Highest available address+1 */
  _Word ProcessorSpeed; /* In 250-kHz units */
  _Word XMemSpeed; /* Expressed in CPU cycles */
  _Word ttype; /* Transputer type, 2, 4, or 8 */
  _Word Tn; /* Identity within network */
  _Word nT; /* # of transputers in the network */
  _Word nT_Down; /* # of transputers in our branch */
  _Word NBooted[4]; /* Active transputers on each link */
  _Word Network[4]; /* Neighbor's Tn */
  _Byte LinkStatus[4]; /* Linkstatus */
  _Byte ExtLink[4]; /* Links of neighbors */
  _Byte ExtType[4]; /* Types of neighbors */
} SYSTEM;
```

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*1 Source: Infoworld Hardware Benchmarks (33-MHz 80386-based systems)

*2 MIPS is based on Power Meter™ Version 1.2 from Database Group, Inc.



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prints the structure of your transputer network on the host screen. For space considerations, I've omitted the definition of `DispSys()`, which just displays the system structure contents in a formatted table. The crux of this program is the `for` loop in line 26, which descends the processor tree and passes the system structure for each processor it encounters back to the root transputer (in the variable `alien`). `DispSys()` then displays the information. In line 29,

```
channel *from = LINKIN(link);
```

is an example of the assignment of a physical transputer link address to a Par.C channel pointer.

Since the launch of the T800 floating-point transputer, programmers have faced a thorny problem when programming floating-point calculations on processor arrays that mix T800s

with the older integer-only T414. Par.C renders the difference between these transputer types transparent by automatically loading the appropriate math libraries `REALT4.RSL` (software floating-point) and `REALT8.RSL` (T800 FPU instructions) at boot time.

If you know for sure that floating-point math will be performed only on T800s, you can use the compiler directive `#pragma fpu`, which causes the compiler to emit T800 FPU instructions directly instead of by calling the library. This improves performance substantially by allowing the T800's CPU and FPU to run in parallel. To be sure that a T414 never tries to execute T800 code (which would cause a crash), you should include lines like this in your program:

```
par
{
  if( _ttype == 8) DoFloatCalcs();
  MessagePasser();
}

void MessagePasser();
{ ...
}

#pragma fpu

void DoFloatCalcs();
{ ....
}
```

Listing 3: The program gathers information from the system structure in each transputer and returns all of it to the root processor. The root generates and prints a table.

```
#include <system.h>
#include <stdio.h>

void DispSys( system);

int main() {
  int link;
  channel *to;
  channel *from;
  SYSTEM sys;

  GetSysInfo( &sys );
  to = sys.HostLinkOut;
  from = sys.HcstLinkIn;

  if ( _Tn == 1 )
  {
    printf( "Number of transputers in system: %u\n",
            sys.nT );
    printf(
      "Ident Type MHz Link 0 Link 1 Link 2
      Link 3 MemTop\n" );
    DispSys( &sys );
  }
  else
  *to = sys;

  for ( link = 0; link < 4; link++ )
  {
    int child, family;
    channel *from = LINKIN(link);
    SYSTEM alien;

    family = sys.Nbooted[link];

    for ( child = 0; child < family; child++ )
    {
      alien = *from;
      if ( _Tn == 1 )
        DispSys( &alien);
      else
        *to = alien;
    }
  }
}
```

Lasting Impressions

I tested a demonstration version of the Par.C compiler with a restricted program size, running on an IBM PC fitted with a MicroWay Quadputer board containing four T800s with 1 megabyte of memory each. I successfully compiled and experimented with small multitransputer programs. Benchmarking the system posed several problems: There are no established, universal benchmarks for parallel systems, yet; the new BYTE benchmarks are written in Small-C, and the demonstration compiler would not compile programs the size of the Whetstone and Dhrystone benchmark programs.

I comforted myself by running the good old Sieve of Eratosthenes on a single transputer. Ten iterations took 0.5 second. Parsec supplied me with its own results for the Whetstone and Dhrystone benchmarks compared to two other transputer C compilers. They show Par.C running at between 70 percent and 90 percent of the speed of the others, depending on compiler switch settings. This suggests that if Par.C's run-time system slows it down, it isn't by much.

I was impressed by how small the system is, compared to most concurrent programming systems (it fits easily onto two 360K-byte floppy disks), and by how easy Par.C is to use. It is not so different from using an ordinary PC C compiler; you just type `PARC <myprog>` and then `RUN <myprog>`. This ease of use, coupled with its run-time flexibility, makes Par.C a capable vehicle for anything from quick-and-dirty programming to writing parallel operating systems. On the other hand, there are no compiler checks for misuse of channels, for shared global variables, or for various side effects of replicators. I worry that this oversight will make complex concurrent programs hard to debug. But that's just the way C is (and still people love it). ■

Dick Pountain is a BYTE consulting editor, technical author, and software consultant living in London, England. You can contact him on BIX as "dickp."

Sample Output

```
Number of transputers in system: 4
Ident Type MHz Link 0 Link 1 Link 2 Link 3 MemTop
1 T8 20 * Host <- 2.0 <- 3.0 <- 4.0 80101000
2 T8 20 * 1.1 - 3.1 4.1 80101000
3 T8 20 * 1.2 2.2 - 4.2 80101000
4 T8 20 * 1.3 2.3 3.3 - 80101000
```

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MATH COPROCESSORS

Dedicated hardware helps speed up floating-point math

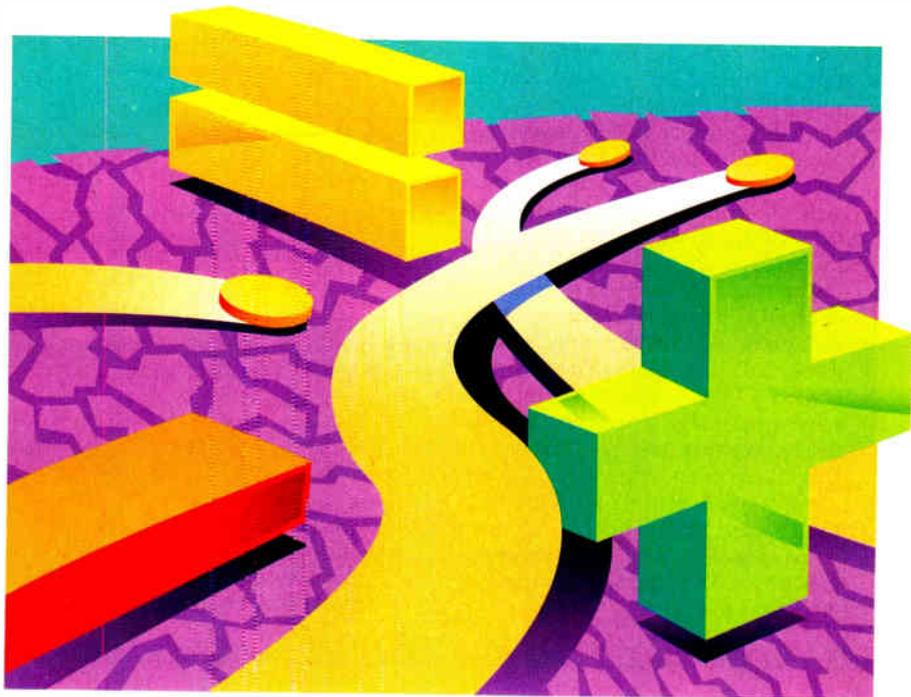
Many programs that do sophisticated graphics or perform complex financial calculations must deal with numbers expressed in *floating-point* notation. Virtually every machine (or the language translators used to write programs for it) contains libraries of routines to manipulate floating-point numbers. Still, because floating-point math is complex, even the fastest library requires hundreds or even thousands of instructions to perform a simple arithmetic operation like addition or multiplication.

When a lot of math needs to be done, floating-point math may cause slow recalculations on large spreadsheets and lengthy redraws in CAD programs. But impatient users can't (and shouldn't have to) wait. How is it possible to speed things up? While it's sometimes possible to recode the software to get around the need for floating-point math, the most practical solution is to throw dedicated hardware at the problem: a *math coprocessor*.

Why Floating-Point Math?

Every modern microprocessor is capable of performing math on two's complement binary integers and fixed-point numbers (i.e., numbers in which a certain number of bits are designated as being below the binary point). Such numbers are useful for solving numerous problems, but they have a fundamental limitation: If each number contains n bits, the biggest representable value is only a factor of $2^{(n-1)}$ larger in magnitude than the smallest representable one.

This means that a business calculation involving mere billions of dollars could



overflow during a 32-bit fixed-point calculation that was scaled to be accurate to the nearest penny. Other tasks, including matrix, scientific, and statistical calculations, can involve combinations of very large and very small numbers that could require thousands of bits to express in the same fixed-point notation.

The problem of expressing both very large and very small numbers in a compact notation isn't unique to the computer world. In fact, long before the advent of digital computers, scientists—who performed calculations by hand or with slide rules—developed *scientific notation* for just this purpose.

In scientific notation, a 2 followed by 26 zeros is written as 2×10^{26} . The number 5 written 10 digits below the decimal point could be expressed as 5×10^{-10} . Note that these two numbers take approximately the same space to write out, despite the vast difference in magnitude—and that both are shorter than they would

be if you had to write out all the zeros.

The power to which 10 is raised in a number written in scientific notation is the *characteristic*, or *exponent*; the number in front is the *mantissa*.

Computer scientists, many of whom had backgrounds in other branches of science, saw the merits of adopting a similar system for computers. Substituting powers of 2 for powers of 10 (so that binary math could be used), they developed similar methods of representing very large and very small numbers in a computer. Because, as in scientific notation, the characteristic specified the location of the decimal point relative to the first digit of the mantissa, this convention was dubbed floating-point.

The IEEE 754 Floating-Point Standard

Just as there is an infinite number of representations for integers and fixed-point

continued

Floating-Point Formats

Figure A shows the IEEE formats for single real, double real, and double extended real numbers. Each consists of a sign bit, an exponent field, and a field called the *significand*.

The significand contains either the mantissa or just the fractional part of the mantissa (i.e., the mantissa minus its high bit). The high bit (called the *integer bit*) can be omitted because nonzero floating-point numbers are usually *normalized*; that is, the significand is shifted over and the exponent adjusted, so that the high bit of the significand is a 1. (This is similar to the conventional manner of writing scientific notation: There should be exactly one nonzero digit above the decimal point of the mantissa.) A 0 is signified by an exponent of 0 and a significand of 0.

The exponent field tells what power of 2 by which the number represented by the significand must be multiplied to get the actual value of the floating-point number. An exponent of all 0s has a special meaning: It indicates that the number is either 0 (if the significand is also all 0s) or extremely small (an *un-normal*). An exponent containing all 1s has a special meaning in IEEE format: It indicates that what's represented is either an infinity (positive or negative) or a NaN (not a number), which is a

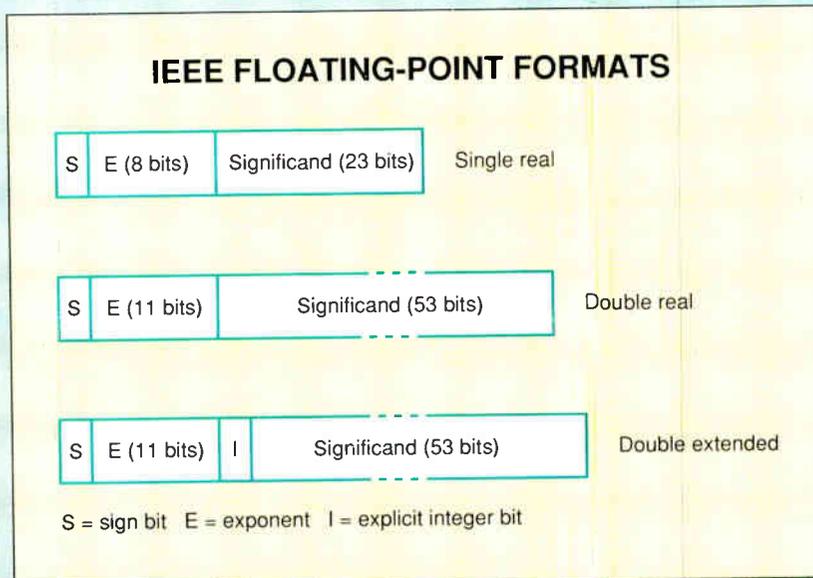


Figure A: Each format consists of a sign bit, an exponent field, and a significand, which contains either the mantissa or just the fractional part of the mantissa.

combination of bits that doesn't represent a valid number at all. (Some hardware/software implementations use NaNs to mark uninitialized variables.)

Exponent values that have neither all 0s nor all 1s represent powers of 2. To

derive the correct power of 2 from the exponent field, you add a *bias* to the value in the field to produce a positive or negative power.

The sign bit is simply a 1 if the number is negative; otherwise, it's a 0.

numbers (each one with a different number of bits and the binary point in a different place), there is also an infinite number of varieties of floating-point notation.

In the early days of computing, each manufacturer had its own convention, with a different range of possible characteristics and a different number of bits in the mantissa. Calculations that ran correctly on one computer sometimes crashed, overflowed, or produced wildly different results on another, and determinations of the possible error had to be done for each notation and architecture.

To ameliorate these problems, the IEEE established standard formats and precisions for floating-point numbers. This standard, whose official designation is IEEE Standard 754-1985, was eagerly embraced by manufacturers and users years before it was finalized.

The IEEE standard specifies the formats of single-precision (32-bit) and double-precision (64-bit) floating-point

numbers, and it gives a list of operations that must be available for those numbers. These include the four basic arithmetic operations (i.e., addition, subtraction, multiplication, and division), as well as remainder, square root, and various conversions. Virtually all math coprocessors also implement transcendental functions like sine, cosine, tangent, arctangent, logs, and exponentiation.

The text box "Floating-Point Formats" above shows the formats supported by the majority of floating-point coprocessors today: single real, double real, and double extended (often called extended real). There's also a single extended real, but it's not required on machines that can handle double real numbers and is seldom seen.

The standard *does* require each machine to handle the extended version of the largest format it supports, primarily so that it can hold intermediate results. The extended formats require a certain minimum number of bits in the mantissa,

but they let manufacturers add more to increase the precision of their products. Table 1 summarizes the requirements for each format.

The numbers represented by floating-point notation aren't spaced evenly along the number line, as are fixed-point numbers. The possible values get closer together near the origin and farther apart as you move away, as shown in figure 1. This is one of the trade-offs of floating-point math: Many calculations produce results that aren't exact and have to be rounded to the nearest value that the notation can represent.

Floating-Point (Im)precision

Since the IEEE standard takes such care to specify the rules for representation of floating-point numbers, you might expect to get very consistent results from the many math coprocessors and compiler floating-point libraries available today. Unfortunately, that's not the case. Different implementations of IEEE

floating-point math can have vastly different degrees of precision. (Intel's 80287 coprocessor, for example, calculates some transcendental functions less precisely than the newer 80387.) For most calculations, this isn't a problem; for others, it may cause very different results, including overflows, underflows, and numeric instabilities.

Because errors can lead to vast liabilities (e.g., from collapsed bridges to failed airplane parts), numerical programmers often learn by hard experience that they need to allow lots of latitude for such errors. Often, they opt to code sensitive algorithms directly in assembly language rather than relying on even the best compilers, which can inadvertently increase errors by rearranging numerical expressions so as to introduce higher degrees of error.

Still, for many applications, even the limited precision of "short" floating-point formats is more than adequate. For instance, when a CAD program uses floating-point math to display a drawing on your screen, a single real's 23-bit resolution will be far greater than that of any display monitor (or even your eye!). In this situation, it's far more important to maximize redraw speed than to go for a few more bits of precision.

Real-World Coprocessors

Different vendors' floating-point coprocessors make different trade-offs in the areas of precision, speed, ease of programming, and power consumption. In this article, I'll discuss the programming models of the three most common coprocessors for personal computers: Intel 8087/80287/80387, Motorola 68881/68882, and Weitek Abacus (3167).

I'll also touch on some of the features of two Intel 80387 clones—NP-3C87 and 83D87—both of which run faster than the Intel chip.

The Intel Coprocessors

The numeric coprocessors that were available for early 8-bit microcomputers and the first 16-bit ones were designed to operate as memory-mapped or I/O-mapped peripherals. To program these coprocessors, you'd write code to load numeric values into registers using I/O or memory read/write instructions; you'd then issue commands in a similar fashion and retrieve the result. These chips, most of which predated the IEEE standard, had the advantage that they could be used on more than one kind of microprocessor; however, the programmer had to know what coprocessor was being used and how it was mapped into the ma-

Table 1: The requirements for the double extended format (and the single extended format, not shown) specify only minimum numbers of bits for each field; manufacturers may implement more.

IEEE FLOATING-POINT NUMBERS				
Format/Parameter	Total bits	Mantissa bits	Exponent bits	Total range
Single	32	24	8	3.4×10^{38}
Double	64	53	11	18×10^{307}
Double extended	≥ 79	≥ 64	≥ 15	$\geq 6 \times 10^{4931}$

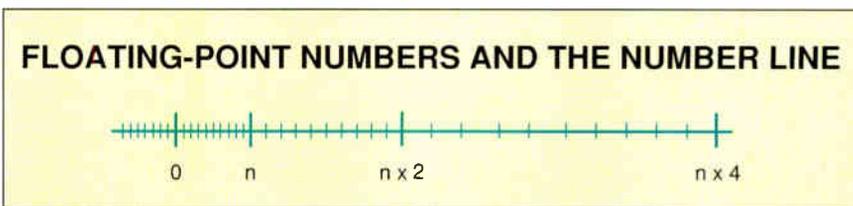


Figure 1: The density of the numbers representable by floating-point notation decreases as their magnitudes increase. For each power of 2 in the exponent, the precision drops by 50 percent.

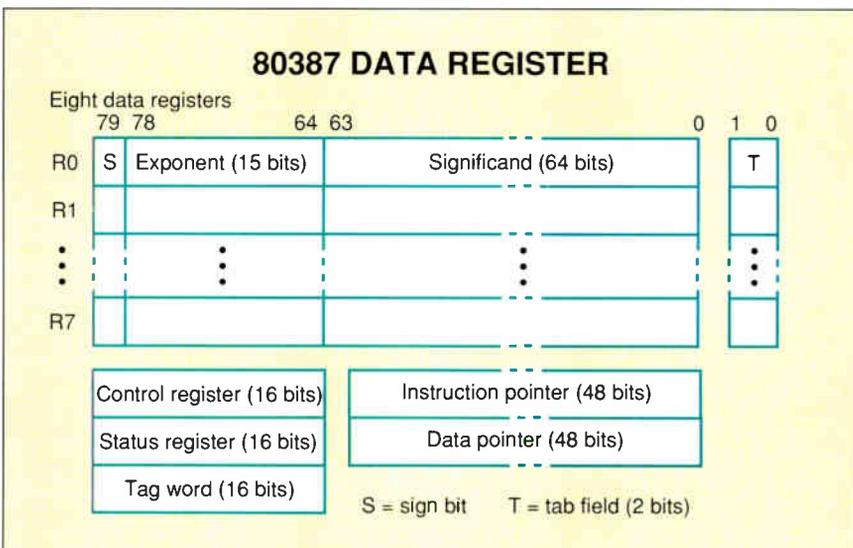


Figure 2: Each register is 80 bits wide. Only one 80387 can be used on the system at a time. The registers can be used as a stack.

chine's address space.

The 8087 broke from this trend. Like the optional FPUs on some large computers, the 8087 was designed to be a *numeric coprocessor extension*—an FPU controlled by the same stream of instructions that fed the 8086 microprocessor. To program the 8087, you simply placed floating-point op codes directly into your software along with those that controlled the main processor; the CPU and the 8087 worked together to decode and exe-

cute those op codes.

If an 8087 was *not* present, another mainframe trick could be used: Floating-point instructions could be made to cause a software interrupt and invoke an emulator to simulate the functions of the 8087 in software.

As the IEEE standard evolved and changed, so did successive generations of Intel coprocessors. The 80287 was designed to conform as closely as possible

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Polynomials: A New Approach to Transcendentals

The start-up company Cyrix (Richardson, TX) hopes to advance the speed standards for numeric coprocessors by implementing new and faster ways of evaluating transcendental functions (e.g., sines, cosines, and logs). Most math coprocessor chips, including those made by Intel and Weitek, use algorithms developed by mathematician Jack E. Volder for a computer of the 1950s called the CORDIC. These algorithms were ideal for the limited hardware available at the time, and they exhibit good *monotonicity*; that is, when a function is expected to increase over a given interval, the result really does go up as you increase the argument.

Cyrix, which implemented an extremely fast floating-point multiplier as part of its chip, chose a different approach that makes especially good use of that hardware. Transcendental functions are approximated by polynomials of the following form:

$$P(z) = \sum_{n=0}^k a_n z^n$$

calculated to an accuracy 10 bits greater

than required for the final result.

By their very nature, polynomials tend to be much "bumpier" than the functions they approximate, but the error decreases with the number of terms in the expansion. Engineers at Cyrix were able to prove mathematically that, given enough terms and enough bits of precision, they could achieve results that were monotonic and correct to the very last decimal place of an IEEE double extended floating-point number—better and also faster than the 80387.

Cyrix, funded by the same venture capitalists who financed Compaq, Cypress Semiconductor, and Lotus, should be selling its 80387-compatible coprocessors in quantity by the time you read this, at prices about the same as for a Weitek coprocessor running at the same speed.

For a more complete (and quite fascinating) description of the techniques used to implement polynomial approximations on the Cyrix chip, see the *Fas-Math 83D87 Accuracy Report* cited in the bibliography.

to the state of the standard in 1982, and the 80387 accommodated the final version of the standard issued in 1985.

Figure 2 shows the 80387 data register model as seen by the programmer (which is virtually identical to that of the 8087 and 80287). Note that each register in the stack is 80 bits wide and holds a number in double extended format. Every number that's loaded into the 80387 is converted to this format on the way in and can be rounded, if desired, to a smaller format on the way out. The large internal format provides a high degree of precision for intermediate results.

A nice feature of this series of coprocessors is their ability to manipulate 16-, 32-, and 64-bit integers (as well as binary-coded-decimal numbers with up to 18 digits) transparently. Numbers in each of these formats can be converted automatically to and from the double extended format during a load or store operation.

The 80x87 registers can each be accessed in one of two ways: by its number (from 0 through 7) or relative to an internal stack pointer. The latter technique

makes it easy to perform calculations as you would on a calculator that uses Reverse Polish notation—and also helps compilers (which typically convert expressions to this notation) generate code. Most 80x87 instructions can operate on the top two elements of the stack and replace the top one with the result; if desired, both of the original operands can be removed (so that only the result remains) by adding a "P" (for pop) to the end of the assembly language mnemonic for the instruction.

The 80x87 instructions are too numerous to list here, but they include (as all IEEE processors must) addition, subtraction, multiplication, division, remaindering, comparisons, and rounding. There are also reverse subtraction and division operations and several transcendentals, such as tangent, arctangent, log₂, and 2^x - 1. This last function, which seems like an unusual one to offer, is handy for raising numbers to powers, since y^x = 2^(x log₂ y).

There were no sine or cosine functions on the 8087 or 80287, but the 80387 has

continued

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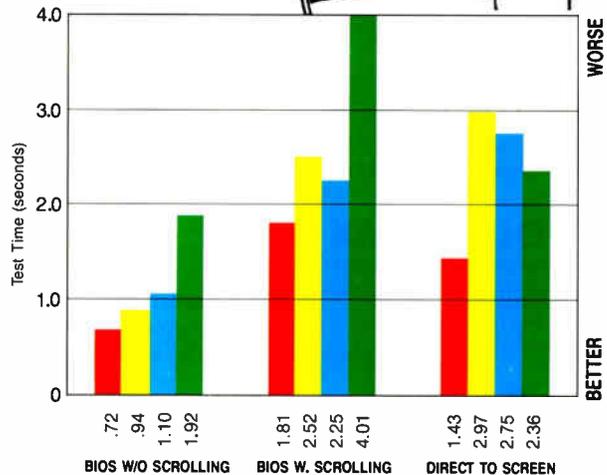
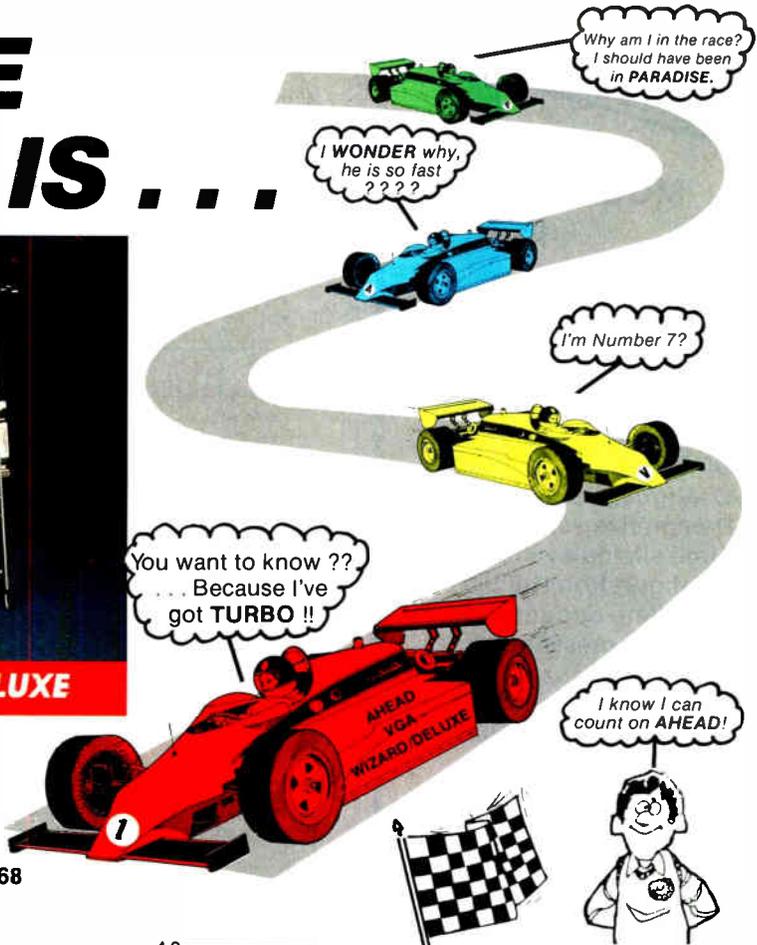
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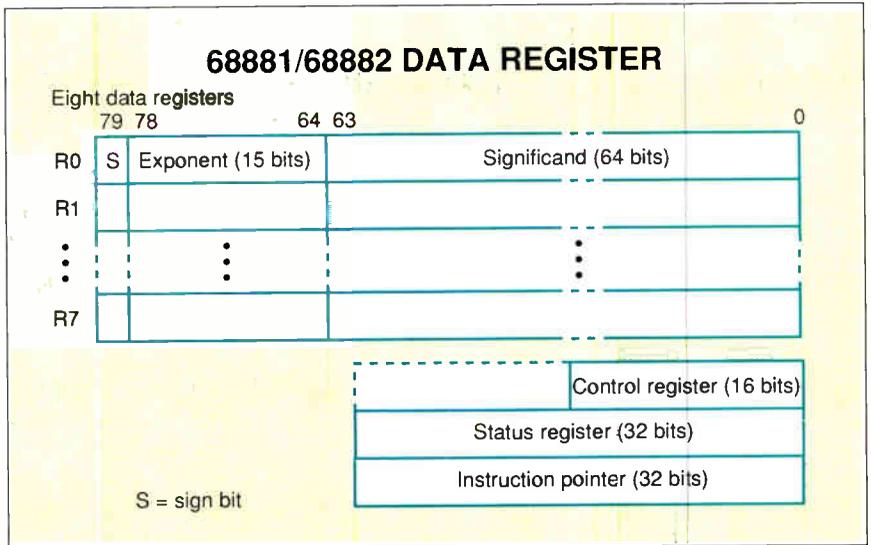


Figure 3: This also has 80-bit-wide registers. The 68000 can manage more than one FPU at a time. The Motorola FPU registers cannot be used as a stack.

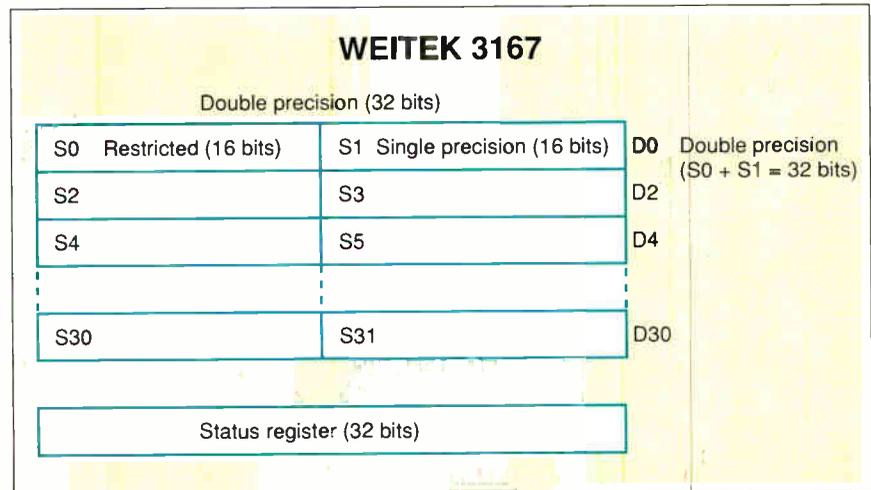


Figure 4: Although the registers are only 32 bits wide, they can be paired for 64-bit operations. There is no provision for double precision extended. The Weitek 3167 uses the address bus for instructions in order to increase throughput.

them, along with a sine and cosine instruction. (This handy operation produces both sine and cosine at the same time, for operations like polar-rectangular conversions.)

Intel has continued to improve its numeric coprocessors. Users report that the 33-MHz 80387 runs faster than a 25-MHz 80387 "pushed" to 33 MHz by increasing the clock speed, indicating that the internal architecture has been sped up between the two versions. And the Intel 80486 contains a built-in coprocessor that's fully compatible with the 80387.

One drawback of the Intel coprocessor

interface is that it doesn't let a single CPU act as the coordinator for multiple floating-point processors. You can't speed up a system still further, or avoid saving contexts during task switches, by adding more math chips, as you can with some architectures.

The Intel Compatibles

Booming sales of Intel math coprocessors have led at least two companies to enter the market with faster compatible chips. Integrated Information Technology recently announced the NP-3C87, an 80387 clone that the company claims

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operates between two and three times as quickly when executing certain 80387 instructions. IIT attributes the speedup to wider internal data paths and algorithmic improvements.

The NP-3C87 also offers two new features: an instruction that performs 4×4 matrix multiplication and more internal registers (a total of 32). The latter feature offers tremendous potential for speedups in some calculations—particularly matrix math—but requires that applications be recoded to use the additional registers.

The NP-3C87 also offers two new features: an instruction that performs 4×4 matrix multiplication and a total of 32 internal registers.

The other new entry comes from Cyrix Corp. Its coprocessor, the 83D87, makes fundamental changes in the way transcendental functions are calculated (see the text box "Polynomials: A New Approach to Transcendentals" on page 340) and performs internal calculations with 10 more bits of precision than the 80387. The Cyrix chip performs the simplest math instructions (e.g., adds and compares) even faster than IIT's chip, using only four cycles of the processor clock; transcendental operations are up to an order of magnitude faster than Intel's. In addition, the chip contains features that will let it operate as a memory-mapped peripheral. This feature can save still more time during loads and stores (at the expense of a little more programming effort) and should let multiple coprocessors coexist in a system.

The Motorola 68881 and 68882

The Motorola floating-point coprocessors, the 68881 and 68882, offer most of the same features as the 80387 and kin, but with a few key differences. (The register model and internal architecture of

the 68881/68882 are shown in figure 3.) First, they don't support the stack mode of the Intel processors, nor do they support 64-bit signed integers (at least not directly). But they do support byte-size quantities, which makes them compatible with all the data types offered by the 68000 family. The Motorola coprocessors also feature some transcendental functions not offered by the Intel models, including one that directly calculates 10^x , hyperbolic sine and tangent. There are also more available constants in the processor's ROM.

Unlike Intel, Motorola didn't make provisions for a math coprocessor extension in the earliest versions of its CPUs. The 68000, the 68008, and the 68010 didn't directly support a coprocessor whose instructions were part of the CPU's instruction stream. (The 68020 and 68030 do contain support for coprocessor instructions.) For this reason, Motorola cleverly designed the 68881 and 68882 to be controlled by memory-mapped I/O cycles that could be generated either by a processor's hardware or by software.

Since the coprocessors use op codes that weren't implemented on the earlier processors, they can trap the floating-point op codes (which cause an exception) and talk to the coprocessor with software. There's a small speed penalty when operating in this mode, but the result is that any microprocessor that uses a bus with Motorola-style timings (including a 6809 or even a 6502) could conceivably be set up to use these math chips.

The coprocessor support built into the 68020 and 68030 allows up to seven math chips to exist in the same system; the number of the coprocessor is part of the op code. This is a useful feature for multitasking systems, where many users might be doing floating-point math. In theory, a smart program loader could patch the executable image so that different tasks on a multitasking system used different coprocessors. This would eliminate the need to save and restore the coprocessor context during task switches.

The 68881 and 68882 have similar architectures. However, the 68882 adds special hardware to perform rapid conversions between external formats and the internal double extended format.

The Weitek Abacus 3167

Weitek makes numeric coprocessors that work with several CPU architectures, including Sun's SPARC and the Motorola family. Its best-seller, however, is the 3167, a single-chip numeric coprocessor

continued

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for the Intel 80386. (An older version of the same processor, the 1167, was implemented with more than one chip on a daughterboard.)

The 3167, like the 1167 (and unlike the other 80386-compatible numeric coprocessors), doesn't use the 80386's built-in coprocessor interface. This lets it coexist with an 80387 (or a clone thereof) in the same system. The 3167 is memory-mapped into a fixed 64K-byte block of the CPU's physical address

space: addresses C0000000 to C000FFFF hexadecimal. The coprocessor interprets reads and writes within this block in an unusual way: The data bus carries the data, if any, and the *address* tells the processor which operation is to be performed! This novel parallel approach is one reason for the 3167's efficiency relative to the 80387.

A block diagram of the 3167's simple register model is shown in figure 4. Its register set can store either 32 single real

quantities or 16 double real quantities. The double extended format isn't supported; this means that the coprocessor doesn't, technically speaking, fully conform to the IEEE specification. It also may cause some loss of precision relative to either the 80387 or its clones, since the result of every operation is rounded back to double real format. This lack of precision isn't a problem for many applications, however, and the Weitek processor is quite fast, so it's gaining support from many compiler and application vendors.

The Weitek's instruction set is lean and mean, and it omits instructions to quickly load useful constants (implemented on other processors in this group). This type of instruction isn't as necessary on the 3167 as it is on the other chips because of the unique coprocessor interface; it doesn't cost anything to put the constant on the data bus while the load instruction is on the address bus. The 3167 also has a class of instruction more commonly seen in signal processors: a multiply-and-accumulate instruction that's useful for fast Fourier transforms (used in digital signal processing) and similar operations.

The Weitek interface also offers another feature that clever programmers are sure to exploit. Because of the encodings of the instructions, which place the source and destination register numbers in the least significant bits of a memory address, the repeated string load and store instructions of the 80386 can be used to perform matrix math. As the address increments, so do the source and destination register locations for arithmetic operations.

There is, however, one real snag involved in using the Weitek coprocessor that programmers and users need to know about. The coprocessor's fixed memory-mapped address is above the 1-megabyte boundary of the 80386's real mode. Thus, any program that wants to use the Weitek coprocessor under DOS must either run in protected mode (via a DOS extender) or in virtual 8086 mode under the Compaq Extended Memory Manager, 386Max, or another memory manager that manipulates the 80386's paging unit. Therefore, developers who wish to exploit the Weitek coprocessor may need to license or write a DOS extender, and some users may need to go out and buy a memory manager. These problems disappear, of course, under Unix and other protected-mode operating systems.

Weitek is currently the only company known to be developing a coprocessor for

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the 80486 microprocessor. The 80486, with its on-board FPU, doesn't implement Intel's external coprocessor interface, so external coprocessors have to be memory-mapped. Chances are, however, that most customers who don't want to use the 80486 FPU will take advantage of the expected drop in 80386 prices and buy a fast 80386 instead.

Internal Architectures

While all the internal architectures of the three company's processors are very different, all perform similar functions in similar ways! Before two floating-point numbers can be added, the mantissas must be shifted so that the bits with corresponding values line up; all the coprocessors contain barrel shifters to do this. Shifters are also used to normalize the results of instructions.

Many operations—especially transcendental—require numbers to pass several times through an ALU, which performs simple additions and multiplications. For this reason, all the architectures are laid out so that the output of the ALU can be fed back to the input through a latch. Each coprocessor also contains a ROM with handy constants for transcendental operations and special-purpose hardware for rounding numbers.

Every floating-point coprocessor in this group is controlled by a *microsequencer*, a control unit that coordinates internal operations by executing microcode (i.e., machine language instructions embedded on the chip). The microsequencer works as a traffic cop for data within the coprocessor, routing everything to the location where it's needed. It also manages communications with the host CPU, which can be a tricky task when the host and the coprocessor are processing data concurrently.

Synchronization

Virtually all math coprocessors can perform floating-point operations while the main processor crunches integers. However, unlike most integer operations, floating-point instructions can take widely varying amounts of time to execute depending on the operand(s) and the state of the processor. This means that a program may not know—anthropomorphically speaking—when it's OK to submit the next instruction to the math chip. Therefore, each system must provide a way to synchronize the CPU with the coprocessor. Usually, this is done by halting the CPU until the coprocessor is ready to accept the next instruction.

The original Intel 8087 required the 8088 or 8086 to execute an instruction

called FWAIT (floating-point wait) before each floating-point operation. If the coprocessor isn't ready when the FWAIT is issued, the CPU simply waits until it is. The requirement for FWAITS was removed in later members of the 80x86 family; in the 80286/7 and 80386/7, a hardware signal lets the CPU know it has to wait before submitting the instruction. Unfortunately, most real-mode compilers generate FWAITS to ensure that the code is compatible with all members of the Intel processor family, resulting in a small but significant performance hit.

The Weitek 3167 looks like memory to the 80386, and it uses the 80386's READY-line to generate wait states if the coprocessor isn't ready to accept an instruction. However, the 3167 has a built-in instruction queue and overlaps execution of successive instructions. Therefore, there's no wait in many cases.

The Motorola coprocessors use a status register to indicate when they're busy. The 68020 and 68030 poll this register automatically with microcode; other microprocessors poll it with software. A certain amount of instruction overlap is also possible in these chips.

Other Chips

It's possible to use chips besides the ones mentioned above to implement or speed up floating-point math. Most of these are autonomous processors that are loosely coupled to the host via memory- or I/O-mapped interfaces; they don't get their commands directly from the host's instruction stream.

The INMOS transputers, for example, are sometimes used as floating-point accelerators in microcomputers. Because transputers can be connected in large arrays with almost arbitrary topologies, they're useful for problems that can be solved by many simple processors working in concert (e.g., computational fluid dynamics and heat transfer).

The transputer comes in several models, and only the most advanced one, the T800, has dedicated floating-point hardware. MicroWay sells boards called the Monoputer and Quadputer, which connect one or four transputers (respectively) to an IBM PC backplane. There's also a board called the Linkputer, which lets the PC reconfigure the interprocessor links on the fly. These boards, while quite expensive, can speed up certain computations dramatically.

The Intel 80860, featured in IBM's Wizard board and some new workstations, is also a complete processor in its own right. However, like the transputer, it makes a useful floating-point accelera-

tor. Some of the more advanced Motorola digital signal processors—rumored to be candidates for future versions of the NeXT Computer—are also good accelerators for floating-point math.

Picking a Math Chip

If you're in the market for a math chip, your choice will depend largely on the kind of CPU you have and the software you expect to run. Generally speaking, the coprocessor manufactured by the same company as the host CPU—or clones thereof—will have the most universal support and the most reasonable prices. You'll probably save on development tools as well if you choose this route; odds are that any compiler you already own will generate code for these chips.

If you're looking to use a more powerful math chip that isn't code-compatible with the CPU maker's coprocessor, you may be able to ensure compatibility by buying chips and development tools from the same source. MicroWay, for example, is the primary distributor of Weitek coprocessors and also sells several compilers to support them.

For the heaviest number-crunching applications, you may wish to look into arrays of external processors, such as the MicroWay Quadputer. If you take this route, however, be prepared to shell out cash for expensive hardware and software to support these boards. ■

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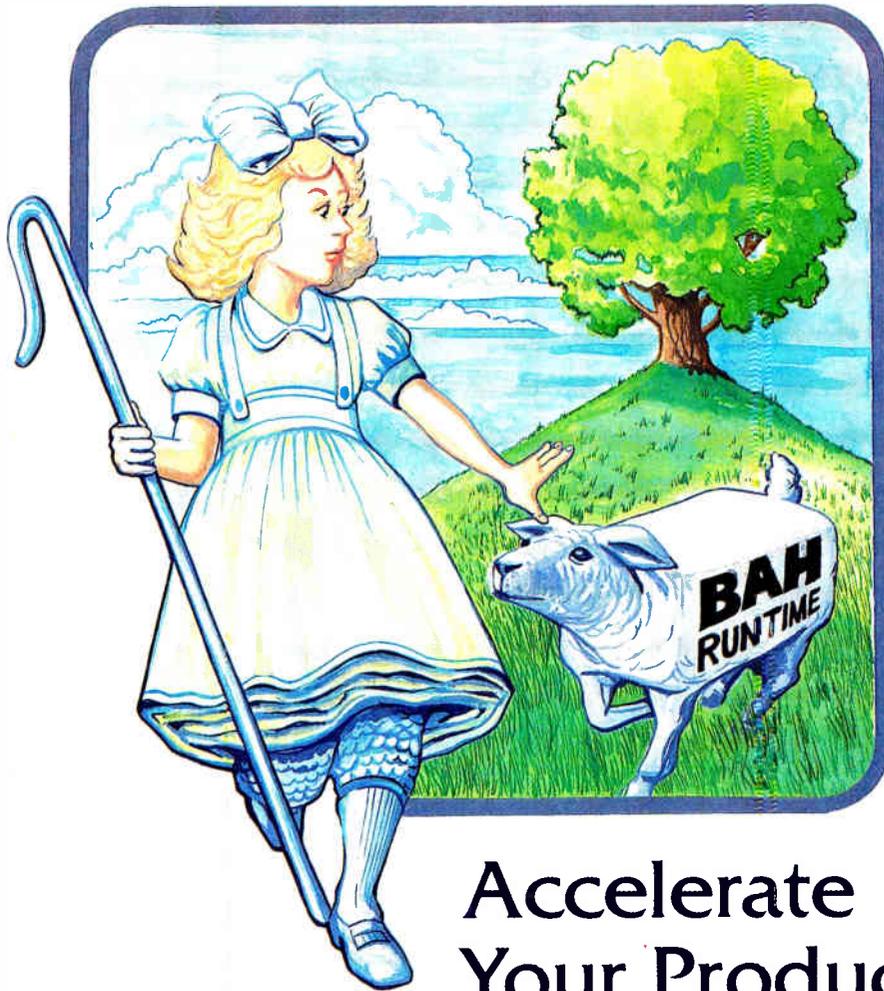
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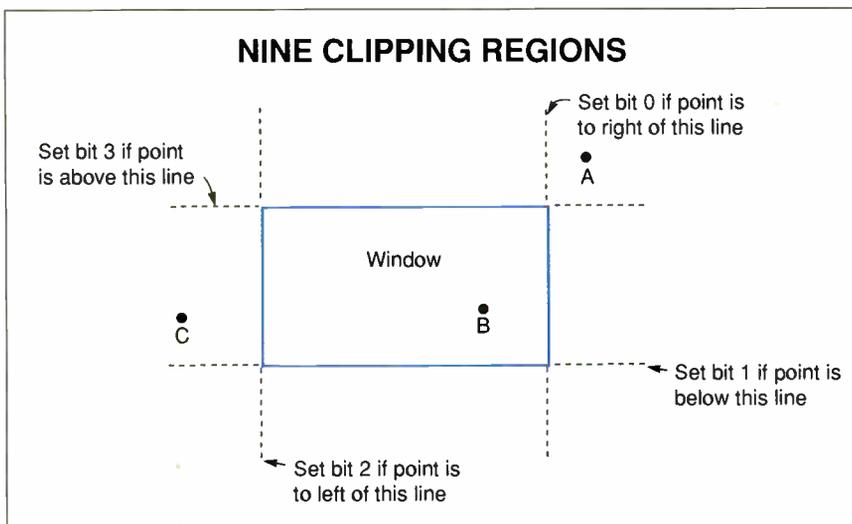


Figure 3: Matching point coordinates with the window boundaries, the graphics software determines where a point lies in relation to the clipping window. So point A would return a clipping code of 1001_2 ; point B, 0000_2 ; and point C, 0100_2 .

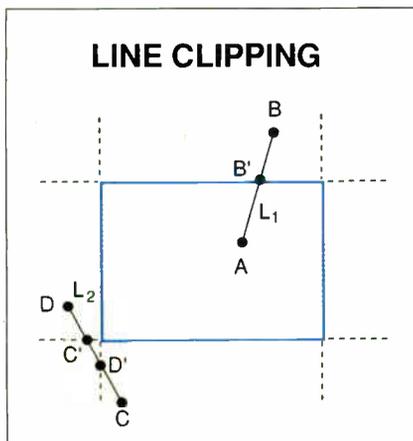


Figure 4: The clipping of line L_1 is successful, since the software can project point B to point B' . The clipping of line L_2 fails—projecting C to C' and D to D' produces a segment that is still outside the window.

software running at the level of lighting pixels on the screen would be working in viewport coordinates. Clipping occurs in window coordinates, and some substantial math takes place in converting from window to viewport coordinates.

Since stroke characters are composed entirely of lines (you'll see shortly that the dot on an i can be coded as a 1-pixel-long line), it is more efficient to clip the line at the window and pass the coordinates of the resulting, shortened segment to the routines that actually draw in the viewport.

The usual technique for clipping lines

begins by splitting the drawing plane into nine regions defined by the borders of the clipping window (see figure 3). When the software examines a line for the purpose of clipping, it determines which of these regions each endpoint lies within and assigns to each endpoint a clipping code. The clipping code is a 4-bit number, with each bit corresponding to a region. The bit settings are arranged so that, by forming the bitwise AND of the codes for a line's two endpoints, software can deduce whether a portion of the line might lie within the window. A code of all 0s indicates that the point lies within the window. The clipping routine therefore follows this procedure:

1. Determine the clipping codes of both endpoints of the line segment.
2. If both endpoints return clipping code 0, the line segment lies entirely within the window. Exit.
3. Form the logical AND of the two clipping codes. If the result is not 0, the line segment lies entirely outside the window. Exit, indicating that the line is entirely invisible.
4. If the result of step 3 is 0, a portion of the line segment may lie within the window. Any endpoint whose clipping code is not 0 is projected (along the segment) to the nearest appropriate window border. Reevaluate the clipping codes and return to step 2.

Step 4 is the most complex, since it in-

volves geometry that can get moderately hairy. If you're deeply interested, see the text box "What's in the Window?" on page 360. Otherwise, just look at figure 4. Line L_1 extends from point A to point B. Since point A is within the window, the software leaves it alone. Point B, however, is above the window, so the software must project it down to the top-most border (to point B'). It is the segment extending from A to B' that actually appears in the viewport.

Even this algorithm can do some wheel spinning. Examine line L_2 in figure 4. When the software evaluates point C, it determines that the point is below the clipping window. So it projects C along L_2 to C' , which lies along the line defining the window's bottom border. Since D lies to the left of the window, the software projects it to D' . The results don't do much for L_2 , and the segment still lies outside the window. This is a special case not covered in the steps I gave above, but the software has to be aware of it. Thus, if after projecting both endpoints to new locations the resulting segment still lies outside the window, the clipping algorithm gives up and marks the line as undisplayable.

Character Building

Bit-mapped characters are easy to construct; they are simply bit patterns copied out of ROM and onto the display screen. A bit set to 1 in graphics ROM appears as a lit pixel on the display. (You can maneuver some pointers on the PC so that the firmware retrieves the character definitions from a user-built table in RAM.) Stroke characters are more abstract; you're not lighting pixels, you're drawing lines. The line command lights the pixels.

My software defines stroke characters as a series of graphics commands that specify the direction and distance of travel for an imaginary pen. The character-drawing routine can also specify whether the pen is raised or lowered. As an example, see the stroke definition for the character B in figure 5. Two commands—MOVE and LINE—are all that the software needs to create the character. Each command takes two arguments: first, the number of pixels to move in the x direction; second, the number of pixels to move in the y direction. MOVE lifts the pen before moving it, while LINE actually draws a line.

Whenever the software is about to draw a character, the pen begins in the lower-left pixel—a position called the *character origin*. To draw a string of

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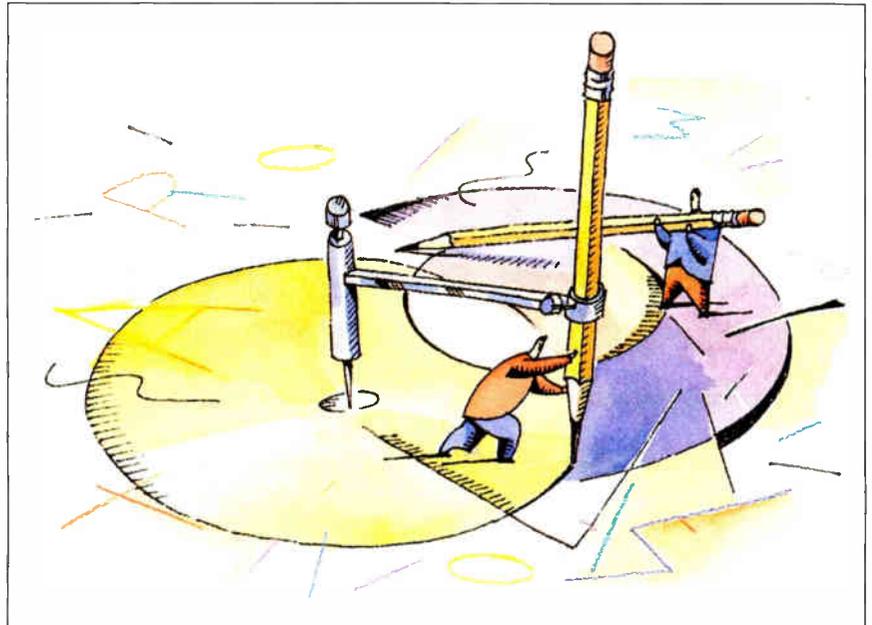
STROKE-CHARACTER GRAPHICS

Stroke characters allow you to easily mix text and graphics

More and more often, text and graphics are sharing the stage on our CRTs. Today's presentation, CAD, and desktop publishing software demand simultaneous text and graphics display. Such demands are already met by some systems: On the Macintosh, the ground-floor primitives that underpin QuickDraw are also used to display text. Other systems carry a legacy of the glass-teletype past. Although things are getting better, on the IBM PC you're usually in either text mode or graphics mode.

The simultaneous presentation of text and graphics on the screen suggests that software combining the two can be simplified if you resolve text display into a series of graphics commands. (CAD software is a good candidate.) This idea feels comfortable; after all, when you pick up a pencil and print a note to yourself, you form the characters out of line segments. You should be able to duplicate that action on the computer: Don't display the character, *draw* it. Then you can use the line-drawing graphics commands that are surely already in whatever graphics package you're using as the low-level drivers for text display.

Characters drawn in this fashion are referred to as *stroke* characters. They are distinguished from the *block* characters (also referred to as *bit-mapped*) that you see when a PC display is in alphanumeric mode (see "The ABCs of Digital Type," November 1989 BYTE). While software displays a stroke character by generating line segments, it forms block characters by copying a bit image (usually kept in ROM) onto the screen. Firmware on the graphics board usually handles block-



character display by scanning screen memory, determining where a particular character is to be displayed, and passing the bit image of the character to the display hardware.

Stroke characters have some distinct advantages over block characters. You can draw stroke characters aligned to any pixel on the screen; typically, block characters must be displayed at character boundaries. Most important on the PC, you can easily mix stroke characters and graphics. The mix is even easier if the graphics package has to perform sizing (zooming in on portions of the graphics), rotation (viewing objects from different angles), or clipping (for multiple windows). Now that I've mentioned sizing and clipping, I can talk about the fundamentals of graphical windowing systems and how stroke characters fit in.

The View from the Window

A *window* is an imaginary chalkboard on which your program does its drawing

(see figure 1). From a mathematical perspective, a window is a rectangular region located somewhere in the (x,y) plane. Your software establishes the window's location by specifying the coordinates of two of the rectangle's opposing corners. In the example given in figure 1, the identifying corners are upper left and lower right. This is how the Mac's QuickDraw describes all rectangular objects—even grafports.

Some graphics packages expect you to define a rectangle by specifying the coordinates of a corner and the rectangle's width and height. This style is used by Presentation Manager and the X Window System, although PM positions the rectangle by its lower left corner and the X Window System by its upper left corner. So much for standardization.

As in real-world windows, the window shown in figure 1 restricts your program's drawing area. Imagine that you've drawn a 10-inch line on a piece of

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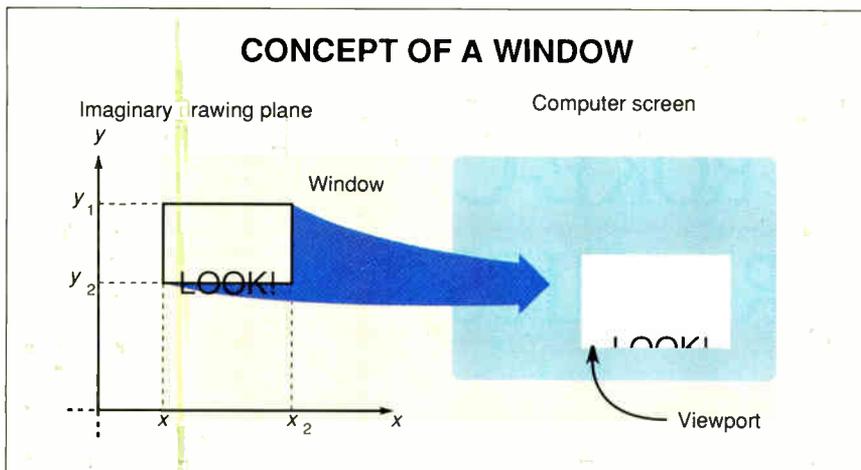


Figure 1: A window defined by the rectangle $((x_1, y_1), (x_2, y_2))$ is mapped to a computer display. Notice that only the part of the text within the window is displayed on the screen.

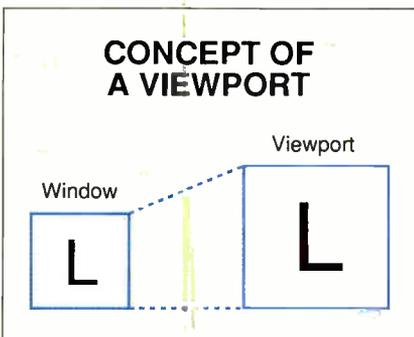


Figure 2: If the viewport area is larger than the window area, objects grow in size accordingly. Software can use this to perform zooming operations.

paper. Now imagine that you've cut a square hole—3 inches on a side—in a large piece of cardboard, and you've laid that cardboard on your drawing paper. Only a portion of your 10-inch line shows through; you have "clipped" the line into a shorter line segment. That hole in the cardboard is a good model of how a window limits what is finally displayed. Often, the window is called a *clipping window*. On some systems, the clipping window is best thought of as a hole through which you can see a portion of a theoretically infinite drawing plane. By moving this hole about on the plane, you reveal different views.

As your program draws inside the window, the results are displayed on the screen. Just where the contents of the window appear is determined by the *viewport*, which is another rectangular region whose location and dimensions are defined in the same way I have de-

finied a window. However, the position and size of the viewport are restricted by the size of your display screen.

The act of copying a window's contents to the viewport does not produce a real "copy" in the sense of data being moved from one place to another. Everything takes place in algorithms that transform or map a window object's coordinates to the corresponding viewport coordinates.

There's no requirement that the viewport's dimensions match the window's dimensions. If the viewport is wider than the window, objects in the window will appear horizontally stretched. A taller viewport will vertically stretch items (see figure 2). So, by varying the ratios between the viewport's dimensions and the window's dimensions, you can magnify or reduce objects that your software has drawn in the window.

Clipping Levels

Clipping is one of those troublesome-but-necessary jobs. Troublesome because what it amounts to is doing a lot of calculations just to figure out what *not* to display (but it's no worse than hidden-line removal, which I will not cover here). Necessary because if you don't do it, you end up with a mess on the screen.

When you talk about text display, it's important to identify just what sort of clipping is taking place. There are three levels of text-clipping precision: string, character, and stroke.

At string-clipping precision, software determines if an entire string will fit in the window. The string is written only if all its characters will fit. String clipping could be handy if you're putting together

a text-editing package and you want to provide word wrapping. Your word processing application could pass single words at a time to the graphics package to be clipped appropriately. Provided that your graphics package is smart enough to return a flag indicating that clipping has taken place, string clipping is also useful whenever you're writing text near the bottom of a window (as in a terminal-emulation package) and you don't want to display a line of text that might get cut off at the hip. So, if the terminal package attempts to display a string and discovers that the string has been clipped, it can scroll the window and re-try the string display.

Character-clipping precision simply means that the graphics software will draw a character only if that character will fit in the window. This is the kind of clipping that takes place on a PC whenever you run text-mode-based window software, since the software addresses character—rather than pixel—locations. Usually, this clipping is implicit; the software first determines whether the character will fit, and, if not, it either wraps the character to the next line or drops it in the bit bucket.

Software that supports stroke precision will clip only those portions of each character in the text that will not fit in the window. Stroke precision is useful in a variety of applications, CAD in particular. You'll also see it used in software that allows panning and zooming operations on text—desktop publishing, for example. Luckily, if the routines that generate text call on line-drawing routines that already support clipping, you get stroke-precision clipping as a freebie. Since that's precisely what the software provided with this month's column does, my stroke-character graphics package uses stroke-precision clipping.

Inside Clipping

Now that you've read so much about it, how do you do stroke-precision clipping? You might try a brute-force approach and simply figure you can add clipping at the lowest level—that is, to whatever routine actually lights a dot on the screen. Whenever a dot was about to be turned on, your software would ask itself whether that dot was within the clipping window. If not, the routine returns without activating the pixel.

But not only is this technique time-consuming (for lines with large portions lying outside the window, a lot of wheel spinning would be going on), but it would also be a real brain twister to code. Any

continued



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characters, you specify the character origin of the starting character. After it draws each character, the software updates the pen location to the next character's origin. (For simplicity's sake, my software assumes that a character fits within an 8- by 8-pixel grid—known as the *font rectangle*—and that the character set is monospaced.)

This arrangement doesn't handle dots for *i* and *j*. I've added this capability by placing a hook in the software so that, when the last command in a stroke character's definition is a MOVE command, the destination of the MOVE is the site of a dot. If you treat a dot as a 1-pixel-long

line, all the clipping and window-to-viewport transformations are preserved.

All the information needed for the character set must be captured into some kind of data structure. I've designed one that carries the essentials; you'll find it diagrammed in figure 6. The *character height* and *character width* variables define the maximum height and width of a stroke character—which also happen to be the dimensions of the font rectangle.

These dimensions serve two purposes: From them, the software can determine where to reposition the pen as it draws each successive stroke. The software also uses the width and height to calculate the size of the rectangle that must be cleared (i.e., filled with the current background color) before a character is drawn. (I've included a transparency flag variable in this month's software. If you set it, the software does not clear the background field prior to drawing the character.)

Information that the software uses to actually draw the character is held in two arrays. The *character pointer* array is a set of integer offsets. Whenever the software wants to draw a character, it resolves that character's ASCII value into an index to that array. The software then uses the pointer at that index as an offset into the *character data* where the commands defining the character begin.

Each drawing command is compressed into a 16-bit word (see figure 7). Two bits hold the command number, 1 is used as a flag to indicate the last command in a series, and the remaining bits

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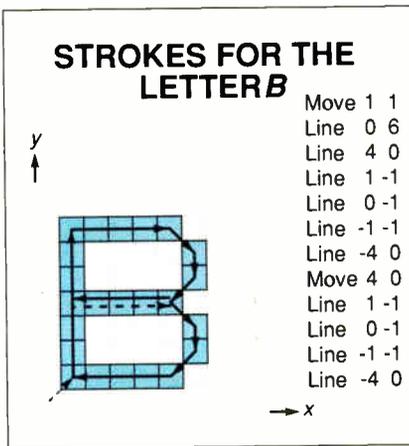


Figure 5: On the left is a stroke character B as it appears when drawn at the normal size. On the right are the stroke commands used to generate the B.

STROKE CHARACTER STRUCTURES

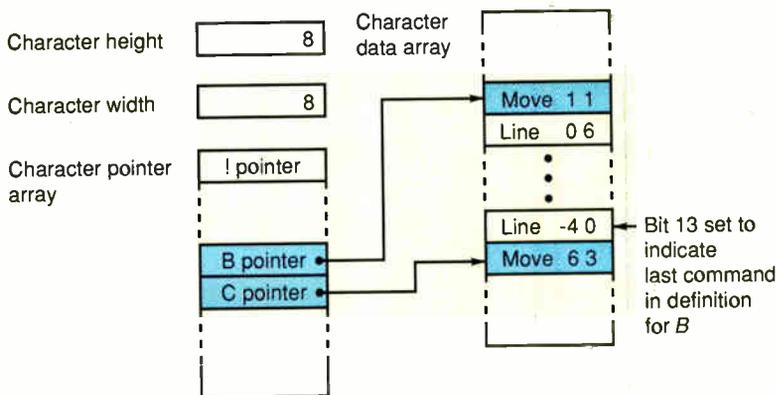


Figure 6: Data structures for defining stroke characters. Each printable character in the character set is associated with a pointer in the character pointer array. Each pointer indicates an offset into the data array where the commands defining the character begin.

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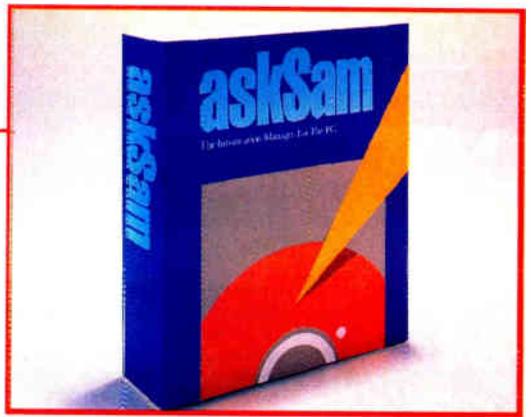
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are divided between x and y distances. Since constructing these arrays can be a kingly pain in the neck, I have built a simple BASIC program that accepts an ASCII file composed of human-readable commands like those appearing in figure 5. It outputs two ASCII files that you can easily combine with your word processor to create a C-compatible include file that holds your custom-made stroke-character set.

Actually, the structure I've defined here is reminiscent of the data structure the Macintosh uses for its fonts; my version is somewhat trimmed down, of course. A font on the Mac is defined by a data structure, called a *font record*, consisting of header information (parameters such as the maximum character width, the width of the font rectangle, and so on) followed by three arrays.

The first array, bitImage[], holds the bit maps of each character defined by the font. You can locate a character's bit-map definition by referring to the next array, locTable, which is an ordered set of pointers equivalent in function to my character pointer array. The final array, owTable (short for offset/width table), serves a couple of purposes. Each entry in owTable corresponds to an entry in locTable, and either holds a -1 (indicating that the character is unprintable) or an offset/width pair. The offset indicates the number of pixels from the left side of the font rectangle to place the character's origin. The width field defines that character's width and thus permits proportional fonts. You can find details of a Mac font record in (where else?) *Inside Macintosh*.

continued

STROKE CHARACTER DATA

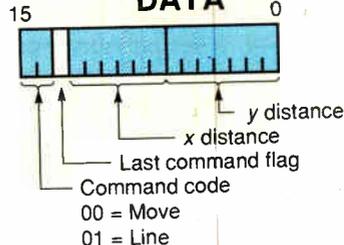


Figure 7: The format of an entry in the character data array. The last command flag is set to 1 to mark the end of a character's definitions. Both the x distance and the y distance fields are stored in two's complement form to allow drawing in negative as well as positive directions.



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What makes a window? It's not what the software draws, it's what the software doesn't draw. Since screens can consist of thousands of pixels, it would be inefficient to examine each pixel prior to lighting it. Most drawing operations can be resolved to drawing lines; consequently, determining what portion of a line lies within the window and drawing only that segment is the essence of clipping.

In figure A, the applications software has requested that a line be drawn from point P_1 to point P_2 . Since both points lie outside the window, the portion of the line that is actually displayed lies between points A and B. Given that you can calculate the coordinates of A and B, you can modify the command to draw a segment from A to B and save having to examine pixels from P_1 to A and B to P_2 .

Fortunately, the math for these cal-

culations is well defined. I've given a bibliography at the end of the article if you want the details. I'll give the results here. For point A, the x coordinate is obviously $XWMIN$, and the y coordinate is given by

$$y = y_1 + \frac{XWMIN - x_1}{(x_2 - x_1)(y_2 - y_1)}$$

For point B, the y coordinate is $YWMAX$, and the x coordinate is

$$x = x_1 + \frac{YWMAX - y_1}{(y_2 - y_1)(x_2 - x_1)}$$

Notice that these calculations require division operations. This means that if you perform the calculations using integer mathematics, you'll want to perform the multiplication first to minimize round-off error. (Of course, it's best if you have a floating-point copro-

cessor, optimize the clipping equations for the coprocessor, and do all calculations using floating-point numbers. This will give you more control over accuracy.)

Once the line is clipped, you will need to scale it from window to viewport coordinates. If you assume that the viewport's rectangle is specified by $(XVMIN, YVMIN)$ and $(XVMAX, YVMAX)$, then the transformation equations are

$$xv = (xw - XWMIN) \times XWPSCALE + XVMIN$$

and

$$yv = (yw - YWMIN) \times YWPSCALE + YVMIN.$$

The quantities $XWPSCALE$ and $YWPSCALE$ are scaling factors. They are given by

$$XWPSCALE = \frac{(XPMAX - XPMIN)}{(XWMAX - XWMIN)}$$

and

$$YWPSCALE = \frac{(YPMAX - YPMIN)}{(YWMAX - YWMIN)}.$$

These scaling factors control how characters swell or shrink, depending on the size of the viewport as compared to the window. Again, if you're doing integer calculations, beware: These factors are represented as fractions; you'll want to multiply them by some constant to preserve accuracy. If you do, you'll have to be careful with the equations for xv and yv above; you'll need to divide by the constant after you multiply by $XWPSCALE$ and $YWPSCALE$. Life gets easier if you use a floating-point coprocessor and do everything in double-precision mathematics.

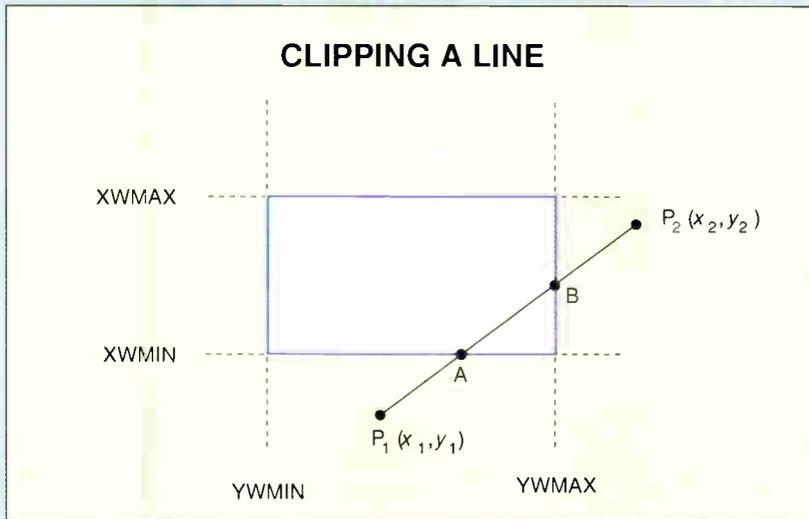


Figure A: Even though the points P_1 and P_2 lie outside the window, a portion of the line connecting the points falls within the window. Only this portion is displayed.

The Plot Thickens

Once you've built your stroke-character set, you can begin exploring the possibilities of varying the character height and width. When you do, you might find that you don't like the results: stroke characters drawn really big stay skinny.

This is, of course, because I've defined a stroke character as a series of endpoints to line segments. Widening the character doesn't make the line thicker;

it simply means that the imaginary pen travels farther when drawing horizontal line segments. You might not mind this, but for very large characters on a screen, the characters' anorexia can get downright distracting. Especially for presentation graphics, thickening the lines composing a character makes its appearance much more appealing.

I know of two techniques for doing this. The first is easily stated: Draw the

character with thick lines. Of course, creating thick lines is not simply a matter of modifying the low-level line routine to light pixels on both sides of the central line. The resulting line routine would not clip properly at stroke precision. (Routines that actually light pixels operate in viewport coordinates. Remember, clipping takes place in window coordinates.) As an example, suppose you used this

continued



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technique to draw a six-pixel-wide line that happened to lie across the top border of the viewport. Some of the pixels would "spill" out above the viewport. Apparently, you have to add clipping at the viewport level.

Software for this technique is easily constructed. Whenever you want to draw a thick line, the software determines whether the line is more horizontal or vertical. For more vertical lines, each time a pixel is lit, adjacent pixels to the

left and right are also lit. For more horizontal lines, adjacent pixels above and below are lit (see figure 8). The effect is that for more vertical lines, horizontal segments are stacked atop one another; more horizontal lines are constructed by stacking vertical line segments beside one another. Since the low-level line-drawing routine draws only vertical or horizontal segments, it's quite easy to construct the routine so that it draws only that portion of the segment that lies within the viewport.

The second technique involves even tighter interaction between routines that operate in window coordinates and routines that operate in viewport coordinates. The idea is to repeatedly draw the character, each time starting at a different origin. A diagram of how this works is shown in figure 9, where the origin steps around the perimeter of a square.

The difficulty here is that the origin of the character is expressed in window coordinates, but generating the adjacent pixels of the origin must take place in viewport coordinates. Again, by the time you're working in viewport coordinates,

continued

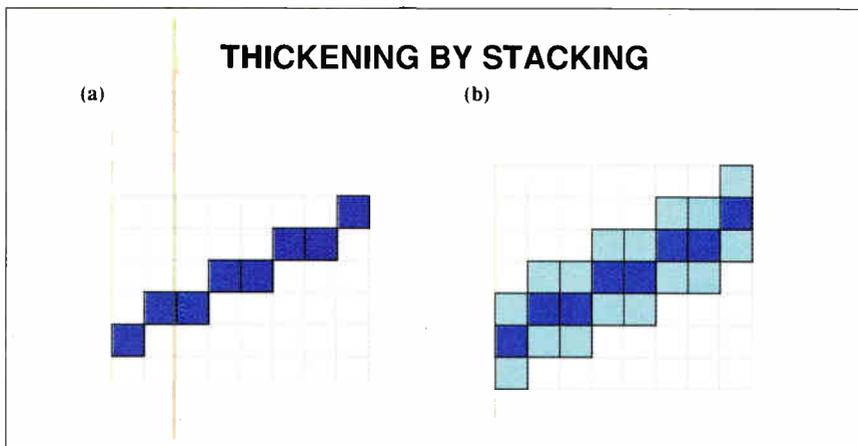


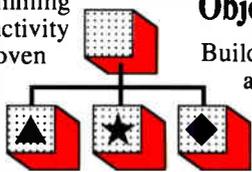
Figure 8: (a) The software draws a 1-pixel-thick line. In order to draw the thick line (b), the software treats each pixel of the line as the midpoint of a vertical line segment. This thick line is composed of vertical segments because it is more horizontal. Thick lines that are more vertical are composed of horizontal segments.

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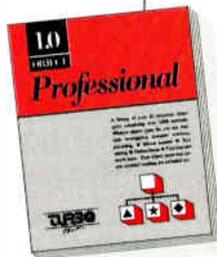
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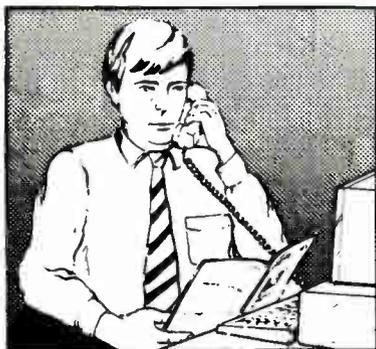
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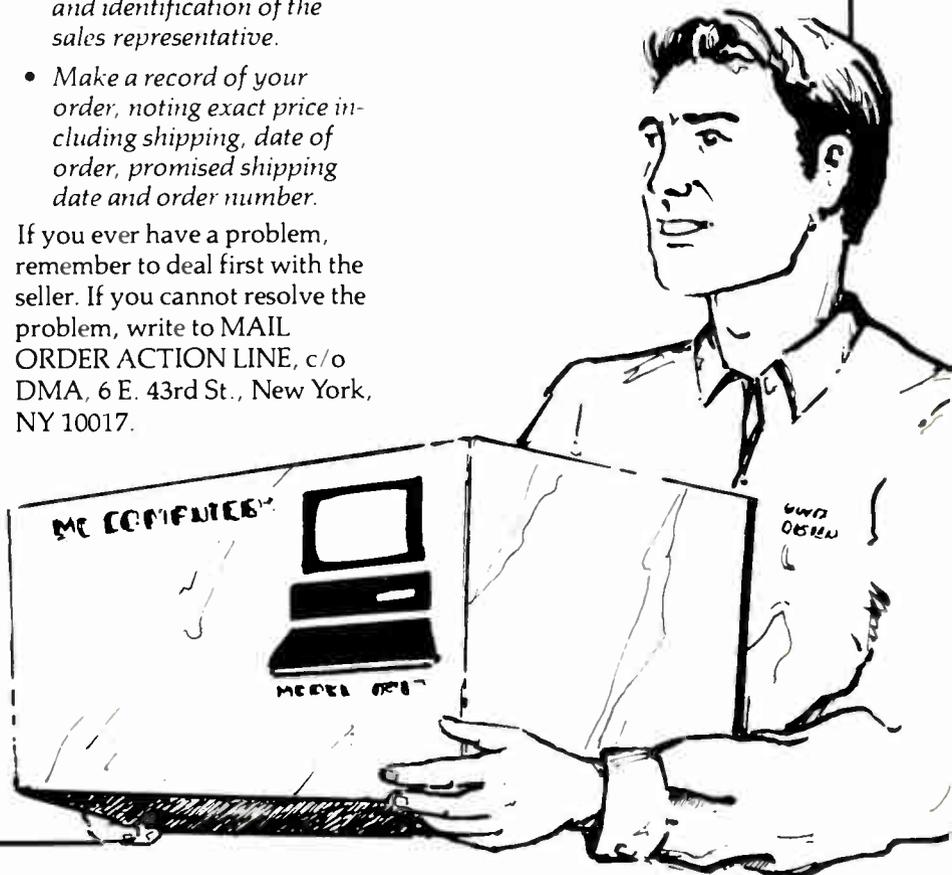
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you're past the clipping that takes place in window coordinates. Therefore, this technique is easiest to apply if you use string- or character-level clipping. Of course, if you dispense with any window-

to-viewport transformations and simply do all your drawing in the viewport, it would be easy to create software to draw thick characters in this fashion.

Notice that you could expand this tech-

nique to allow the user to define a "pen shape." In my opinion, this method is more flexible than the stacked-line-segments method. You could define circular pens for a more rounded appearance, perhaps even a diagonal pen shape for a hint of calligraphy. (The software that accompanies this month's article uses the stacked-line-segments algorithm to generate thick characters.) This technique has a speed problem; a significant number of pixels are redrawn (as many as three times in the example shown). If you decide to create a stroke-character package using this method, you'd be well advised to investigate optimization methods to reduce pixel rewrites.

Stroking Away

Admittedly, stroke characters take longer to display—they must be drawn by software rather than copied by firmware (as in many block-character systems). It's also typical that the data structures needed to define a stroke-character set consume more memory than those for an equivalent block-character set. However, as I've already mentioned, there are a

continued on page 414

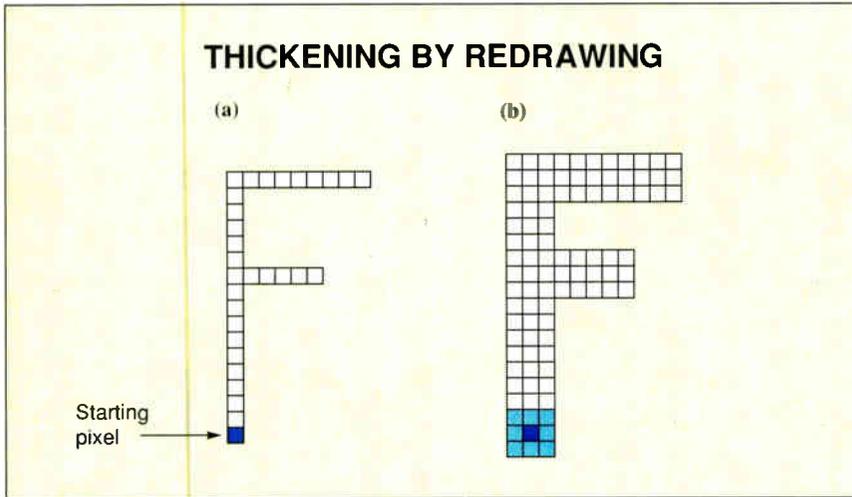


Figure 9: Another route to thicker characters. (a) A 1-pixel-thick letter F. (b) A thick letter F is created by redrawing the 1-pixel-thick character while stepping the starting pixel around the perimeter of a square.

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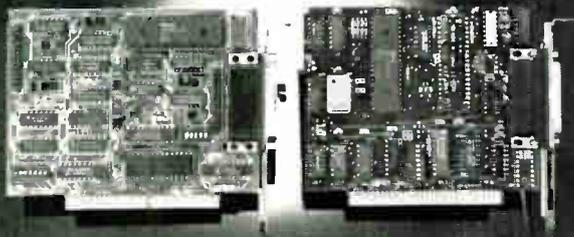
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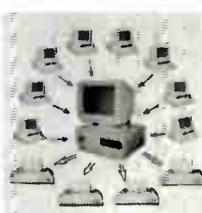
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M8051S



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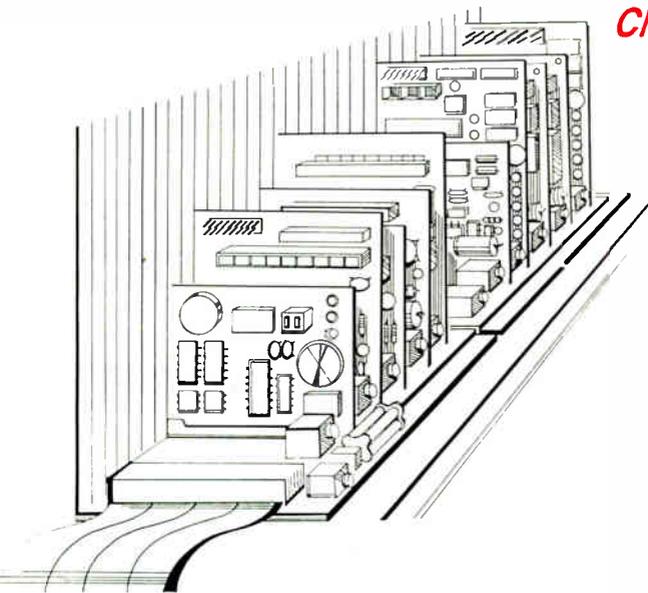
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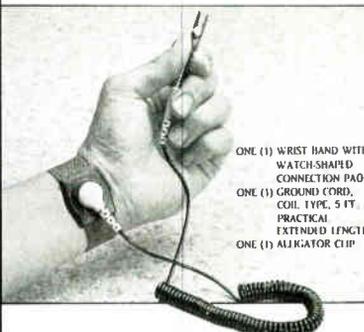
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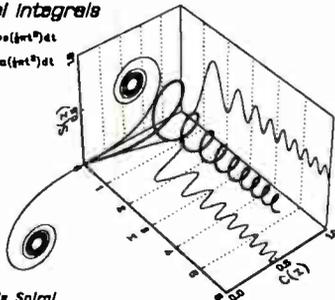
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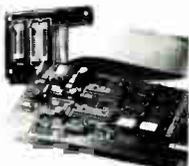
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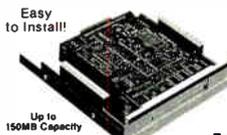


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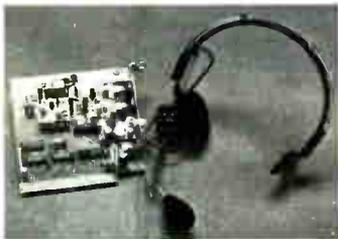
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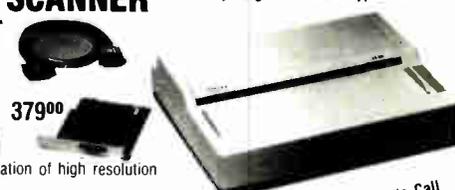
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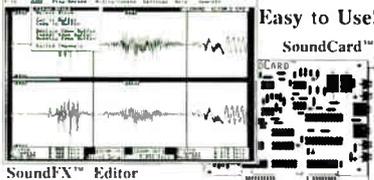
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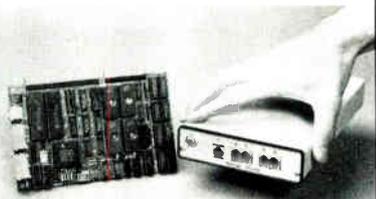
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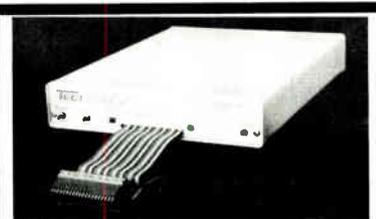


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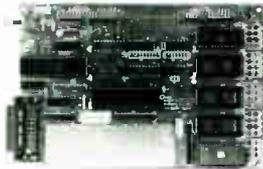
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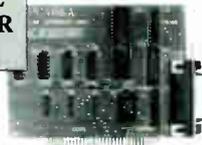
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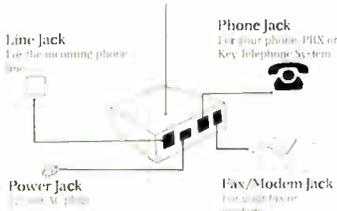
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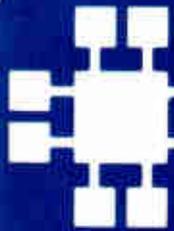
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I stopped recommending CGA display systems to my friends about 4 years ago. At the time, the cost per pixel^{*} was lower for CGA than EGA, and my suggestion was frequently ignored. Now, however, VGA has a lower cost per pixel than either CGA or EGA. In fact you should expect to get about 60% more resolution for your dollar with VGA as compared to CGA.

This isn't just a numbers game. Operator comfort and display presentation are the real key issues. With more and more programs using a GUI (graphical user interface), the need for high resolution color increases.

Reading text on a CGA display is not particularly easy for any length of time. The lines seem to run together and during scrolling the first few lines on the screen flicker.

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If the move to full color VGA isn't in your pocketbook, please let me suggest a monochrome VGA system as an alternate choice. With 16 or 64 levels of gray scale, it is particularly useful for desktop publishing where your printer doesn't do color anyway.

Derick Moore, Director of Engineering
^{*}pixel = picture element, one dot on the screen

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41256-120	262144x1	120ns	16	2.95
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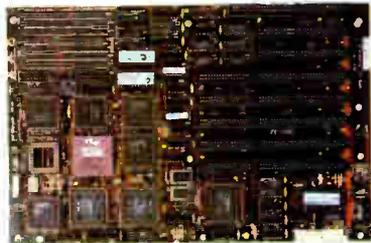


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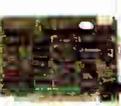
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JANUARY 1990

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PRODUCTS IN PERSPECTIVE:

Short Takes for February will include PC-Kwik OS/2 from Multisoft, TWindows from Mosaic, PowerBasic from Spectra Publishing, PC-Write Lite from Quicksoft, and a new QMS laser printer.

The **Product Focus** will cover third-generation spreadsheets: Access Technology's 20/20 2.33.11; Ashton-Tate's Full Impact 1.1; Borland International's Quattro Professional 1.0; Computer Associates International's SuperCalc5; DacEasy's Lucid 3-D 2.2; FormalSoft's ProQube 1.03; Informix Software's Smartware II Spreadsheet 1.0 and WingZ 1.1; Lotus Development's Lotus 1-2-3 release 3.0; Microsoft's Excel for Windows 2.10, Excel for OS/2, and Excel 2.20; Mosaic's Twin Level III 3.03; and WordPerfect's PlanPerfect 5.0.

Reviews: Don Crabb will give a penetrating analysis of the Macintosh Portable. Continuing in the portable mode, we'll look at the Zenith MinisPort. Our peripheral review will feature Hewlett-Packard's LaserJet IIp, a downsize laser printer that features affordability.

Application reviews will focus on application swappers, programs that help you into and out of other programs. Included will be AutoSwap 1.2 from The Lambda Group, Dr. Switch 1.7 from Black & White International, HeadRoom 2.0 from Helix Software, Software Carousel 3.0 from SoftLogic, and Switch-It 3.0 from Better Software Technology. Also in the lineup is a review of 386Max, a program from Qualitas that can help you maximize your machine's performance by making available otherwise unused RAM.

Penultimately, we'll look at Origins, a fast two- and three-dimensional competitor to AutoCAD on the Mac that's also easy to use. Lastly, Reviewer's Notebook brings us short reviews of these new products: CocoNet, a multitasking, protocol-independent operating system that unifies Unix, Novell, and DOS; two speedy external hard disk drives for the Mac—Cobra 210e from Rodime Systems and MacKIT 140E from Toshiba America; and Zeamon 1.0 from SoftCare Systems, a CP/M type utility program that adds new (or resurrected) commands and wild-card options to the standard DOS and OS/2 command processors.

IN DEPTH:

Our subject this month is **multimedia**, a marriage of the best of image, voice, text, and video processing. Rob Lippincott discusses multimedia today and tomorrow. Phillip Robinson looks at multimedia through the eyes of the various players. Next, Tim Shetler delves into the database design issues for multimedia. And Rick Cook explores how you can make that presentation more exciting now, before the multimedia revolution becomes widespread.

FEATURES:

Jerry Pournelle leads off our Expert Advisors with **Computing at Chaos Manor**. On succeeding pages, David Fiedler brings Unix a step closer to general comprehension with **Unix /bin**, Don Crabb explores the world of the Mac in **Macinations**, Wayne Rash provides the insight of a committed productivity maven in **Down to Business**, Mark Minasi illuminates the dark corners of the next generation of DOS-inspired operating systems in **OS/2 Notebook**, and Bill Catchings and Mark Van Name ponder the evolving connectivity environment in **NetWorks**.

Added to these are two up-to-the-elbows columns for those whose computing horizons want stretching. In **Under the Hood**, Brett Glass looks at SCSI and reveals the workings of this versatile, open interface. For the productivity-deprived, Rick Grehan's **Some Assembly Required** analyzes different tools to put multitasking on your desk.

On top of everything else, there will be articles on **data storage technology**, **object-oriented programming**, and **ray-tracing transputers**. Also, look for our back-of-the-book features, Hugh Kenner's **Print Queue** (more fun with a book review you'll never have) and **Stop Bit**, informed opinions from us, from you, about what's going on with computers.

continued from page 364

number of pros that outweigh the cons.

In addition to desktop publishing and CAD, other uses of a stroke-character set include the definition of characters that might not otherwise be available. For example, you could define an APL character set and—using the transparency flag—even supply overstriking.

Finally, by extending the character pointer array in this month's software to include character-width information, you could easily create a proportional character set. Since a stroke character is defined by MOVE and LINE commands, there's no reason why portions of a character can't extend outside the font rectangle. When part of one character overlaps adjacent characters, it is referred to as *Kerning*.

PGRAF.ASM contains the assembly source code for the low-level line-drawing routines that support thick characters and viewport clipping. Currently, the software supports only CGA modes. PGRAF.C contains Turbo C-compatible source code that provides window and viewport creation and stroke-character drawing. SCHAR.BAS is a GWBASIC-compatible program that accepts an ASCII input file of character-definition commands and produces output that can be included in your C programs for defining custom stroke-character sets. ■

Editor's note: *The 8088 assembly source code for this month's article is available in a variety of formats. See page 5 for details.*

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Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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PRINT QUEUE

Hugh Kenner

The Big Picture

Things do go wrong; does that mean nothing works?

No, Murphy did not say, "If anything can go wrong, it will." What Capt. Edward Aloysius Murphy Jr., a developmental engineer at Edwards Air Force Base, proposed in 1949 was subtly different: If a way to do a job wrong exists, someone someday will do it that way. That was when wild rides on rocket sleds were probing human tolerance for deceleration; and, with Col. J. P. Stapp's life on the line, a technician had installed all the sensors backward. (For what Murphy really said, and how instant perversion of what he really said illustrates Murphy's Law, see Dianna Waggoner's piece in *People*, January 31, 1983, page 81.)

Murphy's Law pertains to human inattention, not to crafty demons circling in the air. His point was that the sensors needed modifying so there'd not be two ways to install them. Lots of common contrivances deserve a Murphy Medal. One thing you can't do wrong with an RS-232C interface—I almost said one of the *few* things—is insert the plug upside down. Beveled housings on plug and socket see to that. Score one for Capt. Murphy.

John Gall's allegiance, though, is to those demons (*Systemantics; The Underground Text of Systems Lore; How Systems Really Work and Especially How They Fail*, General Systemantics Press, Ann Arbor, MI). A bare 6 pages into *Systemantics*, he's quoting Murphy's Law "as it appears on the walls of most of the world's scientific laboratories: If anything can go wrong, it will." That is a variant on the schoolboy adage, "Jellybread always falls jelly-side down," and is readily aligned with Parkinson's various laws (e.g., "Work expands to fill the time available for doing it") and with the Peter Principle ("People rise clear up to their level of incompetence").

Gall rejects what held Murphy's attention, the room that systems tend to offer for human fallibility. No, he's explicit in assuming that

"people are generally doing the very best they know how." But he also notes that, "Systems operate according to Laws of Nature, and Laws of Nature are not suspended to accommodate our human shortcomings." And Gall's Laws of Nature seem tainted with the demonic.

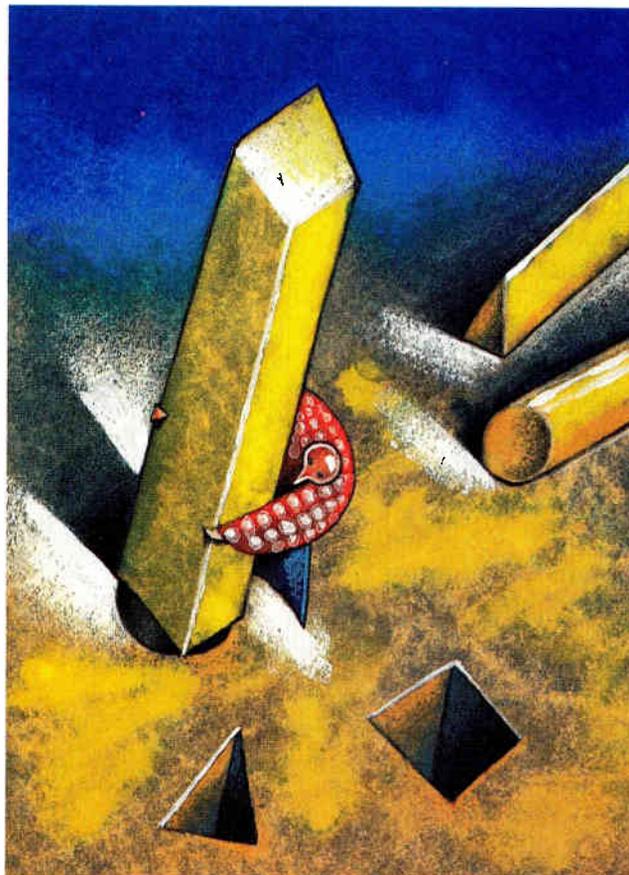
He offers 228 numbered examples of things making no sense. Beltline freeway lacks exit ramp to city. Emergency telephone line runs 3 hours behind; callers put on hold. Hungry nations export food. . . .

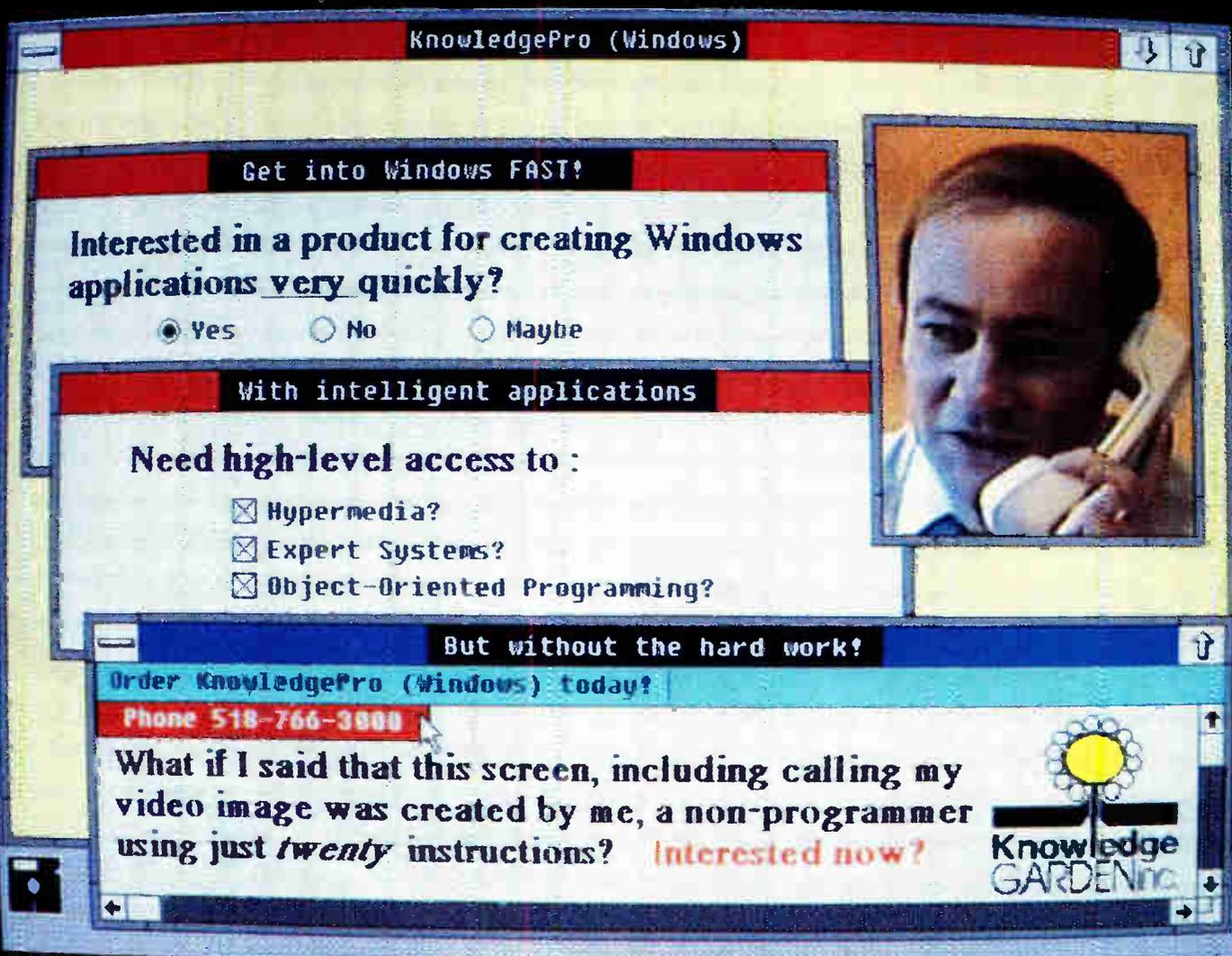
On and on, till your eyes glaze over. Muster, though, a heroic effort of attention, and you may find yourself asking what Gall's list is a list of. For here's "Successful flying machine invented by bicycle makers," and here's "Bankrupt railroad system continues to fail under government auspices." And my response to the Wright Brothers item is, "Why not?," and to the Amtrak item I say, "What magic did you expect from a change

of auspices?" And as for "A. G. Bell invents telephone, retires to phone-free island," well, Bell thought he'd invented a business machine, which no more belonged in the home than did a cash register. Those are items planted to set the unthoughtful tittering. And when Gall wants a *nervous* titter, he draws on nuclear plants, especially that standby, Three-Mile Island.

It's a known scenario. Although I've never experienced the presence of L. J. Peter, I did once hear C. Northcote Parkinson lecture. That was a disconcerting afternoon; although he claimed to be offering a heretic's social insights, Professor P. relentlessly played everything for laughs. One of his running gags was to exempt from each bleak formulation the college that happened to be his host that day. "Regardless of work to be done, institutions expand at a steady rate; *except of course* at the University of California, Santa Barbara."

continued





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That brought down the house once or twice, but then it wore thin. After half an hour, he'd convinced me that his whole structure of laws amounted to just a profitable shtick.

Likewise, reading through Gall's book, I grew more and more skeptical about his "Laws of Nature" being anything save "Laws of Human Nature," Murphy's Law in its pristine form a salient case. Gall is witty sentence by sentence, and his whole book is so elaborately organized it becomes in itself a send-up of a system, purporting as it does to give you what it also says cannot exist, ways to beat a system's penchant for failing.

It feeds, too, tacitly, on our hunger for overviews. For we've ample experience of systems going wrong—the mail misdeliv-

I f doing
a job wrong is possible,
someone sometime
will do it wrong.



ered, the rule-book misread—and some GTF (general theory of failure) would be a comfort. Still, I incline to credit Murphy with putting it best: If doing a job wrong is possible, someone sometime will do it wrong. (Last September, a travel agent in Limerick, Ireland, tried to ticket me from Shannon to where my car was parked at Dulles International Airport in Washington, D.C. Every piece of paper I carried—yes, the ticket itself—said plainly "Dulles." But I ended up at Washington National, a \$50 taxi ride from Dulles. We don't need a GTF to explain one Irishman's ignorance of D.C. geography.)

We're nonetheless embedded in the Age of the Overview. Arno Penzias, Bell Labs vice president for research, has written *Ideas and Information: Managing in a High-Tech World* (Norton, New York). Penzias tells us about information; about numbers, words, and pictures; about rules; about six or seven other topics, too. Always informative and always clear, his anecdotal approach affords a sturdy bridge into a couple of more formal texts.

Thus, Penzias discussing rules quotes Dr. P. C. Wason, a British psychologist, to the effect that most people overestimate their ability to apply logic to a problem. Example: Cards numbered 2, 4, 3, 7, and the claim, "If there's a 2 on one side, there's a 7 on the other." How many cards need you turn over to test the claim? Everyone sees you must turn over 2 to check for 7, and then 4 and 3 to eliminate a lurking 2. Five people out of six next turn over the 7, not grasping how the rule says nothing about what's behind a 7: how in saying *if*, it avoids *if and only if*. "Mathematicians," Penzias remarks, "make logic a full-time occupation." That doesn't make logic essential to people in general, most of whom (outside of Congress) solve real-world problems pretty well.

Now turn to *The Computer and the Mind* by Philip N. Johnson-Laird (Harvard University Press, Cambridge, MA), a big, ambitious, scrupulously written book that surveys what we learn about human cognition when we apply models from computer science. And here (page 225) is a variant of the card problem, with Wason duly cited; here too is a quick version of a real-world equivalent, which anyone solves with ease; finally, a

general conclusion: that purely formal theories of human reasoning have "severe problems." Penzias would not dissent. But the thrust of the Penzias book concerns how a science-man (himself) thrives in an environment of science. Johnson-Laird, though, is interested in models of anyone's mind; models computing shortcuts need not always fit. Bigger picture, you see.

A continual Johnson-Laird paradigm runs, "We do this. Now program a robot to do it." We can leave home and get back. (The robot resource is a "pushed" stack of directions, to be "popped" as it's retraced.) We can perceive (and in depth!) and identify objects. (The intricate robot resource entails layers of lifetime experience—knowledge squirreled away, retrieved at need.) By page 305 we're hearing about Grammar, "a finite set of rules that characterizes all the sentences in a language," the way Niklaus Wirth's syntax rules shape every possible Pascal program. Grammar, Naom Chomsky showed, cannot be acquired by stimulus and response, the way a dog learns to keep off the sofa when it's swatted enough. We draw on something, so to speak, in ROM: an innate paradigm, called by Chomsky a Language-Acquisition Device (LAD). That's innate? Then we don't enter the world as blank slates for experience to write on? Yes, that is what's being claimed, and via computer analogies. A rich book, recommended.

Finally, here's James R. Beniger's *The Control Revolution: Technological and Economic Origins of the Information Society* (Harvard University Press), an effort to (I oversimplify) trace everything that matters now from the nineteenth century growth of bureaucracy (systematic control). A bureaucracy (a Chinese invention) is hundreds of little men in shirtsleeves sitting at desks. A computer is one little man in shirtsleeves ensconced in a box. But you see the family resemblance.

Beniger's tables are fascinating. The first ("Modern societal transformations identified since 1950") starts with Riesman's *Lonely Crowd*, after 16 items has arrived at McLuhan's *Global Village* (1956), achieves computerized society by 1970, and deep on the second page is into the information age (Wilson P. Dizard Jr., 1982). Or here's information processing and distribution, near the start of which pay telephones are being installed widely (1891), transatlantic wireless is in place by 1907, the feds approve the Pitney Bowes postage meter in 1920, transatlantic airmail commences in 1939. Just how long the control revolution has been going on is astonishing. Or, finally, a span concerning marketing carries us from a 500-page Sears catalog (1894) to a drive-in Dairy Queen of 1939. About midway—1916—the first Piggly-Wiggly store opens, "a maze with turnstiles" that forced customers to pass all goods on display. (And the Book-of-the-Month Club? 1926.)

The more you read in Beniger, the more you deduce that Americans have lived inside a pinball machine for over a century, and that computerization is just a huge effort to control the pinball's randomness. "Toward a Generalized Hardware of Control" is the title of one of his last sections. That's a hint that we ought to be worrying about control.

But if John Gall's *Systemantics* has convinced us that no system can work, then why worry?

Except that, just yesterday, I wrote a program that works. No, it doesn't threaten you. But it works. Is that perhaps ominous? ■

Hugh Kenner is a professor of English at Johns Hopkins University. His reviews have appeared in publications like the New York Times and Harper's. His recent books include A Sinking Island and Mazes. He can be contacted on BIX as "hkenner."

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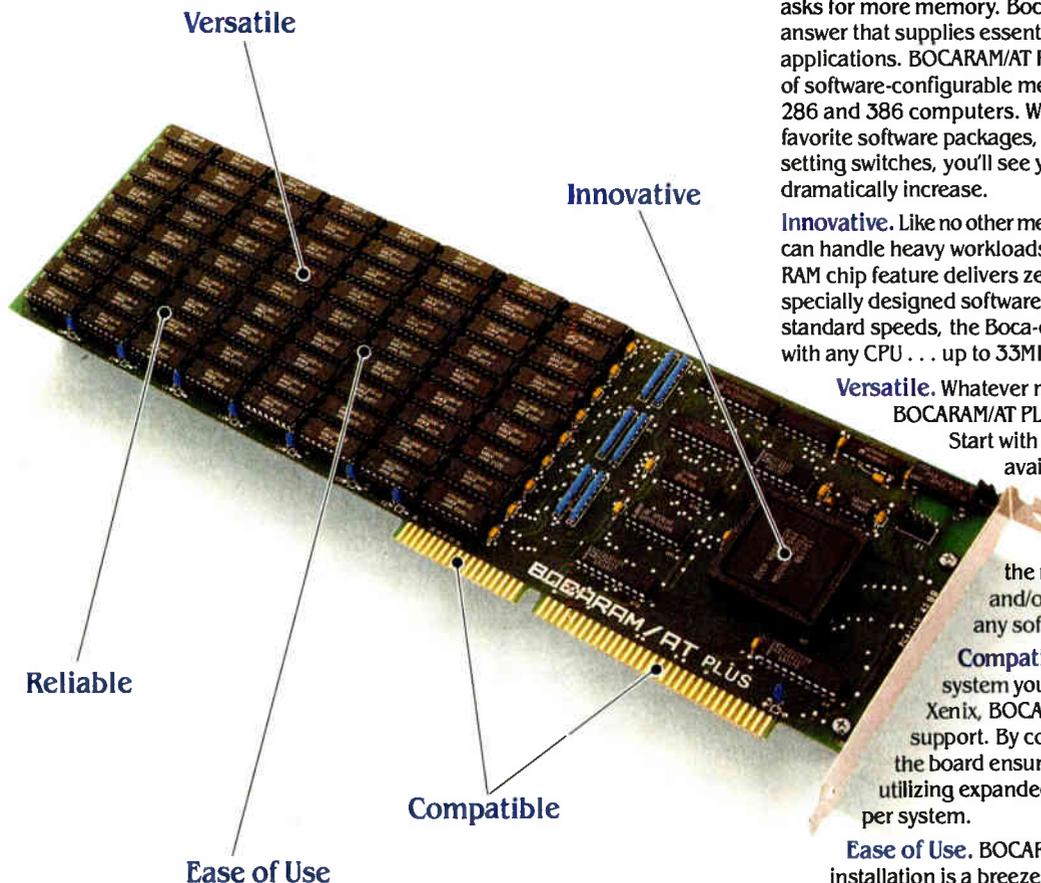
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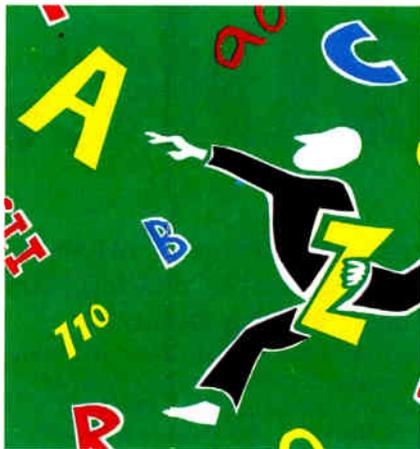
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TIME TO REPLACE ASCII?

Yesterday's character set is no match for today's computers

Place the following terms into descending order: *aardvark*, *AJ*, *Zany*, *A*, and *AZURE*. You probably came up with the following order:

- A)
- AJ
- aardvark
- AZURE
- Zany

Unless, of course, you're using ASCII as a model, in which case your list is as follows:

- A)
- AZURE
- AJ
- Zany
- aardvark

Created by Robert W. Bemer in 1965, ASCII (which stands for American Standard Code for Information Interchange) came about in response to the needs of the time. Bemer created a 7-bit standard set of characters to match bit-oriented programming with the architecture of existing computers. As a result, he defined the digits 0 through 9 so that the 4 low-order bits would equal their binary values. The alphabet is represented twice

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within the character set: All uppercase letters come before all lowercase, and the 5 low-order bits yield the position of the letter in the alphabet. There are 26 letters but 32 possible 5-bit values, so six symbols were inserted between uppercase and lowercase.

In fact, ASCII uses punctuation marks and operator symbols to fill in all the gaps created by bit-aligning the various character groups. The less-than, equal-to, and greater-than symbols are between the digits and the uppercase alphabet. The slash, used for division, is just below zero, but the backslash is in the gap between uppercase and lowercase.

In the 8-bit ASCII set (ASCII-8), the discontinuities continue. Symbols for greater-than-or-equal-to and less-than-or-equal-to were added miles away from less-than and greater-than and in reverse order. The symbol for division was added, while multiplication and the not-equal-to symbol, used in all programming languages, were not.

In case you don't believe that ASCII causes problems, let me give you the ABCs (that's Ada, BASIC, and C) of compound delimiters. Compound delimiters are used in programming languages when a single appropriate symbol does not exist. C uses `>=` for greater-than-or-equal-to, as does BASIC, which also allows `>=`. Ada accepts `>=` but uses `=>` for "arrow." Everyone knows that "arrow" in C is `->`, just as everyone knows that `!=` is not-equal-to in C, whereas `/=` is not-equal-to in Ada but would mean assignment-with-division to a C compiler. The symbol for not-equal-to in BASIC is `<>`, which Ada calls a box and which has no counterpart in C, which uses `--` to indicate decrement, even though Ada would think it meant "comment." BASIC calls comments "remarks" because, remarkably, comments in C are `/*` (division and multiplication).

The problems inherent to languages based on ASCII won't be acknowledged until programs start collapsing under

their own weight, like beached whales.

In spite of the recent delays, none of the software firms seems to have noticed that the tide is on its way out. The Japanese have been criticized for their lack of software expertise, yet they have recognized the importance of character sets in the TRON project (April 1989 BYTE), which has both 8-bit and 16-bit sets. The world looks to the U.S. for software leadership, so explain why, in word processing searches, I have to press Control-R for "Return" because pressing the *real* Return key causes a search to begin.

It's time to develop a character set that is more closely matched to the computer architectures of the 1990s. Creating an appropriate character set would require matching the binary representation and sequence of the characters to the manner in which those characters are used in today's computers. Naturally, the set would be extensible. The alphabetic characters would begin directly after the digits, making both decimals and hexadecimal bit-maskable to their binary values. Multiplication and other operator symbols common to all programming languages would be included in the set, eliminating the need for compound delimiters. As much as possible, the set would expedite checking by ranges instead of by tables. Compiler design and application development would be greatly simplified.

The computer industry is looking to object-oriented languages and RISC processors to increase the efficiency of both the computer cycle and the software development cycle. I just read that the Intel 80486 microprocessor includes decimal arithmetic instructions with ASCII adjust. Now, how do you suppose it will alphabetize *aardvark*, *AZURE*, and *Zany*? ■

Rip Collins is an author who is currently working on a book titled Beyond Artificial Intelligence. He can be reached on BIX c/o "editors."

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