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BYTE

JUNE 1989

A McGRAW-HILL PUBLICATION

REVIEWS

Mac SE/30
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6 16-bit VGA Cards
Tandon and FiveStar 80386s
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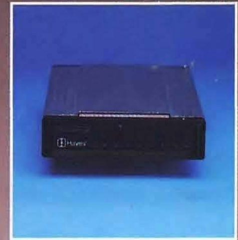
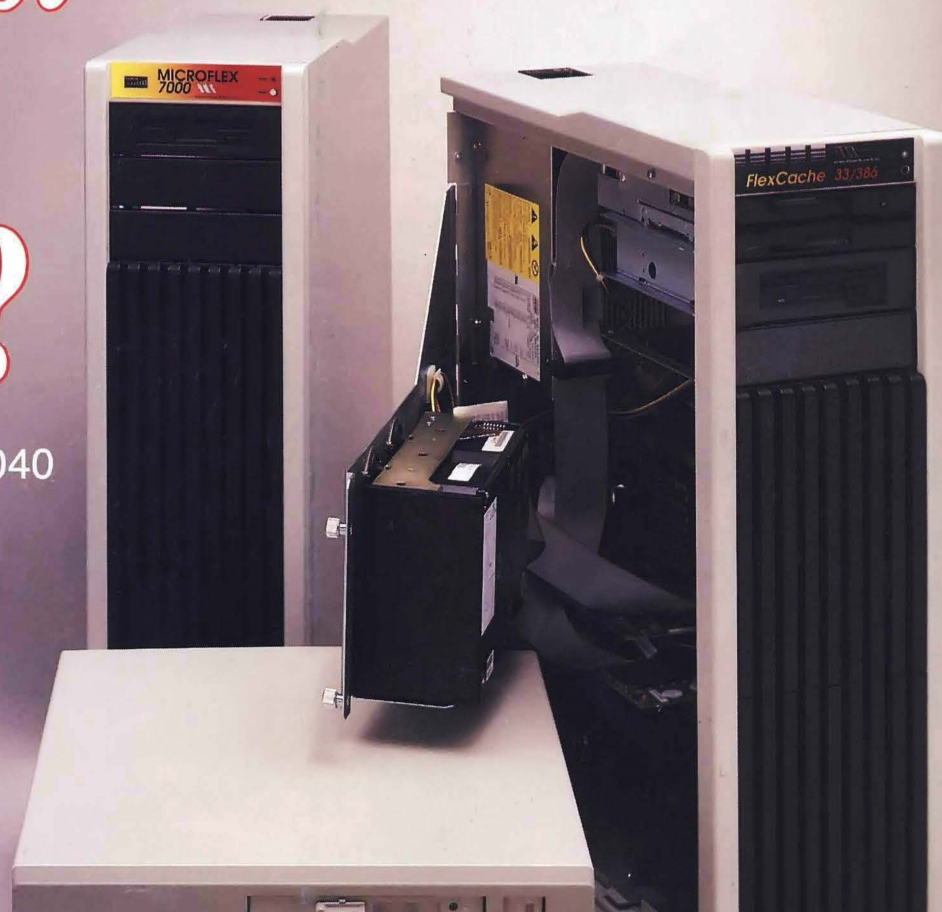
PRODUCT FOCUS



17 High-Speed Modems

The *Fastest* 386s Ever?

ALR's New 33-MHz, MCA, and SX Machines



The 80486 and 68040 Compared

IN DEPTH

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Printer System 300: $199.95.
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STANDARD FEATURES:

PC MAGAZINE EDITOR'S CHOICE

"You will have to look far and wide to find a better price-performance package for the power user that is lurking inside you."
November 29, 1988

- Intel 80386 microprocessor running at 20 MHz.
- Choice of 1 MB or 4 MB of RAM* expandable to 16 MB using a dedicated high speed 32-bit memory slot.
- Advanced Intel 82385 Cache Memory Controller with 32 KB of high speed static RAM cache.
- Page mode interleaved memory architecture.
- VGA systems include a high performance 16-bit video adapter.
- Socket for 20 MHz Intel 80387 or 20 MHz WEITEK 3167 math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Dual diskette and hard disk drive controller.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 200-watt power supply.
- 8 industry standard expansion slots.

OPTIONS:

- 20 MHz Intel 80387 math coprocessor.
- 20 MHz WEITEK 3167 math coprocessor.
- 1 MB or 4 MB RAM upgrade kit.
- 2 MB or 8 MB memory expansion board kit.

***Lease for as low as $135/Month.*
Extended Service Plan pricing starts at $251.

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	TTL Mono		VGA Color Plus	
Hard Disk Drives	1 MB RAM	2 MB RAM	1 MB RAM	2 MB RAM
40 MB-29 ms IDE	$3,699	$3,898	$4,199	$4,398
90 MB-18 ms ESDI	$4,199	$4,398	$4,699	$4,898
150 MB-18 ms ESDI	$4,699	$4,898	$5,199	$5,398
322 MB-18 ms ESDI	$5,499	$5,698	$5,999	$6,198

DISCLAIMER: *All systems are photographed with optional extras, which some computer retailers won't even recognize.*

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All Dell laser printers come with 1.5 MB RAM, full-page 300 DPI graphics, and have 31 standard fonts (7 resident and 24 downloadable from diskette). Dell laser printers also provide Hewlett-Packard LaserJet Plus,^ Epson/FX,^ IBM Proprinter^ and Diablo 630^ emulations.

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25 MHz 386.

When you need the highest-performance 386 computer, this is it.

STANDARD FEATURES:

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- Advanced Intel 82385 Cache Memory Controller with 32 KB of high speed static RAM cache.
- Page mode interleaved memory architecture.
- VGA systems include a high performance 16-bit video adapter.
- Socket for 25 MHz Intel 80387 or 25 MHz WEITEK 3167 math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Dual diskette and hard disk drive controller.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 200-watt power supply.
- 8 industry standard expansion slots.

OPTIONS:

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- 25 MHz WEITEK 3167 math coprocessor.
- 1 MB or 4 MB RAM upgrade kit.
- 2 MB or 8 MB memory expansion board kit.

***Lease for as low as $199/Month.*
Extended Service Plan pricing starts at $370.

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Hard Disk Drive	VGA Mono		VGA Color Plus	
	1 MB RAM	2 MB RAM	1 MB RAM	2 MB RAM
40 MB-29ms IDE	$5,499	$5,698	$5,799	$5,998
90 MB-18 ms ESDI	$5,999	$6,198	$6,299	$6,498
150 MB-18 ms ESDI	$6,499	$6,698	$6,799	$6,998
322 MB-18 ms ESDI	$7,299	$7,498	$7,599	$7,798

THE DELL SYSTEM 220
20 MHz 286.

It's fast as most 386 computers. But at less than half the price. The footprint is small, too.

STANDARD FEATURES:

- 80286 microprocessor running at 20 MHz.
- 1 MB of RAM* expandable to 16 MB (8 MB on system board).
- Page mode interleaved memory architecture.
- LIM 4.0 support for memory over 1 MB.
- Integrated diskette and VGA video controller on system board.
- Socket for Intel 80287 math coprocessor.
- One 3.5" 1.44 MB diskette drive.
- Integrated high performance hard disk interface on system board.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports (integrated on system board).
- 3 full-sized industry standard expansion slots available.

OPTIONS:

- External 5.25" 1.2 MB diskette drive.
- 3.5" 1.44 MB diskette drive.
- Intel 80287 math coprocessor.
- 1 MB or 4 MB RAM upgrade kit.

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Extended Service Plan pricing starts at $264.

System 220	With Monitor			
Hard Disk Drives	VGA Mono		VGA Color Plus	
	1 MB RAM	2 MB RAM	1 MB RAM	2 MB RAM
40 MB-29 ms IDE	$2,999	$3,198	$3,299	$3,498
100 MB-25 ms IDE	$3,599	$3,798	$3,899	$4,098

THE DELL SYSTEM 200
12.5 MHz 286.

This full-featured 286 computer runs at 12.5 MHz, and is completely Microsoft MS-DOS and MS OS/2 compatible.

STANDARD FEATURES:

- 80286 microprocessor running at 12.5 MHz.
- 640 KB of RAM expandable to 16 MB (4.6 MB on system board).
- Socket for Intel 80287 math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Dual diskette and hard disk drive controller.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 200-watt power supply.
- 6 industry standard expansion slots.

OPTIONS:

- Intel 80287 math coprocessor.
- 512 KB RAM upgrade kit.
- 2 MB RAM upgrade kit.

Extended Service Plan pricing starts at $166.

System 200	With Monitor & Adapter	
Hard Disk Drives	VGA Mono	VGA Color Plus
40 MB-40 ms	$2,499	$2,799
40 MB-28 ms	$2,699	$2,999
90 MB-18 ms ESDI	$3,199	$3,499
150 MB-18 ms ESDI	$3,699	$3,999
322 MB-18 ms ESDI	$4,499	$4,799

****Performance enhancements (Systems 325, 310 and 220): Within the first megabyte of memory, 384 KB of memory is reserved for use by the system to enhance performance.***

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For us, however, fast enough is not enough. By utilizing an Intel® 82385 Cache Memory Controller, page mode RAM and interleaved memory, the 310 not only delivers the aforementioned speed, but enough horsepower to do everything from CAD/CAM to mega-spreadsheets to databases the size of the Manhattan Yellow Pages.

It even has the umph to work as a network file server.

TELL US WHAT TO DO NEXT.

As much as the System 310 has to offer, it doesn't even begin to reach its full potential until after we've heard your input.

For it's only in this way that we're able to custom configure every 310 system. To give users exactly what they need. No more. No less.

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Storage? You can have a 40 MB hard drive. Or choose a 90, 150, or 322 MB ESDI drive.

The System 310 comes standard with 1 MB of RAM. Want more? We can add as much as 8 MB to the system board.

Still not enough? We can add another 8 MB by installing a high-speed memory expansion board. You can even run your System 310 as either a MS-DOS,® OS/2 or UNIX® system.

The same holds true for monitors. You can choose between VGA mono with paperwhite screen, or VGA Color Plus, for high resolution colors on a larger screen.

The point here is that when you order a System 310, you not only get a 386-based system that's incredibly fast, powerful and versatile, but incredibly personal as well.

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There are two times when it can be pure hell to deal with a computer retailer.

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Getting after-the-sale service isn't always easy either.

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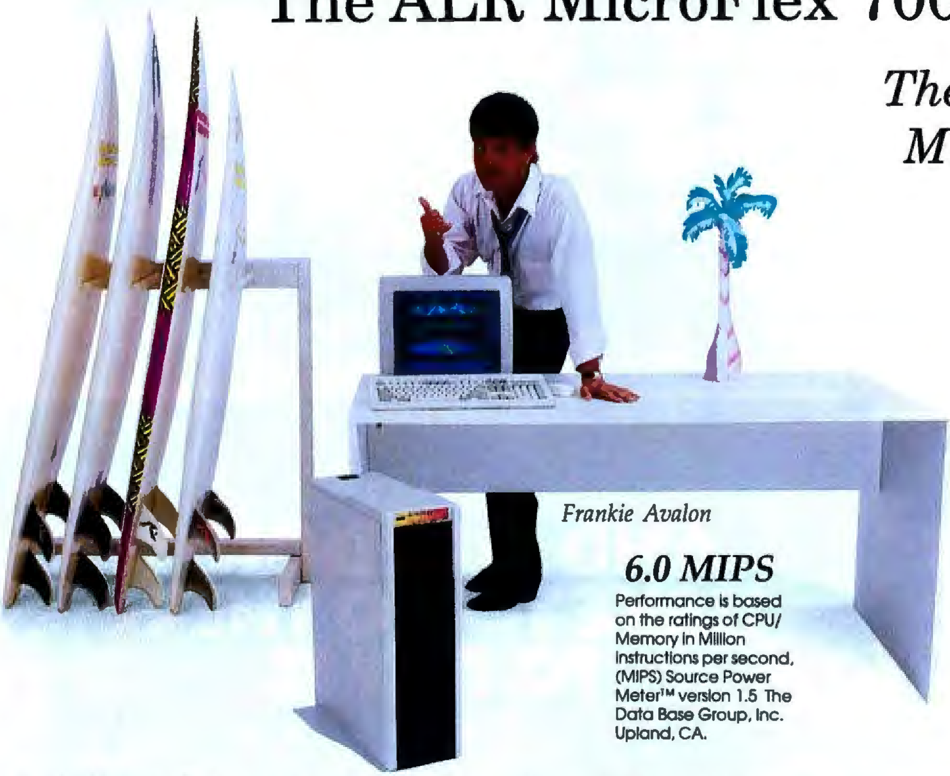

Frankie Avalon

6.0 MIPS

Performance is based on the ratings of CPU/ Memory in Million Instructions per second, (MIPS) Source Power Meter™ version 1.5 The Data Base Group, Inc. Upland, CA.

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7.5 MIPS

Performance is based on the ratings of CPU/ Memory in Million Instructions per second, (MIPS) Source Power Meter™ version 1.5 The Data Base Group, Inc. Upland, CA.

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Circle 16 on Reader Service Card (DEALERS: 17)

BYTE

JUNE 1989 VOL. 14/NO. 6

COVER STORY

FIRST IMPRESSIONS

The Fastest 80386s Ever?

by Rich Malloy

page 109

Preliminary tests suggest ALR will continue to dominate the DOS performance arena.

PRODUCTS IN PERSPECTIVE

FIRST IMPRESSIONS

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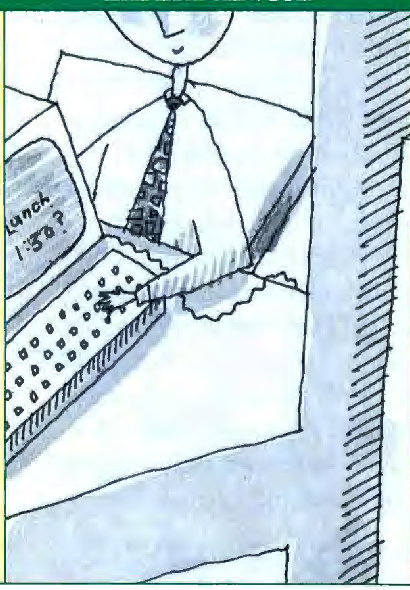

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IN DEPTH

MACINTOSH SPECIAL EDITION

Security/254

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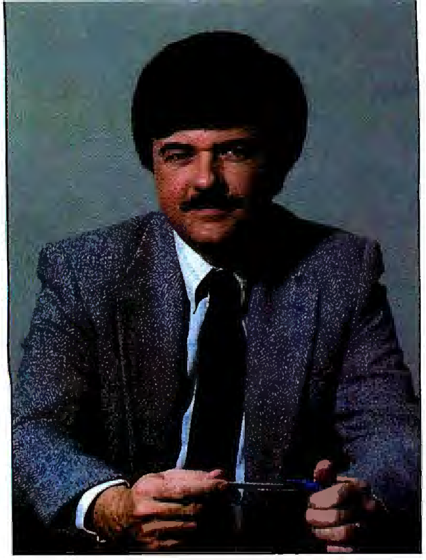


CHECKING OUT THE NEW 80486 AND 68040

A first look at these two new chips reveals amazing similarities and strange differences

At Spring Comdex in Chicago in April, Intel finally took the wraps off its long-awaited 80486, just days after Motorola announced its latest powerhouse, the 68040. (For additional details on both of these new chips, see our Microbytes story on page 13.)

Both chips were worth waiting for. They are blazingly fast (with reported speeds in the low to mid teens of million instructions per second), both contain roughly 1.2 million transistors, both are packaged in ceramic pin-grid array carriers of roughly the same size (slightly larger than the current 80386 and 68030 carriers), and both employ similar internal architectures: They each combine several functions that previously had to be handled by separate chips.

You can think of the 80486 as a device that combines an enhanced 80386 CPU, an enhanced 80387 FPU, a memory management unit, and an 8K-byte cache and controller—all on one chip. Similarly, the 68040 places on one chip an enhanced 68030 combined with a 68882-compatible FPU, an MMU, and separate data and instruction caches.

But when you step back from the specifications, some basic differences appear—differences that may have more to do with Motorola and Intel than with the chips themselves.

For example, a number of the companies that were at Comdex already had early samples of the 80486: We saw two working 80486-based machines and one separate 80486 motherboard. Although Motorola beat Intel's announcement by a few days, we've seen no working 68040 computers, and not even any sample chips. It's strange—and a little disturbing—to see how far along 80486 system development is and to see nothing on the 68040 side. We'll bring you news of 68040 systems as soon as we learn of them, but for now, let's look at what does exist.

IBM's 80486

The Microbytes story on page 16 provides details of an 80486-based PS/2 Model 70 that IBM Entry Systems President James Cannavino showed me less than 24 hours after Intel's official rollout of the 80486. The story also tells you how IBM did it—but the bottom line is that IBM engineers had an 80486 running DOS, OS/2, and AIX in an amazingly short time. Best of all, they ran roughly twice as fast as on a similarly clocked 80386 machine.

While this was a "technology demonstration" and not a product announcement, it still represents an engineering tour de force for both Intel and IBM: Despite the fact that we were seeing a raw prototype unit running a brand-new prototype chip, everything ran smoothly. The prototype daughtercard itself was uncommonly neat, clean, and almost jumperless. (I've seen messier boards in off-the-shelf hardware from some other manufacturers.)

Intel's Box

Intel also demonstrated an 80486-based computer but took a very different tack: It showed its new chip powering a generic AT box from which all identifying markings had been removed. Because the AT-style box lacked a separate CPU carrier, Intel installed the 80486 via two large add-on boards: a daughterboard that lay flat, parallel to the motherboard, and a "granddaughterboard" (which actually carried the 80486). The granddaughterboard plugged into the daughterboard; the daughterboard plugged into the AT's motherboard. We're not talking slick here.

Like IBM, Intel hastened to point out that its 80486 system was not a real product, but merely a technology demonstration. But while IBM's demonstration was clean and well developed, Intel's was large and clunky. Also, it was heavily populated with custom PLDs (programmable logic devices) and with numerous empty sockets.

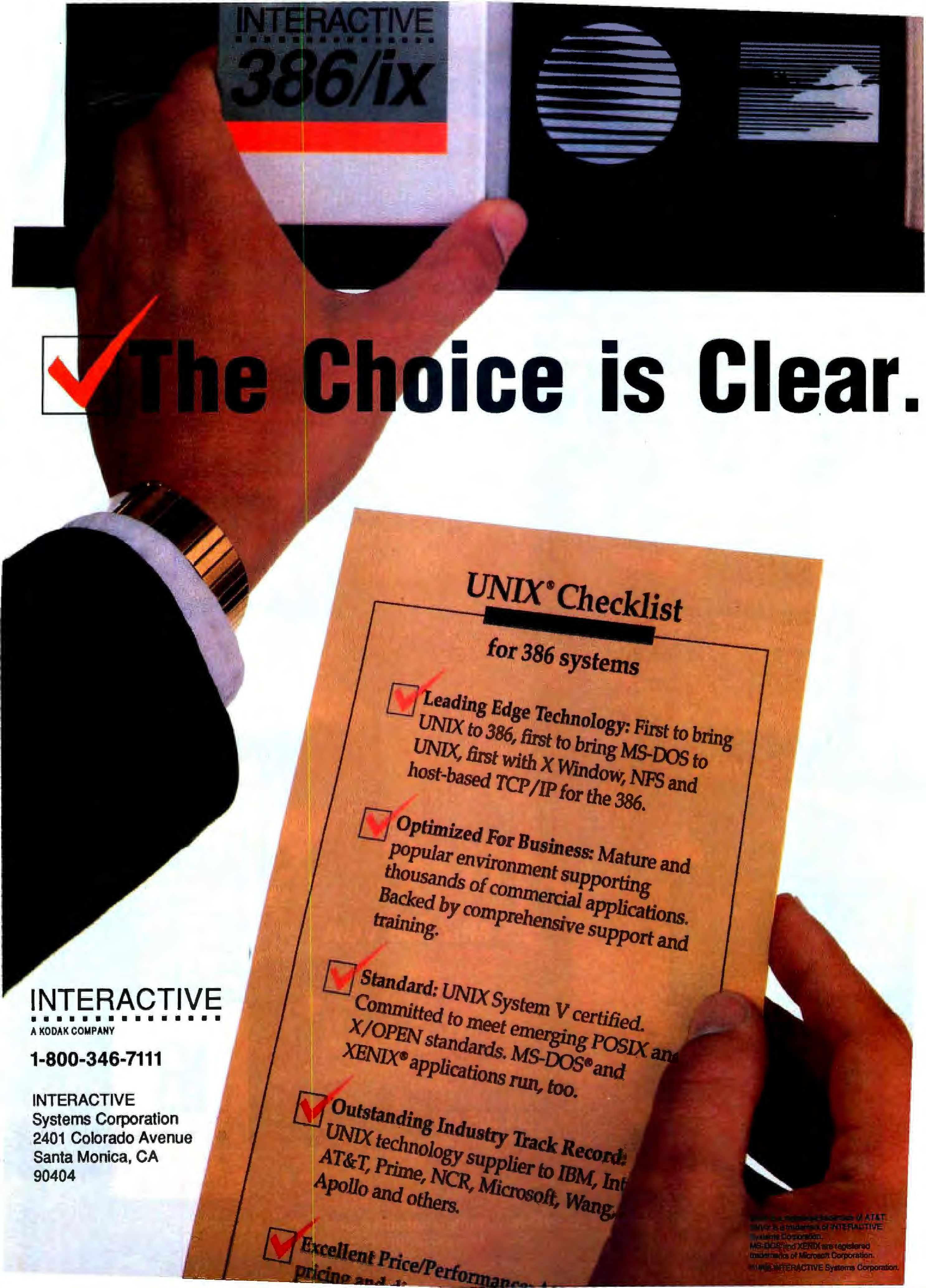
This was all a little surprising. Since Intel provides motherboards and entire systems for OEMs, it shouldn't have been all that difficult for the company to produce something closer to IBM's approach. It's hard to reconcile the elegance of the chip itself with the raw quality of Intel's demonstration system. It's also hard to understand in light of what Cheetah was able to do.

Texas Gamblers

Cheetah—a small Texas company known for its high-speed motherboards—took a wild gamble on the 80486. Unlike IBM, it had no inside track to confidential prerelease information (after all, IBM owns a piece of Intel). Unlike Intel, Cheetah doesn't own the chip specification. But Cheetah does have a ton of expertise and a fair helping of Texas-size confidence. It designed a motherboard for the 80486 based on nothing more than its best guesses as to what the chip would be.

Its gamble paid off, and the motherboard that Cheetah brought to Comdex was well suited for the 80486. About the time you read this, the company's first production 80486 motherboards should be leaving the factory, which gives Cheetah a shot at being the first company with a marketable 80486 motherboard. BYTE is first in line to get a unit, and we'll report our test results as soon as we possibly can.

—Fred Langa
Editor in Chief
(BIX name "flanga")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Staff-written highlights of developments in technology and the microcomputer industry, compiled from Microbytes Daily and BYTEweek *reports*

80486, 68040 Open New Season of CPU Power

This year, spring brought more than the return of baseball to the land. Right about the time of opening day at ballparks all across the country, two division champions in the personal computer industry, Intel and Motorola, introduced microprocessors that could triple the performance of IBM PC-compatible systems, Macintoshes, and Unix workstations as well. The new 80486 and 68040 processors from Intel and Motorola are certainly significant landmarks in terms of processor design. But before getting too excited about nitro-burning desktop computers, remember that there's some question about whether other system components, such as memory, can keep up with the blazing clock speeds. It takes more than a fast CPU to make a fast computer.

After more than a year of speculation, Intel finally released details of its 80486 processor at Comdex in Chicago. The newest member of the 8088 family of processors will be approximately two to four times faster than the 80386. Some microprocessor experts say the 80486 is the first complex instruction-set computer (CISC) chip to challenge RISC chips in performance. Intel also officially introduced the 33-MHz version of the 80386, scheduled to be available later this year. Computer makers from ALR to Zenith announced—in harmony, as it were—that they will offer personal computers using the new chip.

The 80486 handles several functions that today are performed by separate chips. It's a combination of an enhanced 80386 processor, an enhanced 80387 FPU, a memory management unit, a cache controller, and an 8K-byte cache.

The 80486 could have a profound impact on the high end of the personal computer industry. In addition to vastly increasing the performance of these systems, the new chip should also lessen the amount of space required on the systems' motherboards. Further into the future, hardware designers could take advantage of the 80486's capabilities for parallel processing, which will increase performance further.

Fortunately for users, the performance increase of the 80486 is not obtained at the expense of compatibility. Intel engineers said in interviews with BYTE that the 80486 is completely compatible with both the 80386 and the 80387 FPU. The 80486 does have some new instructions, but these are designed to be "transparent," so that 80486-oriented software should run on 80386-based machines as well, but perhaps not quite as quickly.

The new 80486 instructions increase performance significantly, but even when working with 80386 instructions, the 80486 performs much faster than its older relative. With its on-chip equivalent of an 80387 and an 8K-byte cache, along with a RISC-style design, the 80486 running at the same clock speed as an 80386 is roughly three times as fast. For example, Intel claims that the 80386 at 25 MHz runs the Dhrystone benchmark at 13,000 Dhrystones per second, while a 25-MHz 80486 runs a phenomenal 37,000 Dhrystones per second—as fast as some RISC chips.

Intel has slated several versions of the chip. The first two, a 25-MHz and a 33-MHz version, will run at 15 to 20 VAX MIPS, according to Intel.

Motorola Counters with 68040

But before Intel could announce the 80486, arch rival Motorola released details—although sketchy—about the architecture of its upcoming 68040 processor. Like the 80486, the 68040 combines CPU, FPU (its instructions are code-compatible with the 68882 FPU), and cache on a single chip. According to Motorola, the 68040 contains 1,200,000 transistors; the 80486 has 1,160,000. But the company was vague about several technical details and would not say when the chip will ship or how much it will cost.

Like the 68030, the new chip will use a Harvard-style architecture—that is, separate data and code buses. Each bus also has its own on-chip cache, which improves performance. On the 68030, these caches are 256 bytes;

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At the same time that **Intel** announced details of its 80486 CPU, the company also introduced **33-MHz** versions of the 80386 CPU, the 80387 FPU, and the 80385 cache controller, as well as low-power versions of the 80386SX and 80387SX that can slow down to 2 MHz to conserve energy (but they're not fully static, so you can't actually stop the clock).

Prime Computer (Natick, MA) says it will help Intel with an **ECL** (emitter-coupled logic) implementation of the 80486, which the company expects could be used in multiple modules on a single mainframe computer and perform at a speed of 120 MIPS. Prime said it hopes to have the self-cooling package done by 1992.

Amidst the spring barrage of new chips from Intel and Motorola, **Harris Semiconductor** (Melbourne, FL) introduced a **25-MHz** model of the **80286**. The Harris chip is designed to compete with 25-MHz versions of the 80386. Harris says that, depending on the software the chip is running, the 80286 can run as much as 20 percent faster than a 25-MHz 80386. The chip costs $142 in batches of 1000.

Apple has a new LaserWriter driver (LaserWriter 6.0) that **supports color PostScript printers**, such as those from QMS and Tektronix. For the first time, Apple is supporting laser printers that don't bear the mark of the bitten, rainbow-striped apple. The new driver, announced at the recent NCGA conference, also supports halftones and gray-scale images on black-and-white PostScript printers.

Toshiba (Irvine, CA) has prototyped an 8-megabyte memory module that uses Toshiba

continued

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4-megabit DRAM chips. With the memory module, a T5200 portable computer can be outfitted with a total of 14 megabytes. The 4-megabit chips were scheduled to start shipping in April, according to a spokesperson.

Developers interested in working with the **Open Software Foundation's graphical user interface**, Motif, can now order a copy of the Preliminary Functional Description. The 200-page document, which costs $30, covers such components as the window manager and the toolkit. Phone the OSF Advance Information Desk at (617) 621-8835.

How to save shelf space: **Digital Equipment Corp.** officials said at the CD-ROM conference that they have accomplished the goal set for them by **Bill Gates** last year. While not naming DEC, Gates asked that a particular set of documentation that takes up 15 feet of shelf space be put on a CD-ROM disk. The VMS 5.1 documentation and DECwindows manuals are now available on a disk for $895. DEC plans to move its entire documentation library to CD-ROM.

The number of **CD-ROM readers** out there is 171,000, according to a study released by research firm InfoTech. That might be low compared to the number of Elvis sightings in the past year, but it's four times higher than the number of CD-ROM systems in 1987. "CD-ROM is a publishing medium that has come of age," said InfoTech president Julie Schwerin. Last year, about 580 titles were available on CD-ROM, she said.

While demonstrating the new versions of **Lotus** 1-2-3, a Lotus official was asked about the possibility of Lotus doing a **Windows version** of the spreadsheet program. "We don't see Windows as a long-term graphical interface for the masses," he said.

Sony (San Jose, CA) is offering a new **DAT** (digital audio tape-

continued

Motorola representatives would say only that the caches are bigger on the 68040. The chip will also have bus-snooping capability, which is helpful in a multiprocessor environment where several processors can operate on the same set of data.

Motorola also announced a 50-MHz version of its 68030 CPU. The news was designed to upstage Intel's anticipated announcement of 33-MHz versions of the 80386 CPU, 80387 FPU, and 82385 cache controller.

By moving the FPU back onto the main processor chip, both Intel and Motorola are turning the clock back. The two companies are gradually returning us to the days before the existence of a separate FPU. This could be a good move, since the FPU has had the effect of dividing users into haves and have-nots—those with a numeric coprocessor and those without. For hardware developers, that means no more empty coprocessor sockets taking up space; for software developers, it means they can write code for one system without worrying whether the user will or will not have the FPU. Of course, the other advantage of having the FPU on the same chip as the CPU is that it greatly reduces the distance (and time) that signals have to travel between these two units, resulting in a significant boost in performance.

Along with its own on-chip FPU, the Intel 80486 also has its own cache controller and an 8K-byte on-chip cache. Although the cache is rather small, Intel claims that with most software, the cache hit rate (the percentage of times the processor will access memory that has already been moved into the cache) is 90 percent.

RISC, Caching Contribute to Gains

Intel also says it has employed high-speed RISC techniques for the most frequently used operations. For example, when code and data are already in the cache, simple instructions that move data take just one clock cycle to execute. On the 80386, the same instructions require two to four cycles. And the 80486's instructions for calling subroutines are three times faster than those on the 80386.

The cache is also involved in the 80486's parallel-processing capabilities. When several processors are present, each with its own memory cache, it's difficult to be sure that each cache accurately represents the current state of memory. To accomplish this, the 80486 cache controller watches the bus to determine when the other caches are accessing conflicting areas of memory. Other multiprocessor features of the chip include multilevel cache support, burst bus capability (a 32-bit burst every clock), and a standardized multiprocessor architecture that's designed for any combination of processors, including the 80486, the 80386, and Intel's new RISC chip, the 80860.

The 80486 shares substantial technology with the high-speed graphics-oriented 80860. Although the 80486 doesn't have the 80860's instruction pipelining features, you can increase the performance of the chip by arranging the instructions in certain ways. Intel said it will make available a compiler that is optimized for the 80486 and that will rearrange instructions in order to speed up performance. Even though the 80386 and 80486 are "code-compatible," some programmers will have to choose between optimizing for the 80386 and optimizing for the 80486. According to Intel, programmers will get a 10 percent to 15 percent performance boost from optimizing for the 80486.

Intel officials said they expect to see 80486-based machines replacing the 80386 in high-performance systems such as file servers, but they said they see many 80486s going into multiprocessor systems as well.

Advance samples of the 25-MHz 80486 should be available to hardware developers by this fall, with full production by the end of the year, Intel officials said. The 33-MHz version is scheduled to be available in samples at the end of this year, with a 40-MHz version in 1990 (and 50- and 60-MHz versions within the next couple of years). It will cost $950 for a 25-MHz 80486 (presuming you buy them a thousand at a time). That's not much more than the combined cost of an 80386, an 80387, a cache controller, and an 8K-byte cache—and it offers three times the performance.

The performance of the new processors is indeed impressive. The problem now is coming up with other system components that can keep up with the CPU. This means faster memory and disk I/O. Advances are being made in these areas, but not to the extent that microprocessors are changing. Clock speed is just part of the equation.

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recording system) drive to OEMs. The SDT-1000 has a storage capacity of 1.3 gigabytes, a data transfer rate of 183K bytes per second, and an average access time of 20 seconds, Sony said. The 5¼-inch unit comes with a SCSI connector. Final prices weren't set as we went to press, but the DAT drives will probably cost computer makers about $2000 each.

RoboMac: **MacMotion** (Medway, MA) has developed a nine-axis robot that runs under **HyperCard** control. The robot, encased in a 19- by 5-inch enclosure, is suitable for materials handling, inspection, and assembly. Design load is 10 pounds, and gripper speed is up to 150 inches per minute. "This type of robot has sold for $300,000 in the past, but we are going to reduce the cost by an order of magnitude to $30,000," said a company official. "We used the HyperCard environment to allow for ease of programming of the system." Meanwhile, at the recent PITTCON show in Atlanta, **Sartorius Instruments** (McGraw Park, IL) had at its booth a droid-like two-legged robot with a Mac SE in its head.

RoboDoc: Speaking of robots, **Carnegie-Mellon University** (Pittsburgh, PA) this fall will open a doctoral program in robotics. The curriculum will cover robotic cognition, perception, and motion, as well as the integration of automatons into manufacturing situations.

Today's mass of **incompatible data** and communications standards is like "a grandmother's attic of information on a scale never before imagined," said **AT&T CEO Robert Allen** at the recent Interface '89 show in New York City. "We've got to clean it up," he said. He compared the computer industry to the railroad, construction, and auto industries, saying that those businesses couldn't have flourished without standardization. "Standards are the key to reaping the full harvest of our technology," he said.

continued

IBM Shows PS/2 Powered by Intel's 80486

It didn't take IBM long to put together a machine using Intel's 80486 processor. At a briefing during Comdex, IBM Entry Systems president James Cannavino showed a PS/2 Model 70 modified with an 80486 chip. IBM engineers got the Intel pin-out specs and designed a new CPU carrier, which IBM calls the "processor complex platform," a little daughtercard that normally carries the 80386 and 80387 chips and static RAM. "The 80486 is an elegant sweep of those separate chips into a single chip," Cannavino said. The engineers had to do some "minor" tweaking of the BIOS, he said, but it took them only three days to get the 80486 system running after they received chips from Intel.

IBM has tested the new Intel CPU with DOS, AIX, and OS/2 and found a doubling of speed between the 25-MHz 80386 and 25-MHz 80486 in routine applications not optimized for the 80486, Cannavino said. He noted that the current chips have problems but that a revision is due soon.

The daughtercard upgrade isn't likely to be a product itself, Cannavino said, because 80486-based bus-master cards are in the works. The demonstration was what IBM calls a "technology announcement." Nevertheless, it's clear that IBM isn't wasting any time getting ready to produce an 80486 system. Cannavino hinted that IBM's first 80486-based PS/2 would ship early next year. "But that doesn't mean at all that we'll be skipping 33-MHz 80386s."

Cannavino emphasized that the real benefit of the next generation of chips will be the high-performance graphical user interfaces that they make possible. Asked if he thought the Apple-Microsoft lawsuit might stall development of those interfaces, Cannavino told BYTE, "I've looked at the issues thoroughly, and I'm not making any changes in IBM's plans for Presentation Manager."

New 32-Bit QuickDraw Means Better Mac Color

Macintosh graphics will become more colorful and application developers will have a bigger paintbox now that Apple Computer has released its 32-bit extensions of Color QuickDraw, the imaging model used by the Mac for displaying color on the screen. The new 32-Bit QuickDraw, which will run on all 68020- and 68030-based Macs (SE/30, II, IIx, and IIcx), establishes a new standard for color applications on the Macintosh, enabling the computer to display more than 16 million colors simultaneously on the screen. (The current 8-bit Color QuickDraw technique lets the computer display 256 colors.) This wealth of colors will mean that developers can build applications that generate images with natural, photographic-quality color. Color scanned images will appear virtually unchanged on the screen.

The new QuickDraw consists of a set of files that you simply copy to the System Folder. You have to have System 6.0.3, but no ROM upgrades are required. While the files will usually be bundled with 32-Bit QuickDraw applications, you can get them from Apple dealers or from the Apple Developers Association (Santa Clara, CA). At least 2 megabytes of RAM is recommended, since 32-Bit QuickDraw takes up 120K bytes of memory, and most color applications require a lot more.

While 32-Bit QuickDraw does indeed use one 32-bit word (4 bytes) to describe each pixel on the screen, it uses a maximum of 24 bits to specify the color attributes of the pixel (8 bits for red, 8 bits for green, and 8 bits for blue). The 8 bits left over (called the "alpha channel") are currently unspecified and can be used by application developers for their own purposes, such as adding a transparency mask allowing objects to show through other objects on the screen. Because the entire definition of the pixel is contained within one 32-bit word, or "chunk," of memory, 32-Bit QuickDraw is called a "chunky" color model.

In 24-bit addressing mode, 32-Bit QuickDraw supports the display of more than 16 million colors simultaneously on the screen. It also supports 16-bit, 8-bit, 4-bit, 2-bit, and 1-bit addressing modes, which means that 32-Bit QuickDraw can run on any video board on a Mac II, IIx, or SE/30.

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"Standards do not limit; they liberate creative application of technology." Allen joined the industry's Greek chorus chanting for standardization in a world where users want to mix products from different vendors. Are the chorus members listening to each other?

At Microsoft's annual CD-ROM conference recently, **Michael Schulhof**, vice chairman of Sony Corp. of America, chided the CD-ROM industry for not yet settling on standards. "This industry has emerged from obscurity to confusion," Schulhof noted. "It is time to make ANSI standards official rather than advisory."

Raster Image Processing Systems (Boulder, CO) said it has cracked the encryption scheme used by **Adobe's PostScript** type fonts, which could enable people to use

continued

In the lower-resolution modes (16 bits or less), 32-Bit QuickDraw uses dithering (the approximation of adjacent colors) to convert the high-resolution color data to the lower-resolution mode. If the monitor is black-and-white, the converted image will appear in gray scale, with the number of gray-scale levels depending on the resolution of the video board (an 8-bit gray-scale board can display 256 levels of gray).

But color is not cheap. To have all these hues, you'll need a third-party video board and monitor. Radius introduced a series of color video boards that support 1152 by 882 pixels and feature a 72-Hz screen-refresh rate and up to 3 megabytes of video RAM. Radius is offering a 16-bit version, the DirectColor/16, for $3695; and a 24-bit version, the DirectColor/24, for $4995. Radius also has a 19-inch color display for $4295. SuperMac's Spectrum/24 board sells for $3999; current owners of SuperMac color boards can trade up to the Spectrum/24 for $2499. RasterOps is selling its ColorBoard 224 for $5195; owners of the ColorBoard 104 can trade up for $3000.

RasterOps has for some time been offering 24-bit video boards that use a color model that's incompatible with 32-Bit QuickDraw. Instead of the chunky color model used by 32-Bit QuickDraw, RasterOps offered boards that used a chunky planar color model, in which the bits defining the pixel are stored in separate chunks (32-bit words) for each color (red, green, and blue). Rather than displaying the pixel with a single memory access to a single 32-bit word, as in the chunky model, the chunky planar model requires three memory accesses to three separate 32-bit words, one for each color. Developers who have written software for RasterOps's chunky planar will have to rewrite their programs to support 32-Bit QuickDraw. RasterOps insists that it will support all current customers and let them upgrade to boards and software patches that support 32-Bit QuickDraw.

Because it involves very complex

continued

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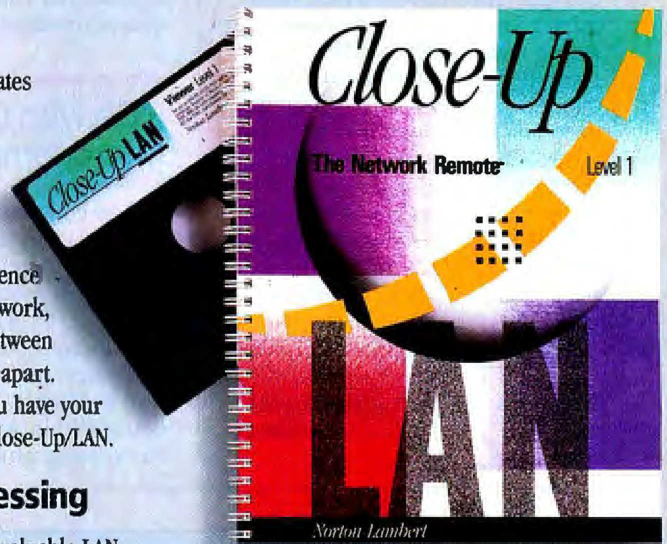

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Adobe fonts on printers lacking Adobe-licensed controllers. RIPS, which makes high-speed laser printer controllers, cracked both the character descriptions and "hints," which basically handle how a character should stretch or scrunch and still remain aesthetically appealing as its point size changes. An Adobe-licensed laser printer knows how to interpret Adobe fonts, but now RIPS controllers should be able to do that. RIPS expects to integrate its decoding technology into its controllers. How did RIPS crack the code? "We took a logic analyzer, hung it on a 68000 bus, and observed," said chief technologist Ray McCaslin. With that puzzle solved, RIPS controllers should be able to handle any Adobe font, he said.

Here's one you won't find at your

continued

memory management, particularly in its dithering or transfer modes to lower resolutions, 32-Bit QuickDraw is noticeably slower than 8-bit Color QuickDraw. One manufacturer, E-Machines, has decided to build a graphics accelerator into its 24-bit video boards and will not announce its products until this summer.

The new QuickDraw launches the Mac into the high-end full-color market, but with a high price tag and questions about the system's performance. A 24-bit video board and full-color display add at least $7000 to a Macintosh system, putting it in the same price range as full-color setups from Silicon Graphics or Sun Microsystems.

Apple believes that it can compete with companies like SG and Sun because it is a "general-purpose" machine rather than a specialized workstation, according to Laurie Girand, Apple's product manager for Macintosh system software.

PCs with CDs: Multimedia Machine of the Masses? Microcomputer Moguls Think So

The computer of the future will be a multimedia device—a machine that plays stereophonic sound and shows full-motion video with a clarity rivaling TV. All this will cost less than today's conventional personal computer, and, just like TV, there will eventually be one in nearly every household in America. That's the scenario being promoted by Microsoft, IBM, Sony, Intel, and Philips.

At the recent Microsoft-sponsored Fourth International Conference on CD-ROM, those companies all pledged to support this multimedia concept and to develop the technology necessary to make it real. Intel and IBM will jointly fund a development center to promote Intel's DVI (Digital

continued

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NANOBYTES

neighborhood video store: "What **Neural Nets** Can Do" is an 80-minute videotape (VHS) intended for people who need to judge the actual practical potential of neural net technology, according to the company offering the tape (Lawrence Erlbaum Associates, Hillsdale, NJ). This video tutorial stars **James Anderson**, professor of cognitive and linguistic sciences at Brown University and coeditor of *Parallel Models of Associative Memory*. The tape and accompanying 144-page manual cost $250; a demonstration tape costs $10.

The Fortran Journal is a new publication offering programming hints, short news items, and product reviews. The journal comes out six times a year. The cost for a one-year subscription is $28 in the U.S. and $36 everywhere else. Contact the **Fortran Users Group**, P.O. Box 4201, Fullerton, CA 92634.

As part of a venture with Hitachi, **VLSI Technology** (San Jose, CA) has developed a 256K-bit static RAM chip with an access time of 35 ns, VLSI says.

As part of their new working relationship, **Sun Microsystems** (Mountain View, CA) and **Cray Research** (Minneapolis) are offering a channel interface that connects Sun workstations with Cray supercomputers. The FEI-3 adapter consists of two VME boards that slip into a Sun-3 or Sun-4 and connect with 100-megabit Cray channels. Sun has written drivers for process-to-process communication and remote log-in.

Apples and Oranges: AST Research (Irvine, CA) has sold off its line of Apple products to Orange Micro (Anaheim, CA). AST's products for the Mac include Mac86 and Mac286, coprocessor boards designed to allow the machine to run IBM PC software.

And from the Department of It Loses Something in the Translation: After-booting-up message seen recently on a foreign laptop: "Now had loaded lat-top utilities."

Video Interactive) technology, designed to compress 70 minutes of high-quality video into a form that can be stored on a CD-ROM disk and viewed on a personal computer. Microsoft, Sony, and Philips released their CD-ROM XA specifications in an effort to set a standard for how audio is handled in future CD-ROM-based products. XA disks will be able to hold 8 hours of stereophonic sound (or 16 hours of mono).

To make computers exciting to consumers who could care less about spreadsheets and word processors, it will take a flashy video interface and high-quality audio, said Microsoft chairman Bill Gates. All that and a low price will make a personal computer a consumer item rather than a specialized set of hardware.

"While a poison index and the Bible on CD are nice things to have," Gates said, "they are not the types of things that will sell to the general public."

By 1990 or 1991, Gates said, the magical computing machine for the masses will be a 1-megabyte system with Windows, XA sound, extended VGA resolution featuring overlayed text with high-quality pictures, and the start of interactive tools. After that, this multimedia machine will be running OS/2 Presentation Manager, will have 4 megabytes of RAM, be able to play stereo sound, and have the DVI chip providing capabilities to display full-motion video.

"IBM shares the excitement of multimedia," said IBM Entry Systems president James Cannavino. "This will reshape how people envision personal computers." Cannavino pledged IBM's support to DVI, CD-ROM, and multimedia. IBM and Intel aim to have a single Micro Channel board that can handle high-quality video and sound by 1991. Intel announced at the conference a system for developing DVI applications. The $21,500 Pro 750 is built around an 80386-based AT with seven DVI-related boards.

Agnus Gives Amiga Graphics Better Memory

With the release of the new Agnus chip for the Amiga—the custom chip that handles graphics operations—Commodore Business Machines removed one of the major graphics bottlenecks in that computer. The new chip, a plug-in replacement for existing Agnus chips in all Amigas except the original model A-1000, lets programs use up to 1 megabyte of memory for graphics. The megabyte of display memory will give developers more headroom, allowing higher-resolution images and generally improved graphics on the Amiga.

The chip is available through Commodore service centers, said Amiga product manager Keith Masavage. He said the cost of the chip will be between $100 and $150.

The new chip fixes a peculiarity of the Amiga architecture that has been cramping some users and applications programmers. Although the machine can be filled with as much as 8 megabytes of memory, the Agnus chip could address only 512K bytes. That meant that only 512K bytes could be used for display purposes. Masavage said that a typical high-resolution screen on the Amiga could use as much as 150K bytes. Animation often requires holding more than one screen in memory at a time, and since some of the 512K bytes (called "chip memory" in the Amiga world) has to be used for direct-memory-access channels, it was possible for an Amiga to run out of graphics memory even though most of its total memory was unused. Some developers with both Amiga and Macintosh versions of their products have taken to using Mac IIs to get high-quality displays of their images.

Despite the memory situation, the Amiga has established itself in the world of professional video and animation, where it competes with systems costing 10 times as much.

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LETTERS

and Ask BYTE

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Marshall W. Magee
Norcross, GA

Executing Operations

"Worth the RISC" by Trevor Marshall and Jane Morrill Tazelaar (February) was a very good survey about where RISC is today.

In the section headed "What Is RISC?" the article states that most RISC instructions execute in one cycle: "The RISC chips, however, execute most of their instructions in one cycle and make further performance gains with a technique called *pipelining*, which uses multiple execution units."

If by "execute" the authors mean to process an instruction from instruction fetch to instruction completion, then a typical instruction takes four cycles: instruction fetch, decode instruction and fetch registers, execute operation, and write back registers.

However, the "execute operation" part of the pipeline takes one cycle. Since each stage of the pipeline is simultaneously processing a different instruction, an average of one instruction is finished per cycle. Therefore, instructions are processed at a rate of one instruction per cycle.

If by "execute" the authors mean the "execute operation" part of the pipeline, then only one instruction is being executed at a time. This distinction is important because future chips may have multiple sets of pipelines. These chips will be able to process at a rate of more than one instruction per cycle.

Les Faby
Cupertino, CA

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X Windows vs. Display PostScript

"The X Window System" by Dick Pountain (January) was most informative. But the article also contained some misleading information that needs clarification.

Pountain made a few comments regarding the competition between X Windows and the Display PostScript system. For instance, he says that X Windows' main competition is Display PostScript, which offers more powerful typographic functions—although the two systems are not exclusive and might even complement each other. He also describes Display PostScript as "a possible video graphics standard in apparent competition with X Windows."

Display PostScript is not in competition with X Windows. Rather, Display PostScript is an imaging model that can be incorporated into X Windows or any other windowing system. In fact, Digital Equipment Corp. is doing exactly that with its recently announced DECstation 3100 workstation.

In this case, the Display PostScript system is an extension to the X server. To use it, an application goes through the X server. The application program can then use Display PostScript as the imaging model instead of calling on the graphics portion of the Xlib library.

Another point in Pountain's article that needs clarification is the following: "Sun, whose NeWS windowing system is based on Display PostScript. . . ." Sun wrote NeWS, which is both an imaging

continued

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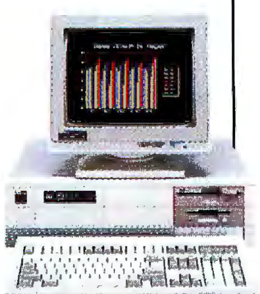

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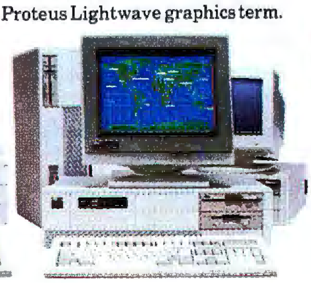

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model and a windowing system, using the PostScript language. However, Sun is not a licensee of the Display PostScript system, nor is NeWS based on the Display PostScript system. Rather, Sun created its product independently of Display PostScript. Sun developed its own extension to the PostScript language for interactive displays and color, and these extensions are not the same as Adobe's extensions.

Pat Marriot
Director of Marketing
Adobe Systems, Inc.
Mountain View, CA

NeXT Performance

Your cover story on the NeXT computer (November 1988) expressed skepticism about the performance of Display PostScript. Having ported FrameMaker, our publishing software, to the NeXT machine, we can report that we're very pleased with the performance of Display PostScript (and the whole NextStep environment, for that matter).

David J. Murray
Frame Technology Corp.
San Jose, CA

API Clarification

I'm glad there's a magazine that provides at least some degree of technical information about OS/2, rather than the now-tiresome debate regarding its chances for success. I am referring to Mark Minasi's OS/2 Notebook column.

As a software engineer trying to write an application for OS/2, I appreciate the availability of a source of information other than Microsoft's overwhelming and unclear pile of manuals. However, in "1988 in Review: OS/2's First Year" (January), the code fragment Minasi gives as an example of an Application Program Interface function call is erroneous and misleading. It should appear as follows:

```
ret_code = DosGetPid(&MyPID);
if ret_code
  printf("DosGetPid failed:
      %d\n",ret_code);
else
  printf("Process ID=%d\n",
      MyPID.pid);
```

There are two differences between my fragment and his. First, he was printing the error message when the call was successful, and the process ID when it failed. In the paragraph following the fragment, he stated its intent correctly—he simply had it coded incorrectly. Sec-

continued

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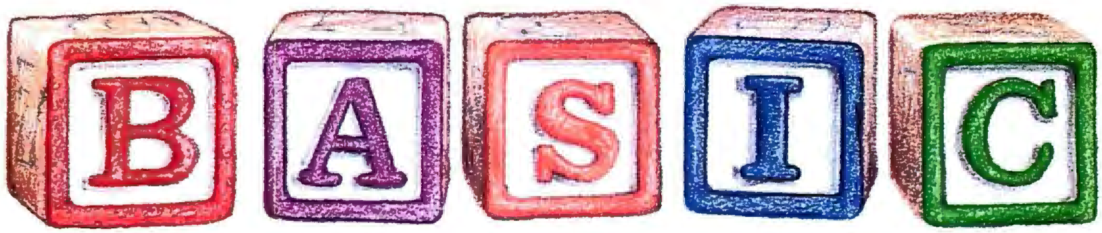

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ond, the variable MyPID is a structure, and his fragment was printing MyPID, which yields the first value of the structure. Fortunately, the first value in the structure happened to be the process ID, so the correct value is printed. This is somewhat misleading, though; had the structure been different, the printed value would have been incorrect.

These points may seem trivial, but working with OS/2 has been a struggle for me, and I think it's important that, on the rare occasions when useful information is published for OS/2 programmers, it should be as accurate and complete as possible.

David P. Sours
Blaine, MN

I did mix up the two clauses—sorry. As to the use of the structure, you're right again. Before your letter, I had never looked it up; rather, I had used it just as Microsoft did in a sample program.

I'm glad you find the column useful. Since that particular column came out, another book chock-full of sample code has come out. Called Peter Norton's Inside OS/2 *(Brady Computer Books, 1988), it discusses areas of OS/2 (not Presentation Manager, alas—just the kernel) and includes sample C code.*

—Mark Minasi

Delivering the Mail

The global village in electronic messaging has already moved from fiction to fact. The world does not need to look toward the future for worldwide electronic messaging. A great deal has already been implemented, and more is under development.

Contrary to the unconnected world described in the "X.400 Grows Up" by Brock N. Meeks (December 1988), intersystem messaging between most major systems in the U.S. and worldwide is now commonplace because of DA Systems' DASnet Service. All users of ABA/net, INET, UNISON, TWICS, the GeoMail network of hosts (installed in the U.S. and throughout Europe), PeaceNet, and, soon, CONNECT's MacNET and GoverNET can communicate with anyone who uses one of several dozen E-mail systems and networks. Not to mention the fax and the post office.

I take issue with Meeks's statement that "To have any kind of global interconnected network, you need a directory of some sort." That has not been the case with mail delivered by the post office or via fax. Though it will be useful, a directory is not the sine qua non of interconnectivity. What would Benjamin Franklin have replied to the proposition that a mail delivery system requires a universal directory of street addresses? I leave the answer to you.

Where X.400 or proprietary connections turn out to be the appropriate way for a service or company to connect, the DASnet gateway to X.400 will be useful to connect these services to all the other DASnet-linked systems.

Anna B. Lange
DA Systems
Campbell, CA

Trees 'n Leaves

I believe there are errors in Rick Grehan's otherwise fine series on B-trees ("Trees 'n Keys," Parts 1, 2, and 3, January through March). Grehan states, "A key's inorder successor will always be on a leaf node. You might want to sketch a few B-trees to convince yourself of this." I entered the following five names into a

continued

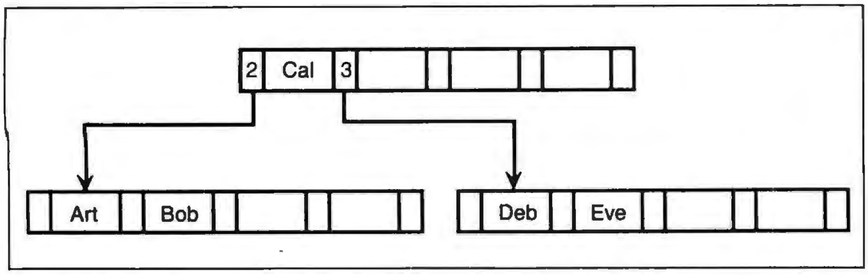

Figure 1: *Reader Spear's B-tree.*

fresh tree: Art, Bob, Cal, Deb, and Eve (see figure 1).

Following Grehan's directions, an inorder traversal would return Deb as the next key greater than Bob, while the true successor, Cal, would be missed altogether. When the pseudostack is popped, the parent key whose right-node pointer will be followed is the inorder successor. This error renders SEEK_NEXT_KEY and DELETE_KEY useless. Once a parent-key successor key has been found, the search must drop down to a leaf to find up to four successors. SEEK_NEXT_KEY provides no way to read the leaf node. The SCANKEY routine could be called to do this. If a parent node holds more than one key, a second index pointer would be needed so that subsequent pops reference the correct key. KEYOFFSET can't be used for both purposes.

There is another error in the SEEK_NEXT_KEY module in line 7, where a GOTO references an undefined line label, L1:. Jumping to L2:, the only line label in the example, sends the code into the middle of a loop, which is probably not good programming practice.

I hope that corrected code examples will be made available so that we can see what Grehan actually intended. I have enjoyed the series very much despite the frustration.

Robert J. Spear
Accokeek, MD

The sentence you quote was in a paragraph describing those keys that are not on a leaf node. And it is true that the inorder successor of a key on a nonleaf node is always on a leaf node. In any case, you're right. It's false that every key's inorder successor is on a leaf; I should have been more explicit. I'm sorry to have led you astray.

In light of this, I think you'll see that SEEK_NEXT_KEY does work for the example you've given (refer to listing 4 in Part 1). Assume that you're at BOB (KEYOFFSET=1, IFLAG=0) and you perform a SEEK_NEXT_KEY. Since the file is not rewound and IFLAG=0, the routine drops down past all those comments, increments KEYOFFSET, and sets IFLAG to 1 (this means the routine is pointing to BOB's right key pointer, which is empty). The WHILE loop doesn't execute, since the key pointer is empty, so the routine zooms back up to the start of the REPEAT loop. Since IFLAG equals 1, the first IF statement executes, but since KEYOFFSET does equal the number of keys on the node (namely, 2), the second IF does not execute. Nor does the third—the pseudostack is not empty. So the routine pops the pseudostack and reads in the node containing CAL. Popping the stack also sets KEYOFFSET to 0. Now the routine hits the ELSE and returns to the beginning of the REPEAT loop. Again, the first IF statement is executed (IFLAG still equals 1), but now the second IF executes (since KEYOFFSET does not equal the number of keys on the node). So IFLAG is set to 0, and the routine returns with everything pointing to CAL.

Finally, you are absolutely correct that label L2 should have been L1. Several people have pointed that out, and I shall probably pay for it for the rest of my life.

—Rick Grehan

Tricky Terms

I found Christopher Greaves's challenge ("Ackerman Exercise," Letters, November 1988) to calculate values of the recursive function Ack(m,n) impossible to resist, and I spent a number of evenings investigating the problem. A microcomputer proved inadequate to deal with the numbers involved, so I had to resort to brainpower and pencil.

As m increases, the value of the function increases ever more rapidly, and for i=0,1,2. . . . ,n produces the following series:

Ack(0,i) = 1,2,3,4, . . . ,$n+1$
Ack(1,i) = 2,3,4,5, . . . ,$n+2$
Ack(2,i) = 3,5,7,9, . . . ,$2n+3$
Ack(3,i) = 5,13,29,61, . . . ,$(2^{(n+3)})-3$
Ack(4,i) = 13,65533, . . . , $(2^{(\mathrm{Ack}(4,n-1)+3)}-3)$

The value of Ack(4,2) is approximately 2.17E19727 and would take more than four pages to type, and Ack(4,3) is already vastly greater than a googolplex.

Greaves challenges his students to "deliver" to him the value of Ack(5,5), which can be simplified to

Ack(5,5) = Ack(4,Ack(4,Ack(4,Ack(4,Ack(4,65533)))))

His carefully chosen words hide the fact that there is no transport company large enough to handle that task, nor is there sufficient paper in the world on which to express the value.

A. J. McCutcheon
Nedlands, Australia

How to Get BYTE Listings

I just finished reading "The Token Ring" by Brett Glass (January). Congratulations are in order for a well-written article that was easy to understand.

How do I go about getting the IBM demo of the Token Ring, given that I do not have access to BIX?

Chris Smith
Whitehorse, Yukon, Canada

BYTE listings are also available on BYTEnet (our free BBS), on disk from BYTE (most issues have an order card bound in), and from correspondent BBSes worldwide. Thanks for your interest.—Ed.

Recipe for Comparing Compilers

"Smoothing Out C" by Steve Apiki and Jon Udell (Product Focus, February) was an informative article. However, the result that "Turbo. . .did poorly on the floating-point test" prompts me to relate data comparing Microsoft C and Turbo C using routines from the book *Numerical Recipes in C* by William H. Press et al. (New York: Cambridge University Press, 1986.) (The FORTRAN/Pascal version of this book was reviewed in the January 1987 BYTE.)

I needed a microcomputer C compiler for a spectral estimation project. Originally, I had intended to use the Microsoft compiler, since several coworkers had been using it and it had always been reliable. For this project, good numerical accuracy was far more important than execution speed. Although Microsoft C and Turbo C produced identical results for most of the *Numerical Recipes* routines that I intended to use, Turbo C pro-

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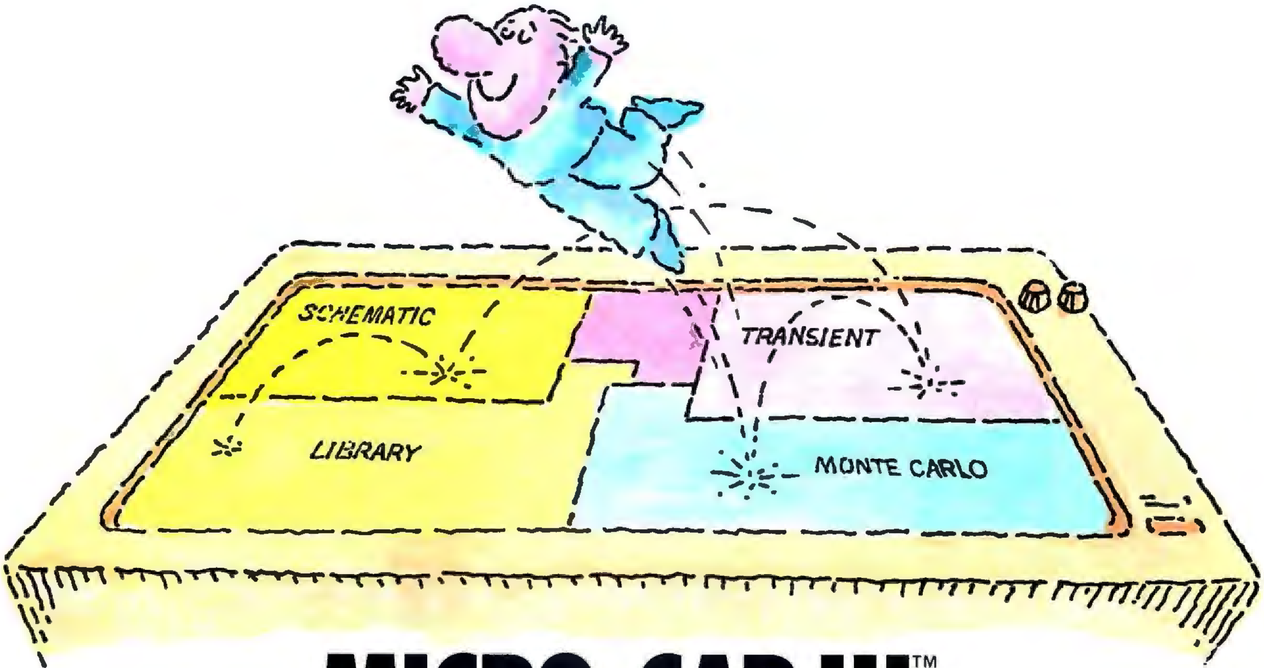

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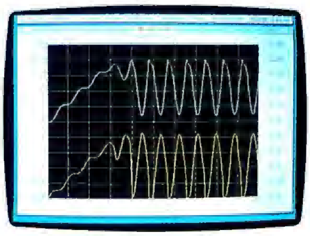

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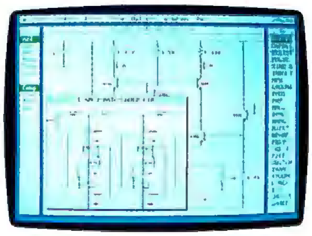

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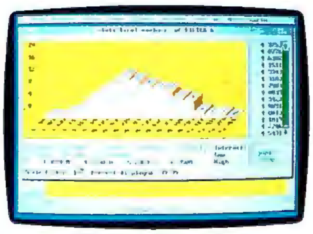

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Table 1: *Results using the* `xmemcof.c` *driver routine. Published results appeared in* Numerical Recipes in C.

Index	Published	VAX-C	Turbo C	Microsoft C
1	1.261539	1.261540	1.261540	1.262617
2	−0.007695	−0.007694	−0.007694	−0.009724
3	−0.646778	−0.646779	−0.646779	−0.646527
4	−0.280603	−0.280603	−0.280603	−0.279950
5	0.163693	0.163692	0.163692	0.163249
6	0.347674	0.347676	0.347676	0.347373
7	0.111247	0.111247	0.111247	0.111045
8	−0.337141	−0.337142	−0.337142	−0.336187
9	−0.358043	−0.358043	−0.358043	−0.358086
10	0.378774	0.378774	0.378774	0.378403

Table 2: *Results using the* `xspctrm.c` *driver routine (overlapped case).*

Index	Published	VAX-C	Turbo C	Microsoft C
1	—	0.001993	0.001993	0.001786
2	—	0.001461	0.001461	0.002544
3	—	0.072356	0.072356	0.147874
4	—	0.062723	0.062723	0.107431
5	—	0.097625	0.097625	0.000332
6	—	0.014102	0.014102	0.000512
7	—	0.000089	0.000089	0.000113
8	—	0.000210	0.000210	0.000131
9	—	0.000052	0.000052	0.000037

vided better accuracy in the two routines `memcof.c` and `spctrm.c`.

I compared compilers by using driver routines supplied in the companion book *Numerical Recipes Example Book (C)*. This book often gives the answers obtained when the routines were run by the authors. I tested the book's sample routines `xspctrm.c` and `xmemcof.c` using Microsoft C, Turbo C, and VAX-C (the latter on a DEC VAX-11/780 minicomputer). The results in tables 1 and 2 show why I selected Turbo C.

Robert C. Briggs
Los Altos, CA

Artificial Distinction

This is in reference to the correspondence on "Minds vs. Programs." Dr. R. J. Ellis ("Factoring the Unforeseen," Letters, February) makes an artificial distinction between "crystallized consciousness" and "living consciousness." Isn't there essentially a confusion as regards the terminology? Humans use algorithms that encompass emotion, self-motivation, and reprogramming capability. A computer program that uses an equivalent algorithm would have all the "human" capabilities listed by Ellis.

The question that remains to be answered is whether the human mind is capable of developing such an algorithm. I believe a human as well as an "artificial" mind would be capable of just that.

Dr. Mohammed I. Saleem
Safat, Kuwait

MS-DOS Computer Server

I'm writing in response to Nicholas Birkett's letter ("Multiuser Advantages," February). Birkett complained about the impossibility of having a "computer server" under MS-DOS. He's mistaken. I know exactly how to accomplish what he wants.

To begin, Birkett is right in asserting that it's impossible for one machine on a LAN to initiate a job on another machine on the LAN. This can be accomplished, although in a roundabout way:

1. Set up the machine that is to do the work in one of the following ways: as a client, in which case only the LAN server(s) can initiate jobs on it; or as a client/server, in which case all clients on the LAN can initiate jobs on it.
2. Set up an initiator process on the machine that is to do the work. I'll describe the initiator process and ways of making it recognize jobs that are waiting to be initiated below.

continued

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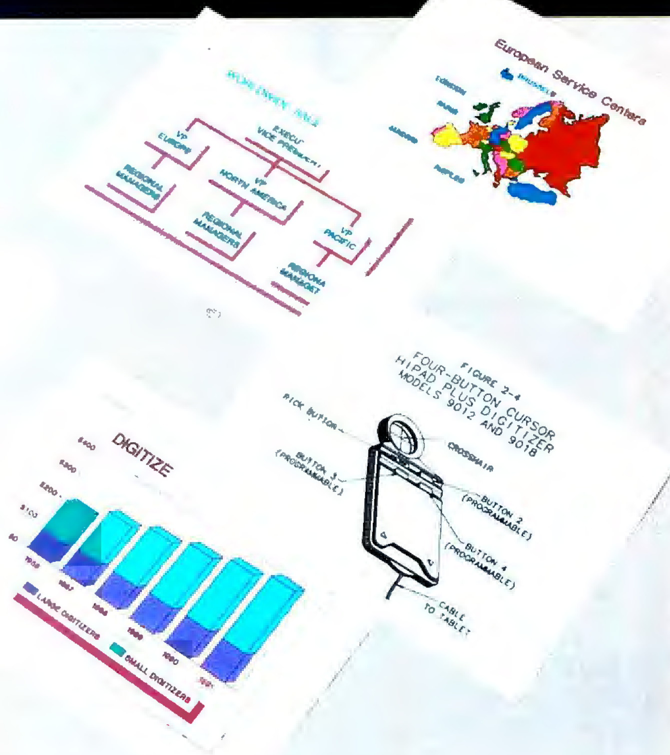

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3. Mount the job to be done as an executable (.BAT, .COM, or .EXE) file on the server or on the machine that will do the work. This is possible because that machine, as a server, will have at least one logical disk on which clients can write.
4. Sit back and wait for the job to be completed.

What I've described is inherently a batch system, and because the only way to have intermachine communications on a LAN is through semaphore files mounted on the server, it cannot easily be made interactive. It is conceptually identical to the way in which print servers work. It can all be done under MS-DOS, and it requires surprisingly little programming.

All the initiator process has to do is idle until something that it recognizes as an executable file turns up. When an executable file appears, the initiator runs it and resumes waiting.

I use a .BAT file to set JOBNUM instead of setting it directly to allow clients to know the next job number and because the batch file will survive shutdowns.

A practical application of this little scheme with clients running jobs that have been teed up on the server is to have PCs on a LAN function as a loosely coupled multiprocessor machine. The individual processors all run the same job(s) in parallel. I'm now setting up such a machine, and my version of RunJob is actually a .BAT file.

In Birkett's case, where clients send jobs to a server/client, the client has to know the next available job number and copy the executable file, with the right name, to the server.

As long as his executable files take the inputs/commands they need as command-line arguments or from a file, which will also have to be on the server, Birkett should be able to use the logic sketched above to get a machine on a LAN to function as a computer server.

Daniel W. Fromm
Cherry Hill, NJ

Clarifying ConvertUnits

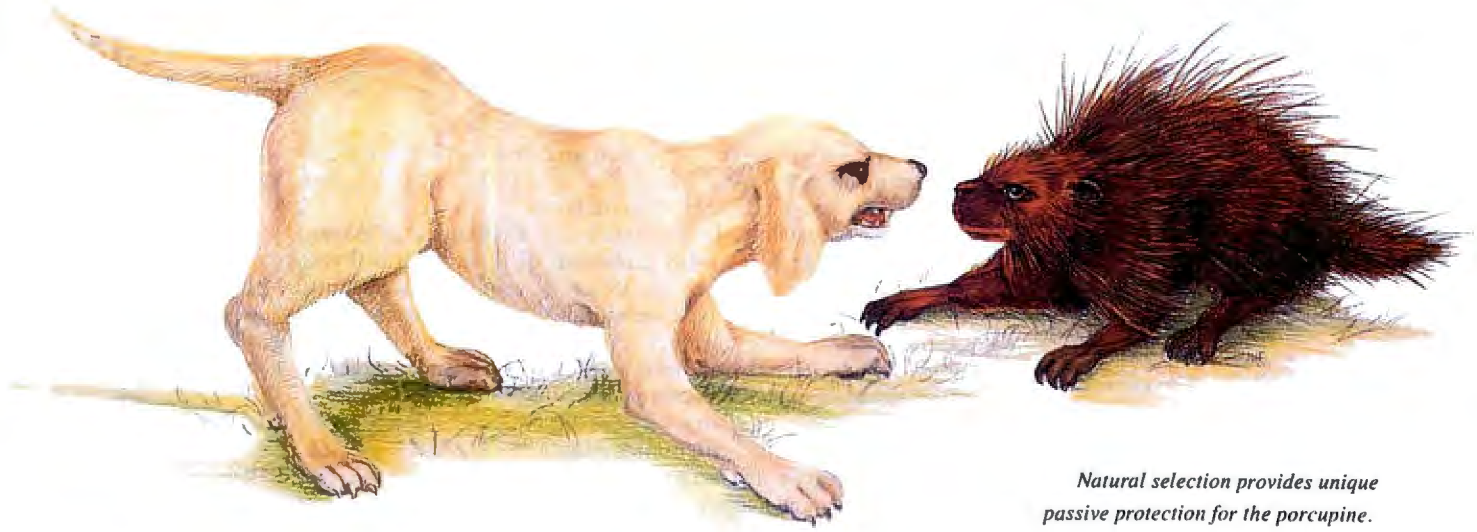
Many thanks to BYTE and Jerry Pournelle for the uplifting and encouraging mention of our ConvertUnits software desk accessory and HyperCard stack (Computing at Chaos Manor, February). We hope we can increase enthusiasm for our recently released product by clarifying several comments.

Jerry says that the manual doesn't tell you that you must copy the database files onto the hard disk. The section entitled "Preparing Working Copies," on page 20 of our manual, states, "Copy the Category documents you will be using to your working disks" and is followed on the next page by "With a hard disk system, copy all of the Category documents that you would use regularly." About the user interface, Jerry states, "now you have to let go of the mouse and press Return, because there's no 'activate' button." There is—the "=" icon, which is described throughout the manual in the "Tutorial" and the "Using" sections. We specifically implemented the "=" conversion button for power users to activate multiple conversions without having to let go of the mouse.

As Macintosh software developers, we are always interested in all insights to enhance the ConvertUnits interface. We would appreciate receiving any other suggestions that Jerry or other ConvertUnits users may have for additional refinements to the program. As longtime

continued

Software Developers



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Mac users, we are also interested in all improvements in the use of Macs.

At GTA, the facility for individual users of ConvertUnits to "customize" the database tables has already generated many hours of analysis and discussion. In fact, our HyperCard stack version includes user-definable currency conversions. We are currently exploring several alternatives for including other user-definable databases in future versions of ConvertUnits, while still maintaining the strict integrity and accuracy of the database tables and numerical conversion factors. In any event, we are currently offering a database customizing service to purchasers.

We are particularly savoring Jerry's concluding remark that he has not seen a better unit-conversion program for the Mac—that was precisely our intention in developing ConvertUnits. It's an honor to have had our software reviewed in BYTE.

John Lancaster
President
GraphicText Applications, Inc.
Vancouver, BC, Canada

ASK BYTE

Missing Math Coprocessor

I am generally pleased with my Toshiba T1000 laptop. But it lacks a provision for a numeric coprocessor. Is there any way to add one? This little machine seems to be pretty popular; I suspect that the addition of an 8087 might make it even more popular.

Wilton Sturges
Tallahassee, FL

I suspect you're right. There is no coprocessor socket on the T1000, and adding one is a task I wouldn't advise you to undertake. If someone comes out with some sort of clip-on outboard, we'll let you know.—R. G.

Significant Difference?

I can usually understand product descriptions well enough to make purchase decisions, but I'm having difficulty understanding the difference between the 80386 and the less expensive 80386SX. There must be a reason for the price difference, or else the more expensive of the two would not sell. The idea of spending less money on a new system appeals to me, but I'd like to know what I'd be giving up in return.

D. Gordon Gray
Bramalea, Ontario, Canada

See our February cover story ("The Mac SE Takes Off" by Nick Baran).—R. G.

Protection, Please

I'll be grateful if you can help me get in touch with any company that makes reliable data-protection software. I have programs and data on my hard and floppy disks that I'd like to protect against unauthorized duplication.

Mohammad Nasim
Riyadh, Saudi Arabia

It sounds like you should contact BBI Computer Systems (14105 Heritage Lane, Silver Springs, MD 20906, (301) 871-1094), which offers a free demonstration disk of its Stopcopy software.

You may also want to check out the firms now offering what is referred to as "hardware key" copy protection. This is usually a small adapter that connects to the computer's RS-232C port. You distribute the adapter with your software, and protected programs verify the legality of the machine by looking for the hardware key. The key's special design permits normal serial-port activity to occur uninhibited. Two companies to investigate are ProTech Marketing (1804 West Southern Pkwy., Building A-112, Durham, NC 27707, (919) 490-4790) and Software Security (870 High Ridge Rd., Stamford, CT 06905, (800) 333-0407.

—R. G.

Speak Forth

I have a number of questions regarding the Forth programming language.

First, what is this 2K-byte kernel I keep reading about?

Second, how do you go about getting Forth started? If the kernel simply looks things up in a dictionary, how does anything get started?

Finally, I've read that there are many ways to implement "threaded code." What are the differences, and what are their pros and cons?

T. Dunlap
Ottawa, Ontario, Canada

I'll tackle your questions in order.

First, with regard to the 2K-byte kernel, I would have to know just which implementation of Forth you were looking at before I could make any accurate comments. The kernel is best described as the minimum amount of code and data you need to create a usable Forth environment. Of course, this is one of Forth's quirks: One person's view of a "usable" Forth environment may be quite different from another's. Still, a basic Forth sys-

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CSR 286/20

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tem usually takes up remarkably little code; early versions on single-board computers did quite well in 16K bytes of RAM. Most Forths for the IBM PC operate within a single 64K-byte segment (though it's easy to add provisions to address beyond that limit), and a program that would consume all of the 64K bytes is—by Forth standards—large.

If you want to see how Forth "gets started," I suggest that you obtain the source code for any of the more popular versions. Then sit down for an evening of intense reverse-engineering.

You'll find that most implementations load the instruction pointer register (often referred to as the IP) with the address of the next Forth word to execute. (Don't get the IP register confused with the code segment [CS] register; they are not the same thing.) When Forth boots up, the starting code sets the IP to point to the first word of the "inner interpreter." This is a sequence of Forth words enclosed in an infinite loop, whose actions are as follows:

1. *Read the next space-delimited item from the input stream.*
2. *If it's a word in the dictionary, execute that word.*
3. *If it's a number, put it on the stack.*
4. *Go to step 1.*

You'll find a more detailed description of this process in R. G. Loeliger's Threaded Interpretive Languages *(BYTE Books, 1981).*

Finally, there are three primary ways to implement threaded code (and there are probably more being invented all the time). Direct-threaded code means that the IP points to a memory cell whose content is the starting address of the code to be executed. Most Forths use direct-threaded code. Token-threaded code means that the IP points to a memory cell whose content is a token that the program can use to determine the true address of the executable code. Usually, this token is an offset into a table of addresses. Subroutine-threaded code means that the executable Forth code is nothing more than a series of subroutine CALL statements. Mach II, which is a Forth for the Macintosh, Amiga, and Atari ST machines, uses subroutine-threaded code. (Mach II is available from Palo Alto Shipping Co., P.O. Box 7430, Menlo Park, CA 94026.)—R. G.

Personal BBS

I have a question concerning the commercial BBSes that I can call with my

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personal computer. How is it that I can get through, even when many other people are using the system? Is one computer running the whole show, or is there a separate computer for each caller, all linked to a central database?

I would also like to know what I can do if I want to set up my own BBS, but I don't want to be limited to just one caller at a time.

Ross Del Duca
Sumner, WA

Welcome to the world of multiuser systems. The setups used by the larger BBSes (e.g., BIX, CompuServe, and The Source) are about as complex as you're going to get. Take BIX, for example. It's a multiprocessor, multiuser Unix system. At present, two CPU systems actually run the BIX program, and another pair act as communications "front ends" (i.e., answering incoming calls and handling the flow and buffering of data between BIX and the users).

Multiuser BBSes available to the end user are equally varied. I've seen people running multiuser BBSes by launching multiple tasks under Quarterdeck's DESQview. Galacticomm (11360 Tara Dr., Plantation, FL 33325) sells multiline communications interfaces (up to 16 modems on a single board) and accompanying multiuser BBS software.

—R. G.

FIXES

• In the February 1989 Short Take entitled "Unix Tools for DOS," the statement that MKS Make contains the Mortice Kern RCS (Revision Control System) is in error. The RCS package must be purchased separately. The price for the RCS is $189. Contact Mortice Kern Systems, Inc. (35 King St. N, Waterloo, Ontario, Canada N2J 2W9, (519) 884-2251).

• With reference to our First Impression on the Intel i860, "Intel's Cray-on-a-Chip" (May 1989, page 113), AMD is pulling its 29000 RISC chip only from one portion of the RISC market, workstations. AMD says that it is instead concentrating its attention on the embedded processor market and that new 29000-family products are on the way.

• The article "A CASE Workshop" in our April In Depth section contained an incorrect phone number. The correct phone number for Cadware (50 Fitch St., New Haven, CT 06515) is (203) 387-1853. ■

CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

Pint-Size Unix?

Dear Jerry,

It seems that microcomputing has now reached puberty, with its attendant changes and confusions. In some ways, this is not an easy time to get into the act, but here I am with my brand-new IBM PC compatible. In looking around to try to decide where I should invest my learning time, I've hit on an idea about operating systems that might help people in a similar situation in the future.

Unix seems to have far more capabilities than I need now and requires far more memory than I have now. But some years down the road, I expect to need many of the facilities afforded by Unix, such as a good environment for writing programs in C and multitasking.

What about dividing Unix up into levels that could be later joined as user requirements increase? For example, level 1 might cover only that part of the operating system that would afford capabilities analogous to those afforded by CPM. Level 2 would add the next most used Unix capabilities, and so on, until successive levels included all of the Unix operating system and all the utility programs. Each level would include software patches as necessary to make that level operate independently but would look to the user the same as it would if he or she were using that part of the whole Unix system.

If that idea would work, it would make Unix practical for the very large and the very small computers, and it would give the user the chance to invest his or her learning time with more confidence that it wouldn't be lost. After all, the Unix system has been around long enough to prove its worth, and if it were possible to start small in Unix, at least you'd have a pretty good idea of where you were going.

From a user's point of view, is this a useful idea or a dumb idea? If it has any merit, I'm sure that the software people will look at it. Possibly they already have.

William Radford
Orlando, FL

Unix is pretty well, uh, unified, but in fact the various levels you describe can be done with Unix shells. American Management Systems has one such shell that tames Unix a lot.

The real problem with Unix is that, just when you think you've mastered it, something else happens. Users don't need surprises.

People who like Unix like it a lot. Most everyone else has a different view. . . .

—Jerry

Why Not Buy Two?

Dear Jerry,

I hope your friend Kelly Freas has not yet bought his Macintosh II. Since you own more than one computer, it's surprising that you didn't suggest that Kelly get more than one. For one thing, two people can work on two computers at the same time.

Of course, the real reason for Kelly to buy an Amiga 2000 and a PC clone, such as the Dell System 220, is that he would have the best artistic machine and the best business machine. He can get a color Amiga 2000 with 3 megabytes of RAM and a 40-megabyte hard disk drive for about $3300. A color Dell System 220 with 1 megabyte of RAM and a 40-megabyte hard disk drive and DOS 3.3 costs about the same.

I think a color Mac II with 4 megabytes of RAM and a 40-megabyte hard disk drive costs about $9000, but I'm guessing. A less powerful PC clone would save money.

You've already determined that the savings could be used to buy a color printer, among other things. This would give Kelly the best and more.

Barton C. Grooms
Amarillo, TX

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 "jerryp."

Well, Kelly got an Amiga; he was impressed with the graphics. Now Laura will have to figure out how to do his accounting, but if they get a Bridge Card (which makes the Amiga run vanilla PC software), I'll donate a copy of the accounting package that I wrote in 1978 and still use.—Jerry

One Man's Interpreter

Dear Jerry,

In his letter, "The Case for GOTOs," Mobolaji E. Osunsanya (Chaos Manor Mail, December 1988) states that an interpreter converts a line of source code to machine code and then immediately executes it. The interpreter that I use doesn't do any "code translation," but instead truly interprets the tokenized source code. I don't understand why the interpretation of tokenized source code should be any slower than the execution of compiled code.

A compiler often compiles the source code down to a bunch of subroutine calls to the library. An interpreter uses the token value for a keyword to immediately do a subroutine call to the appropriate routine.

The use of tokens allows source code storage in less memory and allows a simple and quick indexing into the "dispatch table" of addresses for the routines to handle each keyword. I believe that the difference between a token dispatch in an interpreter and a library routine call in a compiler is minor.

If, in performing a statement or function as specified by a keyword token, the interpreter finds another token, that routine is called. For example, PRINT INT-(SQR(9)) calls the print subroutine. In executing the print subroutine, the INT token is found, resulting in the INT function being called.

In executing the subroutine called by the INT token, the SQR token is found, resulting in SQR being called. Finally, while executing the SQR routine, the number 9 is found. This results in the ASCIIFAC routine being called, which takes the ASCII 9 in the source code, converts it to binary floating-point, and places it in the floating-point accumulator (FAC).

The return from the ASCIIFAC routine returns you to the SQR routine, which now finds the function argument in the FAC. The square root of the contents of the FAC is calculated and placed in the FAC.

The square root routine ends with a return (RTS), which returns you to the INT function, with the argument in the FAC. The INT function then places the result in the FAC and returns. At this point, the PRINT statement calls FOUT, which converts the contents of the FAC to ASCII, ready to print.

The line of source code was never converted to machine code; it was truly interpreted. I don't see how a compiler could do this much faster, other than realizing that the 9 is a constant, which could have then been stored in binary floating-point format, eliminating that conversion at run time. A smarter compiler (or programmer) would have realized that the whole statement calls for the printing of a constant, so the constant could have been calculated at compile time (or program writing time) instead of at run time.

Osunsanya suggests that the use of GOTOs instead of GOSUBs can result in improved program performance (speed, I assume) because of the lack of stack overhead. The interpreter that I work with handles GOSUBs much faster than GOTOs.

Actually, the GOSUB is slightly slower (because of stack overhead), but the RETURN is much faster than another GOTO to get back. This is because a RETURN pulls the actual machine address of where to return (in the tokenized source code), while a GOTO must do a line-number search to locate its destination.

A line-number search is quite slow. It is a linear search from the beginning of the program (if the destination is before the current line number) or from the current location (if the destination is after the current line number).

The line-number search uses the line length stored after the line number in the source code to determine where the next line number is. It then "bounces" from line number to line number looking for the destination.

Since a compiler would substitute a JMP <*Address*> for the GOTO <*Line-Number*>, it would be considerably faster. I imagine that an interpreter could do something similar, but at this point I may be modifying the tokenized source code beyond recovery.

Harold Hallikainen
San Luis Obispo, CA

One of the neat things about writing this column is that I get letters from people who know what's going on inside these machines.

My understanding is that interpreted systems slow down when they are confronted with loops; each statement has to be interpreted yet again as the machine goes through another iteration. A compiler, on the other hand, translates that code once and for all and then executes the machine code however many times is required.

It may be that modern interpreters work differently, but that's certainly the way they worked when I was learning this stuff.—Jerry ■

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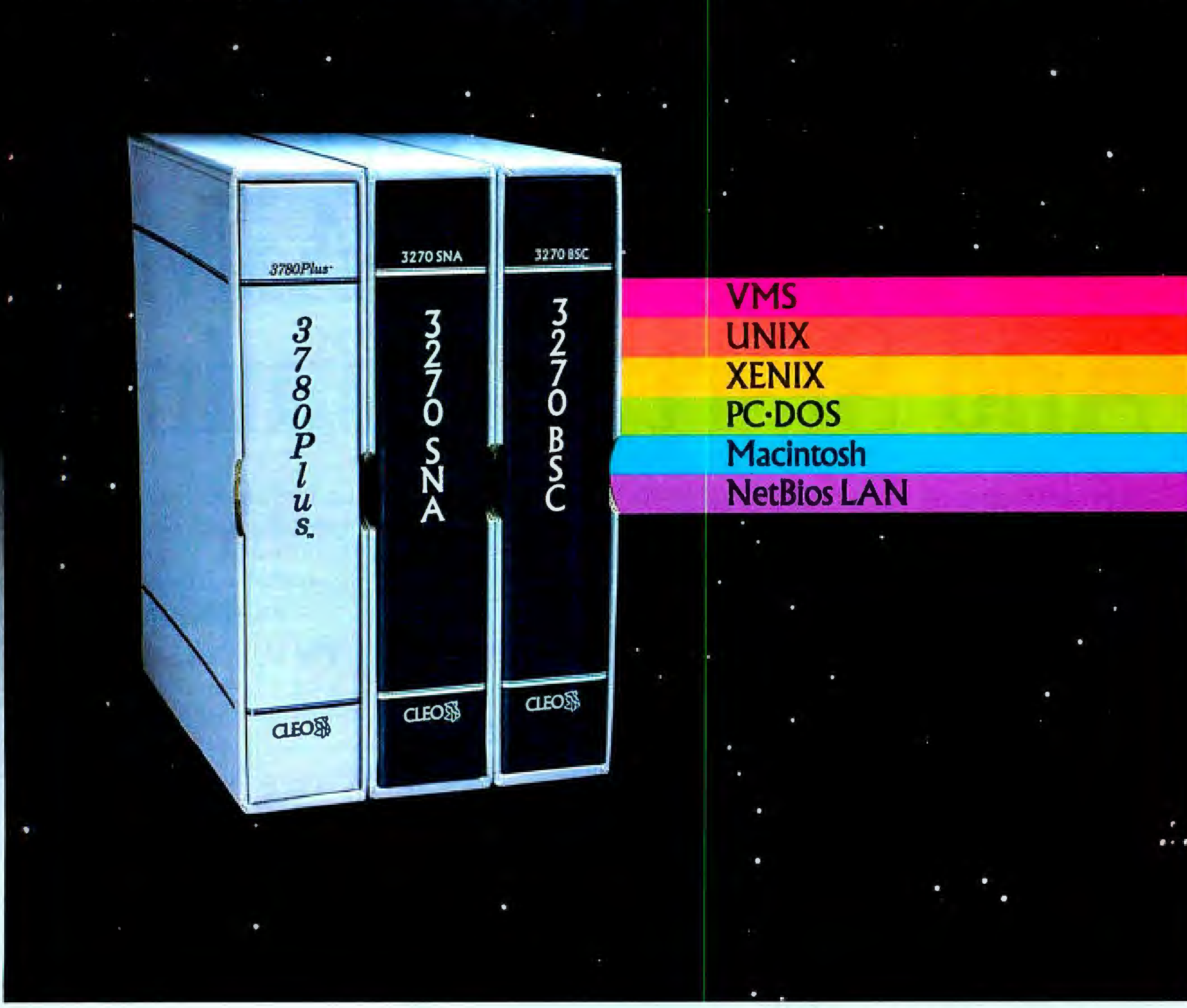

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The Chip War
by Fred Warshofsky

Scribner's, New York: 1989, 448 pages, $22.50

Reviewed by Hugh Kenner

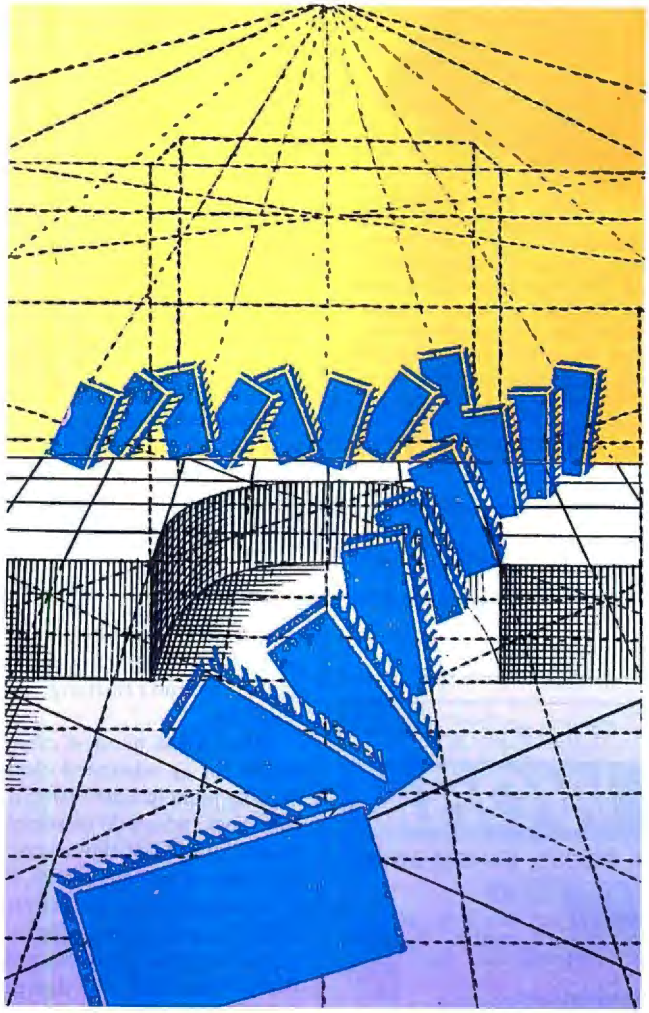
The way it was told to Fred Warshofsky, here's how Sony cracked the U.S. TV market, with "a strategy that might have been drawn by a Go-playing Shogun":

Said Sony to RCA, "Look, we can sell you your low-end model, which you are selling to Sears, cheaper than you can make it." RCA said, "Great," bought it from them, put an RCA label on it, and went on fencing it to Sears.

Said Sony to Sears, a few years later, "We can sell you this same set cheaper than RCA can and put a Kenmore label on it." So the TVs next flowed from Sony straight to Sears/Kenmore, while RCA, noting a mysterious drop in demand, cut back its orders.

Then said Sony to RCA, "Evil round eye, you are not buying the quantities you said you would." That ended the agreement with RCA. Then "they had the distribution channels, the shipping, and now understood the American market because RCA and Sears had explained it to them, and so they started selling direct." And selling *very* good stuff.

The stuff got so good in part because Japan in the early 1970s did not have a large vacuum-tube manufacturing base in place, the kind of base the likes of RCA, GE, Zenith, and Westinghouse were reluctant to abandon. So it cost Japan no pain to go for semiconductors. Also, Japan somehow grasped the appeal of the transistor radio. (Said the Board of Directors at Texas Instruments,



"It's an interesting product, but what value does it have?" TI, Warshofsky correctly remarks, "was not a consumer-oriented company.")

Further nuances: Not only did semiconductors emit less heat and use less power, they reduced the size of the TV. Then by upping the picture tube's deflection angle from 90 degrees to 110, the Japanese not only decreased the depth of the set (and reduced shipping costs), they made tabletop and portable TVs possible. And, Warshofsky says, "U.S. set manufacturers responded not by switching to semiconductors but by abandoning the field to the Japanese."

What they planned to abandon was the smaller sets. "Don't go toe to toe," runs a maxim of U.S. business; "you'll just get driven down to a misery gulch of low profits." No, exploit a different niche. So, dropping portables, they went for big consoles; and lo, the popular size of those proved to be 19 inches, which Japan's 110-degree deflection angle had turned into a tabletop. No win. In the U.S., Zenith is the only color TV manufacturer left.

But back to semiconductors, after all a U.S. invention. There the story is fascinating. A place to start is with the DRAM chip, something inherently low-profit. Memory chips are simple, repeating the same pattern over and over. That makes them cheap to manufacture. Memory boards are also simpleminded, the same chip over and over. That increases demand, which (given the economies of quantity production) shoves costs lower still. Pit several competitors against each other (that toe-to-toe competition U.S. business prefers to avoid), and what with their undercutting of one another, you've got a near-zero-profit situation. No one *wants* to be in the DRAM business. Let the Japanese have it, and welcome.

Oh? In 1953, what would become Sony (started in a garage) "licensed the rights to the newly invented Bell Labs transistor for $25,000. It ranks among the greatest bargains in history." Next, "They seem to be absolute masters at taking this original technology which we invent and improve the hell out of it in such a way that it's better and

continued

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it's cheaper. And then they turn around and sell it back to us at a price that is so low it just drives the Americans out of that business."

Confront such mastery with the U.S. itch to get out of the low-profit DRAM business, and you've a formula for disaster. Yes, DRAMs were "jelly beans," boring. But (says one of Warshofsky's sources), "The Japanese learned what Henry Ford learned. When you make enough of anything, you got to get smarter. So the next thing you know, the [Japanese] jelly-bean manufacturers knew more about manufacturing all kinds of semiconductors than the smart-asses back in the States." Analogy: Though, true, "The Little Red Hen" is no *Moby Dick*, it does help eager kids to learn.

Doodling with simple DRAMs, the Japanese got the clean-room technology down pat and learned all about automation, operator training, and reliability.

When IBM needed clean rooms for an advanced chip-making plant in East Fishkill, New York, where do you think it went for state-of-the-art construction technology? Why, to a Japanese firm, Shimitzu. IBM's face was saved when an American company named Walsh executed the design (i.e., laid the bricks). Also, IBM claims to have actually enhanced Shimitzu's design with its own "base knowledge." Sure. The company even claims that, really, it had just "wanted to see what they had." Sure. Cool it, IBM.

Meanwhile, buyers like Hewlett-Packard and NCR were observing that those Japanese 16K-bit RAMs had a much lower failure rate than U.S. equivalents. And suddenly (1981), leapfrogging a generation, Japan had 64K-bit RAMs to offer. While raising production to fantastic levels (66 million per year by August 1982), they were simultaneously bringing prices down: from, say, $30 a chip to $5. Partly, that was high-volume throughput. Partly, it was achieved by keeping Tokyo prices high to subsidize lower prices in Palo Alto. But mostly it was ruthless kamikaze pricing, "dumping" to wrest a market share.

By late 1985, Intel, who'd invented the RAM chip, had dropped out of the memory business, and Mostek, once the largest producer of 16K-bit RAM chips in the world, had dropped out of business, period. Motorola and National Semiconductor also gave up on memory. Memory chips were an Oriental monopoly.

A 1986 antidumping agreement did little to help; those high Tokyo prices suddenly became low Tokyo prices, and millions of 64K-bit—later 256K-bit—DRAMs got carried by suitcase from Japan to all over southeast Asia, as well as into the U.S. via Vancouver, where chips enter North America duty-free. You can cram thousands into a duffel bag. One smuggler's method was to bring lots of 40,000 across the border to Washington in a rented car, airfreight them to California, and then cover his tracks by driving back to Vancouver and boarding a plane to his home base in California. There, he could sign for the luggage he'd airfreighted. After that, bingo! A market thirsted for chips.

By spring 1987, sanctions were in place against Japan for noncompliance with the antidumping agreement. But it was too late for the U.S. chip manufacturers, most of whom had quit. The chief effect of the sanctions was to start U.S. equipment manufacturers yelling because their component costs were shooting up. (They stay up still.)

"It is time to restore the American work ethic": That's about the essence of Warshofsky's findings. "We must compete with people who display remarkable traits—loyalty, pride, and desire." These people include not only the Japanese, but the "Little Dragons" (Taiwan, Hong

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Kong, Singapore, and South Korea) and even the Europeans. In Korea, the road-cleaning crews have no supervisors. Even so, "they're always sweeping something, picking up something." Compulsively sweeping, picking up—that verges on slapstick. Yet Warshofsky is persuasive: A like sense of communal purpose propels populations who have become our adversaries in the Chip War.

A shiny and compact machine in my kitchen, microprocessor-governed, accepts dry ingredients and wet, then 4 hours and 40 minutes after the push of one button, it delivers a loaf of premium-quality bread. It kneads dough with a look of purpose, pauses for fermentation, kneads again, waits again, detaches the kneading paddle, hunkers down for a long but precisely timed ferment, bakes, and cools. You can watch all this happen through a plastic dome, like R2D2's cranium. Baking temperature gets diligently contoured to local ambience amid a chorus of chirps and clicks. That processor was obviously custom-made. No combination of housewife and home oven is likely to match its finesse. The shipping carton says "Japan." I fear I have seen the future, and it chirps.

BRIEFLY NOTED

The Puzzling Adventures of Dr. Ecco *by Dennis Shasha, W. H. Freeman and Co., New York: 1988, 182 pages, $9.95.* I first heard of Dr. Jacob Ecco when I was a college senior majoring in mathematics. At the age of 19, he had earned his Ph.D. at Harvard with a thesis on combinatorial catastrophe theory, then all but vanished into New York's Greenwich Village. A professor of mine had known Ecco in Cambridge and remembered him as a problem solver of incredible intellect. But Ecco also has, apparently, a great ability to rub people the wrong way—which may account for his turning his back on an academic career (though he was offered an endowed chair in mathematics at the University of Wisconsin at the unheard-of age of 20).

After dropping out of academia, Ecco went into business, calling himself an "omniheurist," someone who solves all problems. He eventually built up a clientele that now includes heads of state, various government agencies, and business tycoons—anyone having a difficult puzzle to solve (and the wherewithal to afford Ecco's ever-increasing fee). This business has been so successful that Ecco can afford to spend most of his time on a pet project: trying to figure out the puzzle of the human brain.

Although rumors of the sheer brilliance of Ecco's puzzle-solving feats have been floating around, almost all his successes have been shrouded in secrecy. Ecco himself is too publicity-shy to permit interviews, and he rigorously protects his clients' privacy. Thus, it is a major feat that Dennis Shasha, a computer scientist at the Courant Institute of Mathematical Sciences in New York, was able to coax Ecco into revealing not only the most challenging puzzles of his career, but also a glimpse into the workings of his amazing mind.

Narrated by Shasha's colleague, Professor Scarlet, the stories of Ecco's puzzling cases are told in a way very much reminiscent of Dr. Watson's chronicling of the adventures of Sherlock Holmes.

Although the names of Ecco's clients have been changed for obvious reasons, we can infer the identity of some: "Code Breaking" (the National Security Agency?), "Circuits Checking Circuits" (IBM?), and "Spies and Double Agents" (I'll leave that one to you). In all, the details of 38 of Ecco's most difficult problems are presented.

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asked questions at various points that will, if correctly answered, lead us to the solution.

The Puzzling Adventures of Dr. Ecco is written in a conversational style that makes it a pleasure to read. Ecco's cases are tough, though; I don't think many people could make a living trying to solve them. The aspect of this book that I find most appealing is that Shasha, Scarlet, and Ecco have chosen problems that face many of us (in different guises) in the day-to-day affairs of computing, science, and business. Paying close attention to the puzzle-solving techniques of a master like Ecco just might make our own professional problems a little bit easier to handle.

—Eric Bobinsky

The Mathematical Tourist (Snapshots of Modern Mathematics) *by Ivars Peterson, W. H. Freeman and Co., New York: 1988, 240 pages, $17.95.* During the twilight of Queen Victoria's reign, it was fashionable for English gentry to pass their idle hours studying mathematics. Some of these amateur mathematicians were amateur only in that they weren't paid for their skills; they contributed not a little to the science of mathematics. Nowadays, we'd be surprised if someone told us they "did mathematics" as a hobby. The entire dry, dusty field has been relegated to the ivory towers—and rightly so, since it never changes; all the mathematics we'll ever need was invented 200 years ago, and there's no reason to subject us to any more of it than we had to take in school. Right?

Actually, mathematics is anything but dry and changeless. It is as fluid as art and as variable as the seasons, and it can be as new and fresh as good literature. Mathematics today is undergoing nothing short of a renaissance, thanks in part to the computer and in part to the warm reception nonmathematicians have been giving esoteric concepts like fractal geometry, chaos, and curved space-time. Today, apparently, there is a general desire for heightened mathematical awareness.

Ivars Peterson, a science teacher and science writer, satisfies that desire by surveying the landscape of modern mathematics: from the first use of a computer to prove a theorem to the (still) mysterious world of prime numbers; from soap bubble surfaces and knots to fractal mountains; from modern cryptology to mathematical monsters; from the uncertainty of chaos to the computer game of Life; and other fascinating topics.

Peterson takes us to the heart of modern mathematics. Using words we can understand, he reveals the excitement of discovery and the allure of the unknown that characterize mathematical research today. With its clear, conversational tone and excellent illustrations, *The Mathematical Tourist* is a landmark book about a field whose rare beauty is far too often hidden from view.*—Eric Bobinsky*

The UNIX Word Processing Book: A Step-by-Step Guide *by Bryan Strong and Jay Hosler, John Wiley & Sons, New York: 1988, 380 pages, $24.95.* This attractive plastic-comb-bound book makes a handy companion beside your Unix terminal. It includes two tear-out reference cards: one on Unix commands and utilities, and the other on specifics of the standard Unix text-editing and formatting programs. The pages are comfortably designed, with wide margins for notes. Two-color printing emphasizes sections, and visual relief is provided with homey illustrations of cats and computers.

Each unit is divided into a section that introduces the concepts mixed with "Hands-On Activities," followed by a review of the material. Strong and Hosler also provide countless examples, exercises, and summaries. This is atypical of

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Unix books. The material is an unusual mixture of relatively advanced Unix text-formatting concepts and very elementary Unix commands and shell concepts. The writing style is appropriate for the nontechnical—perhaps even neophyte—Unix user, but it seems at odds with the material.

The first unit introduces `nroff`. The second unit covers Unix shell concepts, including redirected I/O and pipes, background processes, and shell scripts. The third unit introduces the concepts of typesetting and `troff`. Not until the fourth unit (page 184) are you given any information about the standard editor, vi. And then the text starts at the very basic level of moving the cursor.

The final section gives instruction in a miscellany of Unix commands, including `spell`, `lpstat`, `find`, `grep`, and `diff`. The three appendixes are very worthy guides for any Unix user, as is the glossary.

It seems a shame to have put so much planning into the publication of this book and to have its material miss the needs of the modern Unix user. The target audience seems to be the poor soul who isn't adept at Unix and yet is required to use the old standard Unix tools to turn out documents.

These tools are far from what is considered "word processing" in the more common world of personal computers and word processing machines. I prefer to use vi over any true word processing program that runs under Unix. However, I am a programmer at heart and like the Spartan world of text editors over the elegant world of WYSIWYG word processing. This book was certainly *not* written for programmers.—*Ben Smith*

MS-DOS Developer's Guide, 2nd ed. *by the Waite Group, Howard W. Sams & Company, Indianapolis, IN: 1988, 783 pages, $24.95.* This delightful book is best viewed as an anthology of loosely related topics for developers of MS-DOS software.

The introductory chapters deal with structured and modular design of assembly language programs. TSR programming is given a detailed treatment, including descriptions of privileged DOS calls and internal DOS structures, many of which have never appeared in print. Two chapters on the LIM/EMS are perhaps as clear and thorough explanations of this topic as have been published to date.

Other sections present programming of real-time applications, using a serial port, the basics of EGA/VGA register programming, and the Intel 8087 math coprocessor. There are discussions of disk layout and file recovery and the differences among DOS versions through 4.0. A useful appendix tabulates MS-DOS interrupts and functions that are not publicly documented by Microsoft, with calling sequences. Finally, there is a sturdy tear-out MS-DOS reference card that summarizes the various DOS interrupts and functions.

For a large book with multiple contributors, this has remarkably few inconsistencies and typos. It is chock full of useful examples written in assembly language and C. Because it fills in many gaps in Microsoft's *MS-DOS Encyclopedia*, the *MS-DOS Developer's Guide* is a must reference book for designers of TSR programs, device drivers, and EMS applications.

—*Ben Myers* ■

CONTRIBUTORS

Critic and author **Hugh Kenner** lives in Baltimore, Maryland. **Eric Bobinsky** works at the NASA Lewis Research Center in Cleveland, Ohio. **Ben Smith** is a BYTE technical editor. **Ben Myers** is the designer of Personal Measure, a PC performance measurement package, and lives in Harvard, Massachusetts.

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MAPPLICATIONS ■ Laszlo Bardos

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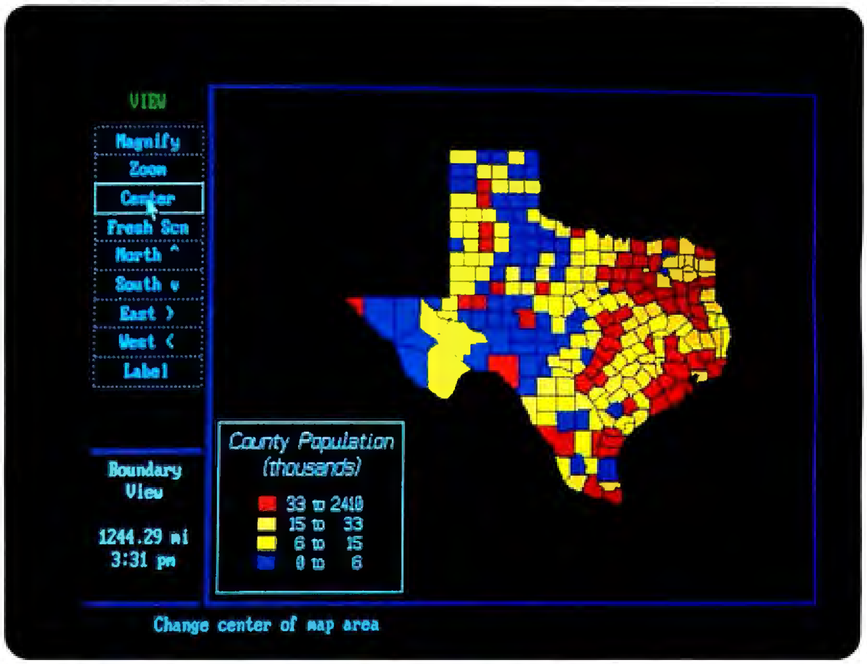

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XDB-C	395	359
XQL	795	599
Xtrieve Plus	595	459

FORTRAN LANGUAGE

	LIST	OURS
F77L	477	429
F77L-EM/32	895	829
GRAFLIB	175	159
Grafmatic	135	119
Grafmatic/Plotmatic	240	219
GRAFPLUS	50	45
Lahey Personal FORTRAN 77	95	89
MS FORTRAN	450	299
PLOTHI	175	159
PLOTHP	175	159
Plotmatic	135	119
Printmatic	135	119
RM/FORTRAN	595	499
SPINDRIFT Library	149	125
TEKMAR Graphics Library	195	169
WATFOR FORTRAN	375	337

GRAPHICS LIBRARIES

	LIST	OURS
Essential Graphics	299	229
GraphiC	395	322
Graphics and Animation	100	89
GSS Graphics Devel. Toolkit	595	509
HALO '88	325	229
HALO '88 for MS Devel.	595	399
PCX F/X	99	90
PCX Programmer's Toolkit	125	115
PCX Text	99	90
Turbo Geometry Library	150	135

LINKERS/LIBRARIANS

	LIST	OURS
LINK & LOCATE ++	395	349
OPTLIB	49	45
OPTLINK	125	115
Plink86plus	495	279
PolyLibrarian II	149	131
.RTLink	195	185

MODULA-2

	LIST	OURS
LOGITECH Modula-2:		
Compiler Pack	99	81
Development System	249	199
TopSpeed Modula-2:		
Compiler Kit	100	89
DOS 3-Pack	180	159

OBJECT-ORIENTED PROGRAMMING

	LIST	OURS
ACTOR	495	423
Language Extension I	99	95
C_talk	150	137
C_talk/Windows	450	399
Smalltalk/V	100	85
Communications	50	45
EGA/VGA Color Extension	50	45
Goodies #1, #2 or #3	50	45
Smalltalk/V 286	200	169
Zortech C++	150	129
w/ source	250	209

OPERATING SYSTEMS/ CONTROL PROGRAMS

	LIST	OURS
Concurrent DOS 386 (3 users)	395	335
10-User System	495	419
DESQview 386 (w/ QEMM)	190	169
QEMM 386	60	55
MS Windows/386	195	130
PC-MOS 386 (single user)	195	179
5 Users	595	539
VM/386	245	205
VM/386 Multi-user	895	759

OS/2 DEVELOP. TOOLS

	LIST	OURS
BRIEF for OS/2	195	CALL
Btrieve for OS/2	595	455
Epsilon for OS/2	195	151
Greenleaf DataWindows	395	309
GSS Dev. Toolkit for OS/2	695	559
KEDIT for OS/2	175	139
MKS MAKE	249	219
MKS TOOLKIT	495	439
MKS RCS	395	349
MKS VI	199	175
Modula OS/2	349	279
NeWS/2	495	CALL
PCYACC/2	395	359
PolyAWK for OS/2	199	159
Vitamin C (OS/2)	345	279
Vermont Views for OS/2	CALL	CALL

PASCAL LANGUAGE

	LIST	OURS
B-tree Filer	125	99
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MS Pascal	300	189
Pascal ASYNCH MANAGER	175	129
POWER SCREEN	129	99
Professional Pascal	595	549
Turbo Analyst	99	79
TurboMAGIC	199	179
Turbo Pascal 5.0	150	105
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Turbo-Plus 5.0	100	80
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Turbo Professional 5.0	125	99

NEW RELEASES

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Logic processing software. Helps you develop the logic portion of any computer program, then creates source code in C, BASIC, Fortran, Pascal or dBASE language. Create "perfect" logic; Logic Gem considers all the possibilities and completes the logic for you, with no contradictions or redundancies.
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SHERLOCK
Programming tool that works to trace, debug, and profile C programs. Includes C language macros and support routines called by those macros, inserted into code and enabled while the program is executing. Effective for debugging complex algorithms such as dynamic storage allocation and recursive tree traversals.
List: $195 **Ours: $179**

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Curses	100	59
dBC III	250	179
dBC III Plus	500	349
RPG 3.0	1600	1279
SecretDisk II	79	59
SideTalk	120	99
SSP/PC	350	279

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Grasp 3.5	199	169
Instant Replay III	150	131
Proteus	149	125
Show Partner F/X	350	319
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Norton Guides	100	75
Tom Rettig's HELP	120	105
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AutoSort	150	131
MS Sort	195	130
Opt-Tech Sort	149	105
Sortex	150	129
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Bas_C (Commercial)	375	323
Bas_Pas (Commercial)	280	242
BASTOC	495	399
dBx TRANSLATOR	550	469
PROMULA.FORTRAN	450	425
TP2C	249	199
UTILITIES		
1 DIR Plus	95	75
BACK-IT	129	120
Command Plus	80	70
w/ Programmer's Toolkit	130	115
Copy II PC	40	35
Copy II PC Option Board	159	139
Disk Technician Advanced	190	159
Disk Technician Plus	130	119
FASTBACK Plus	189	142
HELP ME	99	90
hTest:hFormat	90	80
MACE GOLD	149	129
MACE Utilities	99	90
Magellan	139	CALL
MKS Toolkit	199	169
Norton Commander	89	56
Norton Utilities	100	61
Norton Utilities Advanced	150	101
Pathminder	70	65
PC Fullback	70	59
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V OPT	50	47
Vfeature Deluxe	120	111
Vtools	50	47
XENOCOPY-PC	80	70
XTree	70	60
XTree Pro	129	111
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MKS RCS	189	161
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Seidl Version Manager	300	269
TLIB	100	90
OTHER LANGUAGES		
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Epsilon	195	152
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Microport Sys. V/386 (comp.)	899	759
Microport Sys. V/AT (comp.)	649	549
Microsoft FORTRAN	695	CALL
Microsoft Pascal	695	CALL

	LIST	OURS
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PANEL PLUS	795	675
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SCO XENIX System V (comp.)	1295	999
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Paradox 3.0	725	525
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Turbo Assembler/Debugger	150	112
Turbo Basic	100	75
Turbo C 2.0	150	112
Turbo C 2.0 Professional	250	175
Turbo Pascal 5.0	150	112
Turbo Pascal 5.0 Professional	250	175
Turbo Prolog	150	112
Turbo Prolog Toolbox	100	75
GREENLEAF		
Greenleaf Bus. MathLib, DOS	325	229
Greenleaf Comm. Library	229	165
Greenleaf DataMath Interface	75	69
Greenleaf DataWindows, DOS	295	219
Greenleaf Functions	209	155
Greenleaf MakeForm, DOS	125	99
Greenleaf SuperFunctions	265	189
Greenleaf ViewComm	495	449
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VM/386	245	205
VM/386 Multi-User	895	759
VM/386 NetPak	150	129
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MS C	450	299
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MS Macro Assembler	150	99
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MS QuickC 2.0	99	69
MS Sort	195	139
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MS Windows Development Kit	500	319
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MKS LEX:YACC	249	219
MKS MAKE	149	135
MKS RCS	189	169
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MKS Toolkit	199	179
MKS Trilogy	119	105
MKS VI	149	135
NOVELL		
Btrieve	245	185
Btrieve for Dos 3.1 Networks	595	455
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NetWare System Calls for DOS	195	159
NetWare RPC	950	759
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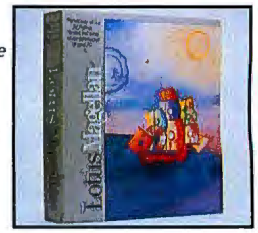

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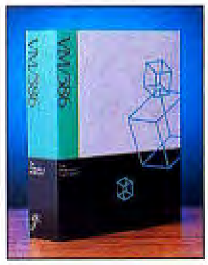
VM/386

"VM/386 should be considered mandatory software as important as MS-DOS." ... Computer Language 10/88



VM/386, PC Magazine Technical Excellence Award Winner, lets you create "virtual machines," each running its own MS-DOS application so you save valuable time while maximizing the performance of your 386 PC. Time consuming tasks like compiling code and running bulletin boards no longer tie up your PC, because they run simultaneously. VM/386 offers the highest level of data integrity and software compatibility available in a multitasking operating environment. Order your copy today!

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List: $245 Ours: $199

Greenleaf SuperFunctions

Greenleaf's advanced library of over 360 functions for C with expanded coverage where you need it today. Greenleaf's SuperFunctions offer mouse support for text and graphics, logical windowing, expanded memory support, advanced time/date functions, an integrated status/error return system, pull-down menu system, keyboard functions, and much more. The library comes with a 500 page manual, reference card, and FREE source code to all demos, functions and examples. This is the one C library a professional programmer should have.

GREENLEAF Software®

List: $265 Ours: $189

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TimeSlicer is the most popular linkable library of C functions for creating multitasking and real-time programs at the application level rather than interfacing with the operating system.

TimeSlicer will allow an unlimited number of tasks to be running concurrently. You can create, suspend or terminate tasks at run-time. Preemptive and non-preemptive modes are supported, as well as waking-up of tasks to optimize special event processing. TimeSlicer C functions can be installed to replace or complement any interrupt service routine.

TimeSlicer is the better choice for creating multitasking programs, giving you greater control and more efficient implementation of your multitasking application than its operating system counterparts.

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Micro Express Ships 33-MHz Machine

The ME 386-33 is an inexpensive zero-wait-state 33-MHz 80386-based system that includes 4 megabytes of 32-bit system memory, a 64K-byte cache, a floppy disk drive, and a 101-key AT-style keyboard.

A VGA monitor is optional, as are two hard disk drives: a 1.2-megabyte 5¼-inch drive or a 1.44-megabyte 3½-inch drive.

You can upgrade system memory to 8 megabytes on the American Megatrends motherboard and to 16 megabytes (total) with a daughterboard.

There are five half-height drive slots, plus two 8-bit, five 16-bit, and one 32-bit card slots, two serial ports, and one parallel port.

Price: $5995; 140-megabyte hard disk drive, $1500; VGA monitor, $750.

Contact: Micro Express, 2114 South Grand Ave., Santa Ana, CA 92705, (800) 642-7621; in California, (714) 662-1973.

Inquiry 1126.

The 33-MHz Micro Express ME 80386 with optional floppy disk drive and VGA monitor.

Unisys Winds Up to 25 MHz

The Personal Workstation² Series 800/25A is now the fastest Unisys microcomputer. It includes 2 megabytes of RAM (expandable to 18 megabytes), two 32-bit card slots, an 8-bit slot, five 16-bit slots, two RS-232C ports, a Centronics parallel port, and MS-DOS 4.01 with Windows/386 and GWBASIC.

Options include hard and floppy disk drives, a keyboard, a math coprocessor, and monitors. Monochrome monitors feature 720- by 350-pixel resolution (12-inch) and 640- by 350-pixel resolution (15-inch).

For networking, you can add up to two 320-megabyte hard disk drives and a 135-megabyte tape backup system through the SCSI port. There are five open slots for half-height 5¼-inch drives.

Price: $7315; with floppy disk drive, $7790; with 140-megabyte hard disk drive, $10,685.

Contact: Unisys Corp., P.O. Box 500, Blue Bell, PA 19424, (215) 542-2244.

Inquiry 1127.

How Little Will You Pay for an 80386?

The SAM3001/386 from HiTech International has most of the things that constitute a 16-MHz 80386, but it sells for only $999.

There's a megabyte of RAM, a 1.2-megabyte 5¼-inch (or a 1.44-megabyte 3½-inch) floppy disk drive, a disk drive controller, a 200-watt power supply, and a 101-key keyboard. It features an Award BIOS and a utility RAM setup disk.

The eight-slot system comes standard with the RAM in one 32-bit slot. That leaves three 8-bit slots and four 16-bit slots open.

Price: $999.

Contact: HiTech International, 712 Charcot Ave., San Jose, CA 95131, (408) 435-8827.

Inquiry 1124.

Toshiba Lightens Up

Toshiba's latest laptop, the T1600, weighs just 11⅞ pounds and runs at 12 MHz.

It features a megabyte of RAM (upgradable to 5 megabytes), a 20-megabyte hard disk drive and a 1.44-megabyte 3½-inch PS/2-compatible floppy disk drive.

The backlit supertwist LCD display is EGA compatible and offers a resolution of 640 by 400 pixels. The screen displays a full 80 characters by 25 lines. It's also detachable.

Each of the two standard-equipment batteries weighs 15 ounces and is removable and rechargeable. One battery defaults to the other when the first one gets to a certain low-energy point.

Bundled software includes MS-DOS 3.3, PC-Kwik Power Pak disk-cache utility software by Microsoft, and hypertext disk-resident DOS. Options include an external 360K-byte 5¼-inch floppy disk drive and a 17-key numeric keypad.

Price: $4999.

Contact: Toshiba America, Inc., Information Systems Division, 9740 Irvine Blvd., Irvine, CA 92718, (800) 457-7777; in California, (714) 583-3000.

Inquiry 1125.

continued

SEND US YOUR NEW PRODUCT RELEASE

We'd like to consider your product for publication. Send us full information, including its price, ship date, and an address and telephone number where readers can get further information. Send to New Products Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Information contained in these items is based on manufacturers' written statements and/or telephone interviews with BYTE reporters. BYTE has not formally reviewed each product mentioned. These items, along with additional new product announcements, are posted regularly on BIX in the microbytes.sw and microbytes.hw conferences.

Removable Drive for IBMs and Apples

The Maxi RD45 is a 45-megabyte removable SCSI hard disk drive system that features an average access time of 25 ms and works on both IBM PCs and Macs.

With the half-length XT/AT kit or the Micro Channel full-length kit, you can daisy-chain up to seven drives. Whichever system you use, the data transfer rate is 500K bytes per second.

Each cartridge measures 5½ inches square and fits into the internal or external 5¼-inch form factor mounts. A write-protect switch on the cartridge protects the disks from accidental overwriting; a cartridge-locking mechanism prevents accidental removal during read/write sessions.

Drive packages contain necessary SCSI connectors, terminators, and one cartridge.

Price: Internal, $1325; external, $1625; Mac interface kit, $80; MCA kit, $250.

Contact: Sysgen, Inc., 556 Gibraltar Dr., Milpitas, CA 95035, (800) 821-2151; in California, (408) 263-4411.

Inquiry 1130.

The Maxi RD45 is a removable hard disk system.

C.Itoh's 18-pin Dot-Matrix Printer for LANs

The ProWriter CI-5000 is an 18-pin monochrome (color optional) dot-matrix printer that's designed as a shared network printer, according to C.Itoh.

The ProWriter CI-5000 prints in draft mode at up to 540 cps, 100 cps in near-letter-quality mode, and 73 cps in letter-quality mode, C.Itoh reports.

C.Itoh claims compatibility with the IBM ProPrinter XL, the Epson FX-286e, and DEC's LA210/LA75/LA50 printers. Paper can be up to 16 inches wide. Paper feed can be friction or tractor-pin in forward and reverse directions. The 33-pound machine measures 6 by 23 by 18 inches.

For networking, there are ports for parallel and RS-232C connectors as well as a 6-pin RS-423 for DECnet and MicroVAX connections.

A port on the printer's left side allows future enhancements with font cartridges and RAM upgrades (up to 128K bytes). The printer includes 8K bytes of RAM.

Price: $1995.

Contact: C.Itoh Electronics, Inc., 2505 McCabe Way, Irvine, CA 92714, (800) 227-0315; in California, (714) 660-1421.

Inquiry 1129.

Hewlett-Packard's DeskJet Plus

The DeskJet Plus is an updated version of the original DeskJet that includes landscape mode, additional built-in fonts (6 portrait and 4 landscape), and revised proportionally spaced text.

Because paper and processor throughput have been improved, the HP DeskJet Plus produces a page of text up to twice as fast as the original. Rated print speeds of both printers are the same—120 cps, or about two pages per minute, for laser quality and 240 cps for draft.

A faster microprocessor on the new printer, however, improves formatting speed, and a faster paper motor and paper pick-up mechanism moves a page through the printer in half the time of the original mode.

Price: $995.

Contact: Hewlett-Packard Co., Inquiries, 19310 Pruneridge Ave., Cupertino, CA 95014, (800) 752-0900.

Inquiry 1128.

continued

This Touchscreen Works with Macintosh Software

The Mac 'n Touch Monitor is a Magnavox display that includes an integral touchscreen, a controller, cable, and driver software that enables the touchscreen to be used with all Macintosh software, including HyperCard. It interfaces to the Mac II over the Apple Desktop Bus (ADB).

The screen consists of a single glass sheet with a coating bonded to its surface to keep it sensitive to touch yet protect it from scratches and from oils on your skin. The coating helps ensure that every point on the screen will accurately read at least 2 million touches.

The touchscreen technology is called analog capacitive sensing, MicroTouch says. Electrodes on the sides of the screen place a linear voltage field across the screen so the controller measures the position of a capacitive coupling from a finger or a conductive stylus.

The ADB allows for conversion speed at 60 touches per second. Optical clarity is 85 percent light transmission, slightly less than clear glass, which restricts about 12 percent of the light.

Display resolution is 640 by 480 pixels, with 256 colors available from a palette of 16 million. Touch resolution is 1024 touch points per axis. The screen's controller automatically averages the entire area of touch contact so your finger can effectively address an individual pixel.

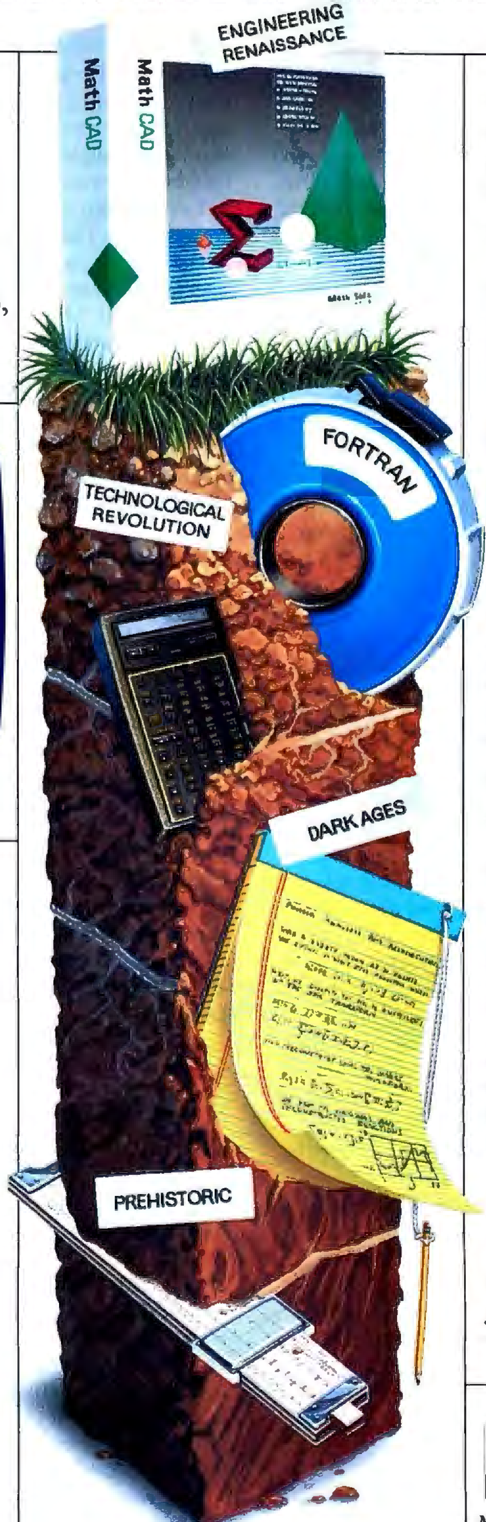
In what MicroTouch calls "lift-off mode," an initial touch locates the cursor. But when you lift your finger off the screen, you get the equivalent of a mouse click. A subsequent tap produces either a double click or a drag.

Price: $1545.

Contact: MicroTouch Systems, Inc., 10 State St., Woburn, MA 01801, (617) 935-0080.

Inquiry 1131.

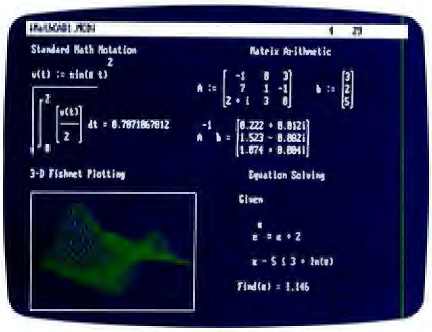
After centuries of practice, mankind perfects engineering calculations: MathCAD.



Announcing MathCAD 2.5: The Dawn of a New Age.

What the historians will call it, only time will tell.

Perhaps the Century of Speed, or the Era of Ease. But whatever the name, this is the age of MathCAD 2.5, the only math package that looks and works the way you think.



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 50,000 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."

PC MAGAZINE EDITOR'S CHOICE
March 14, 1989 issue.
Best of '88
Best of '87

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).

**If you purchased MathCAD 2.0 between 5/1/89 and 6/16/89, you can get a FREE upgrade to version 2.5 (otherwise, the upgrade cost is $99.00 until June 30, 1989; afterwards, the cost will be $149.00).*

MathCAD®

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Available for IBM® compatibles and Macintosh computers. TM and ® signify manufacturer's trademark or manufacturer's registered trademark respectively. PE

Circle 163 on Reader Service Card

Number Crunching with a 50-MHz Bus Master Board

A coprocessor board for your AT, the AT-Super combines the speed of a 32-bit RISC CPU with the convenience of MS-DOS.

The AT-Super has a 50-MHz AM29000 32-bit RISC coprocessor (with separate instruction and address buses) for MS-DOS applications. Peak performance is rated at 25 MIPS, and sustained performance is rated at 17 MIPS. The board has 2 megabytes of instruction RAM and 512K bytes of static RAM.

There's also a bus-mastering mode that can increase performance for graphics-intensive, memory-intensive, and I/O-intensive applications.

In the bus-mastering mode, a "sequencer" chip on the coprocessor card generates the RISC signals and bypasses the CPU (effectively mastering the bus—thus the name) for control of the video card, for example. With the bus-mastering technology, Yarc says, the coprocessor writes directly to the video card or the memory or the peripherals.

Yarc software operating under DESQview allows for four separate concurrent tasks, so you can theoretically install up to four AT-Supers on each of your systems.

Price: $4595.
Contact: Yarc Systems Corp., 5655 Lindero Canyon, Suite 721, Westlake Village, CA 91362, (818) 889-4388.
Inquiry 1134.

DPT Adds Mirroring to Controller

The SmartCache Mirroring kit for Distributed Processing Technology's SmartCache disk controller provides transparent, fault-tolerant disk storage for the IBM PC and compatibles, regardless of the application and operating system. It's designed for a network file server, a multiuser system, or a CAD workstation.

After installing the kit on the main controller board, you add a second redundant drive to handle the mirrored information. If one of the drives fails, the controller automatically switches to the second drive.

The SmartCache Mirroring kit offloads hard disk mirroring overhead from your host CPU to the 68000 CPU on the controller.

DPT claims its caching controller decreases effective hard disk access time by up to 150 times, to about 0.5 ms. Because the DPT controller operates without special software drivers, you can use the SmartCache Mirroring kit with any operating system.

In addition to protection from catastrophic drive failure, SmartCache Mirroring protects the user from disk defects by automatically patching bad sectors when defects occur with good data from the mirror drive. Since the controller handles all disk defect management, it can repair disk defects in a manner transparent to the operating system. An audible alarm is provided that tells the user to install a new drive and restore all data onto it from the mirror drive.

Price: Kit and controller, $1950; upgrade kit alone for SmartCache controllers, $800.
Contact: Distributed Processing Technology, 132 Candace Dr., P.O. Box 1864, Maitland, FL 32751, (407) 830-5522.
Inquiry 1133.

New Frame Grabber for PCs

Video Publisher GS from Willow Peripherals offers 8-bit gray scaling at up to six user-selected resolutions and digitizes at roughly six frames per second.

Two versions of the board are available. The low-end model will support user-selectable scanning resolutions of 256 by 240, 320 by 200, 512 by 240, and 640 by 200 pixels. The high-end board will support 512- by 480-pixel resolution.

The board is shipped with an upgraded version of the software for Publishers' VGA that allows editing and manipulating of saved video images and file conversion to graphics formats such as TIFF, PCX, and EPS. Images can also be enhanced with software such as Deluxe-Paint II or Publishers' Paintbrush and exported to desktop publishing packages such as Aldus PageMaker or Ventura Publisher.

Price: $450 to $595.
Contact: Willow Peripherals, 190 Willow Ave., Bronx, NY 10454, (800) 444-1585; in New York, (212) 402-0010.
Inquiry 1199.

Hercules Unchains Low-Cost VGA Card

This low-cost Hercules VGA card is compatible with the IBM VGA adapter.

The card couples Intel's 82706 VGA controller chip with a Hercules proprietary video BIOS. The Hercules card is designed to exactly emulate IBM's card. It has no jumpers, switches, or special software drivers.

It works with any standard VGA analog monitor or multisync monitors with analog capabilities. But it isn't compatible with the older monochrome Hercules standard.

Price: $299.
Contact: Hercules Computer Technology, Inc., 921 Parker St., Berkeley, CA 94710, (800) 532-0600; in California, (415) 540-6000.
Inquiry 1135.

hyperStore Your Hard Disk Information

The hyperStore/816 is an intelligent hard disk controller board that maintains a continuous data transfer rate of up to 2 megabytes per second, the manufacturer claims. Average access time of data in cache is 0.5 ms.

It's based on the 16-bit Zilog Z80280 microprocessor and includes a half-megabyte of RAM for caching, though it can use up to 4 megabytes. It also includes an on-board controller for floppy disk drives and related peripherals.

The board's operating system, hSOS, is stored in CMOS RAM. To make the most of this RAM cache, the hyperStore uses an approach called "scatter/gather" reads and writes. Random disk reads are analyzed for patterns, and the data is sorted sequentially to keep disk head movements to a minimum.

The hyperStore/816 is currently available only in a modified frequency modulation (MFM) version, though upgraded versions for the run-length-limited (RLL) and SCSI hard disk drives are scheduled to ship later this summer.

Price: $1195.
Contact: Perceptive Solutions, Inc., 1509 Falcon, Suite 104, DeSoto, TX 75115, (800) 343-0903; in Texas, (214) 224-6774.
Inquiry 1136.

continued

Pull out all the stops

Turbo C® Professional is the *only* production-quality C compiler with a completely integrated environment.

Everything you need—*all* the tools—are *included* in this environment, so you never waste time stopping, starting, and switching between tools.

And you're not forced into trade-offs between high-productivity programming and small, fast, reliable code. Instead you get the fastest and the best of both worlds.

There's tight integration between editor, compiler, linker, and debugger that lets you race through your program with a fast edit/compile/run/debug cycle.

Only Turbo C Professional gets it all together

Now everything you need to write *and debug* production-quality, optimized code in *both* C and Assembly language is all yours in one package.

With Turbo C Professional you get:

- Turbo C 2.0 with its own integrated development environment—Compiler, Editor, Debugger, and Linker.
- Plus a separate command-line C Compiler
- Turbo Assembler®—a complete Macro Assembler that's more compatible with MASM than MASM is with itself.
- And the new source-level Turbo Debugger® that lets you debug *any size program*. Turbo C Professional has it all.

Turbo C 2.0	Turbo Assembler	Turbo Debugger
■ Compiles over 16,000 lines per minute ■ Hypertext online Help ■ Supports inline assembly ■ All six memory models supported ■ More than 450 library functions	■ Assembles up to 48,000 lines per minute ■ Compatible with MASM 4.0, 5.0, 5.1 ■ Full 386 support ■ Assembles multiple files	■ Debug any size program ■ Browse through structures with data debugging ■ Set conditional breakpoints, break on memory access ■ Stop, run code, log expressions ■ 386 ICE capabilities

Code: MC10

Turbo Debugger is a winner

Turbo Debugger won *PC Magazine*'s most recent Award for Technical Excellence, and here's what they said:

> *"Everyone who's tried the Turbo Debugger agrees. It wins the (development tool) category's award for Technical Excellence hands down. The user interface is simple yet elegant; the program works the way programmers want to work. Yet again, Borland has advanced the state of the art in an eminently useful way."*
>
> Bill Machrone, Editor-in-Chief, *PC Magazine*

Debug *any size program*

Turbo Debugger lets you debug on a remote machine. That's a win. And in virtual mode of the 386, it allows you to debug *any size program*. Even your largest—*especially* your largest. That's a *huge* win.

And it can give you 12 *different* views of your code. It supports browse-through data debugging; offers flexible breakpoints; supports in-circuit emulation; offers EMS support; has a "Point & Shoot" integrated debugging environment, and is completely CodeView® compatible. Turbo C Professional does all that, so *it* wins—and so do *you*.

Pull out all the stops

Turbo C's integrated environment lets you completely stop stopping. Your program is never interrupted. No stops and no g aps. You compile faster. Link faster. Work faster. Think faster. So turn to Turbo C Professional: There's nothing stopping you now.

This is no ordinary Demo

Not one, not two, but three different demos on the same disk: Turbo C, Turbo Pascal,® and Turbo Debugger. We'll send you the demo disk and fact sheets with technical information for $4.95. **To order, CALL (800) 345-2888 Ext. 200**

BORLAND

Circle 48 on Reader Service Card (DEALERS: 49)

The new COMPAQ DESKPRO 286e. Further proof that what's on the outside,

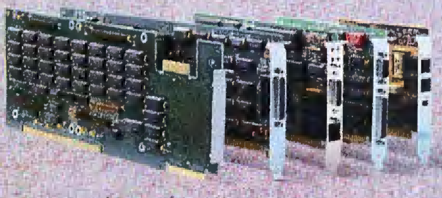
says a lot about what's on the inside.

Compaq has earned a reputation for building the most powerful and reliable personal computers in the world.

In doing this, we've always given users the best combination of features needed to do their jobs. We've also never given up the belief that even the most basic needs deserve more than just basic solutions.

As further proof, we offer the COMPAQ DESKPRO 286e Personal Computer.

It brings together a 12-MHz 286 microprocessor and a long list of integrated features. All in a compact package that runs the latest applications, without taking up more desk space.



Five expansion slots give you room to grow: one for high-speed memory, and four for thousands of industry-standard add-ins.

Your users will find everything they need in a stand-alone PC, perfect for their growing business productivity applications.

Built-in VGA graphics run up to 50% faster than other VGA controllers.

You'll also find a PC that's been rigorously tested with a wide range of network products, so it's compatible in virtually any network environment.

Now for an inside look. High-performance VGA graphics are built right on the system board. So your users can have displays that are easier to read.

Built-in interfaces mean you can connect a mouse, printer, modem or other tools without taking up a slot.

You, in turn, will have compatibility with all your EGA- and CGA-specific software plus performance that's up to 50% faster than other VGA controllers.

In memory, one megabyte is standard and is expandable in increments up to 13 megabytes using a *separate* high-speed memory expansion slot.

This leaves four industry-standard expansion slots open for LAN cards, mainframe links, etc. to customize the COMPAQ DESKPRO 286e to your users' needs.

You can take customization a step further. The COMPAQ DESKPRO 286e can be configured with up to four internal storage devices. Choose fast 110-, 40- and 20-MB fixed disk drives; both $5^{1}/_{4}$- and $3^{1}/_{2}$-inch diskette drives; even tape drives.

You'll get the flexibility to use both $5^{1}/_{4}$- and $3^{1}/_{2}$-inch diskette drives, along with a wide variety of fixed disk drives and tape drives.

As you can see, the new COMPAQ DESKPRO 286e offers the same attention to detail that has made the COMPAQ name unmatched for performance, quality and reliability.

For a free brochure on the COMPAQ DESKPRO 286e and the location of an Authorized COMPAQ Computer Dealer near you, call 1-800-231-0900, Operator 92. In Canada, just call 1-800-263-5868, Operator 92.

COMPAQ

It simply works better.

CONNECTIVITY

Alloy Ships 386/MultiWare

Alloy's 386/MultiWare is a multiuser, multitasking environment that networks up to 20 PCs to a single 80386-based system. Each terminal can run all existing DOS applications in a multiuser environment, Alloy claims.

It consists of the software for your 80386, 386/MultiWare, and an IBM PC AT- or PS/2-compatible board.

The NX386E is a five-user version of 386/MultiWare that works with the IMP2 add-in board, providing RS-232C communications for two terminals (any PC or Apple product with a serial port running Alloy's terminal emulation software).

Multiuser communications are handled by emulation of Novell's File and Record Locking and a similar Microsoft networking software. Multitasking is handled with the Alt-F8 key combination through each add-in board's V20 microprocessor (which is essentially comparable to the 8088). Each IMP2 board also contains 32K bytes of RAM and is available in AT and PS/2 versions. Two IMP2 boards can be used in conjunction with each other, each handling two users plus the host, for a total of five users.

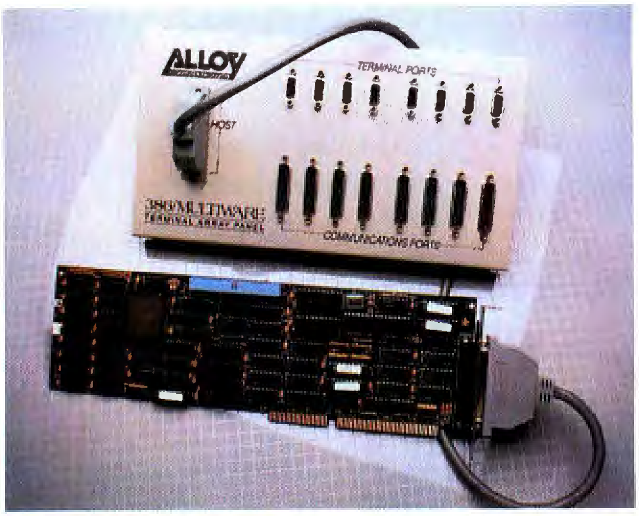
In its full-blown configuration, 386/MultiWare consists of the NX386 software, two IMP2 boards, two IMP8 boards, and two peripherals called Terminal Array Panels.

Each IMP8 also gives you a V30 microprocessor (which is similar to the 80186), 576K bytes of RAM, and a Terminal Array Panel that has eight 9-pin RS-232C connectors for your terminals and eight 25-pin connectors for connection to printers, modems, or faxes.

Price: Basic 386/MultiWare, NX386E, $395; full 386/MultiWare, NX386, $995; basic board, IMP2, $495; full board, IMP8 including Terminal Array Panel, $1995.

Contact: Alloy Computer Products, Inc., 100 Pennsylvania Ave., Framingham, MA 01701, (800) 451-8753; in Massachusetts, (508) 875-6100.

Inquiry 1143.



Alloy's IMP8 board supports eight users through the RS-232C panel.

Serially Connect Up to 256 Devices

PortNet lets you connect up to 256 devices in eight-port groups, with each group as much as a kilometer away from the master switch. It uses unshielded twisted-pair cabling through RS-232C ports. Data transfer rates range from 300 bps to 38,400 bps, and you use your familiar PC communications software.

The Master Switch (MS1000) acts as a file server for the Remote Distribution Units, with a maximum of 32 remotes per MS1000.

Each MS1000 includes a power supply, a motherboard, an Zilog Super8 microprocessor, a backplane for the add-in boards, and about 20K bytes of RAM for setting up the network.

Price: MS1000, $1950; RDU, $495; printed circuit board, $495.

Contact: CBM Electronics, Inc., 160 McCormick Ave., Costa Mesa, CA 92626, (800) 767-8638; in California, (714) 241-8194.

Inquiry 1144.

continued

IBM Ships ISDN Adapter

The 7820-001 is IBM's version of an all-in-one ISDN terminal for microcomputers, minicomputers, and mainframes with standard interfaces. It's the equivalent of a modem for the digital electronics that telephone companies are installing.

For personal computer hookup, IBM supplies a module with a V.24 (RS-232C) port. In addition to supporting full-duplex communication, it supports half-duplex communication rates between 4800 bps and 19,200 bps.

The V.35-compatible module supports transmission rates of 48,000 bps, 56,000 bps, and 64,000 bps. The X.21 module, used mostly for European telecommunications, will support transmission of 4800 bps, 9600 bps, 48,000 bps, and 64,000 bps.

Once the 7820-001 is hooked up, it connects to what AT&T calls a network termination device, an NT1, to adapt the four wires that come out of the 7820-001 with the twisted-pair of copper that constitutes standard telephone wiring.

The fully configured 7820-001 is designed for point-to-point communications. IBM has, however, engineered the device in accordance with CCITT recommendations, so the electronics are available for you to run as many as eight personal computers or other devices through a single 7820-001 in a passive bus configuration.

The terminal adapter is about the size of a college dictionary. The back has three holes for plug-in modules, offering both the S and T ISDN interfaces, as defined by the CCITT. The modules are currently based on an LPDA-2 command set, the Hayes standard sometimes referred to as LAP-D. The terminal adapter has a modular back end, so microcode can be changed to accommodate changes in software on the central-office computers.

Price: 7820-001 without interface modules, $1628; RS-232C module, $525; V.35 module, $630; X.21 module, $525.

Contact: IBM Corp.; check your local white pages or call (800) 426-2468.

Inquiry 1145.

Chronos Groupware Answers Who's on First When

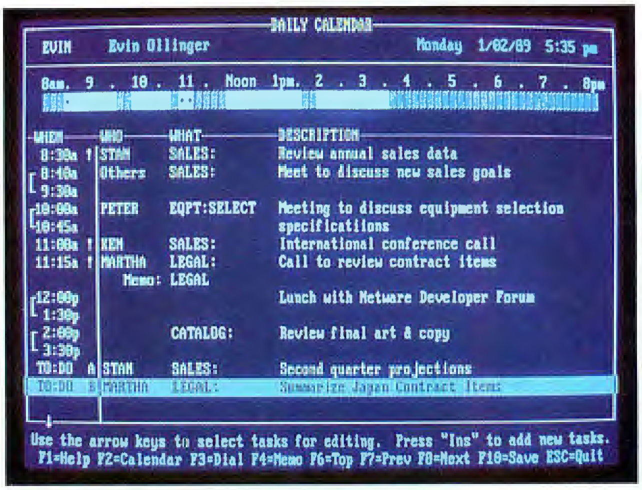
Who-What-When Enterprise is a groupware version of the personal information manager from Chronos.

To run Who-What-When Enterprise, you need a DOS 3.1-compatible network operating system like NetWare, VINES, or 3+ Open. It's designed to handle all users on your server-based network.

The program requires 420K bytes of RAM in each machine; 512K bytes is recommended. The file server must have space for 380K bytes in addition to the resident memory on the nodes. Part of the RAM is used for Btrieve, which is shipped with the product.

Who-What-When Enterprise is an extension of Who-What-When, which features a calendar function, among other things. With Who-What-When, you block out time periods in the days, weeks, months, and years ahead.

The Enterprise version allows real-time group scheduling and coordination. But you can't yet copy the group information to the single-user Who-What-When. When you travel, you have to print your schedule from Enterprise, make hand notes, and update Enterprise when you return.
Price: Single-server site license, $695; upgrade from the single-user version, $695 minus a rebate (unspecified at press time).
Contact: Chronos Software, Inc., 555 DeHaro, Suite 240, San Francisco, CA 94107, (800) 777-7907; in California, (415) 626-4244.
Inquiry 1148.



The Who-What-When daily calendar becomes groupware.

Biscom's Fax System Networks PostScript

The FAXCOM/Publisher is a stand-alone print-processing computer that allows computers to send PostScript files via Group 3 fax.

The tower-style system, which emulates an Epson printer, will work with a wide variety of microcomputer LANs, as well as networks from IBM, DEC, Wang, Hewlett-Packard, and Tandem.

It's based around an 80386 with 4 megabytes of RAM and a graphics coprocessor (for the PostScript algorithms). PostScript files can be sent through your network to the file server, which, in turn, is serially connected to the FAXCOM/Publisher.

This eliminates the need to print out PostScript documents and feed them manually into a fax machine. It differs from fax-on-a-board PC products in that multiple computers can send documents through the server.

The new system, a superset of an existing product from Biscom called FAXCOM 1000+, takes about a minute per page to prepare documents (comparable to many PostScript printers) and transmits at the fax rate of 9600 bps. In the future, Biscom has promised support for graphical standards other than PostScript through the FAXCOM computer.
Price: Under $10,000.
Contact: Biscom, Inc., Forest Ridge Research Park, 85 Rangeway Rd., Billerica, MA 01821, (508) 670-5521.
Inquiry 1149.

Adapter Cards and MAUs Enhance Token Rings

The 4-Mbps variety of IBM-compatible token-ring LANs continues to grow in popularity despite IBM's recent introduction of a 16-Mbps token ring.

MCA Ring Node is a communications adapter card that connects IBM PS/2 Micro Channel–based machines to a 4-Mbps token-ring network.

Each MCA card is compatible with the IEEE 802.2 Logical Link Control standard, and each uses the 802.5-defined token-passing protocol.

The cards are software-compatible with Novell's NetWare, Microsoft's LAN Manager, IBM's PC-LAN, and Madge's Netserver.
Price: $695; file server, $895.
Contact: Madge Networks, 534 Salem Ave. SW, Roanoke, VA 24016, (703) 982-0638.
Inquiry 1150.

TokenCard and TokenHub help you attach IBM PCs and compatibles to your 4-Mbps token-ring networks.

TokenCards link up to 260 stations in a single ring. Each TokenCard has the standard 9-pin D connector for shielded twisted-pair cabling and an RJ-11 for unshielded twisted-pair cabling.

TokenHub is a four-port multistation access unit (MAU) that lets you connect up to four TokenCards at a single network wiring access point.

The TokenCard for the file server includes 128K bytes of RAM for buffering and to download the LCC software. Software drivers for Novell's NetWare are included, and support will include Microsoft's OS/2 LAN Manager.
Price: TokenCard WS (for your PC), $499; TokenCard (for your file server), $599; TokenHub, $399; TokenHub power supply, $89.
Contact: Western Digital Corp., 2445 McCabe Way, Irvine, CA 92714, (714) 863-0102.
Inquiry 1151.

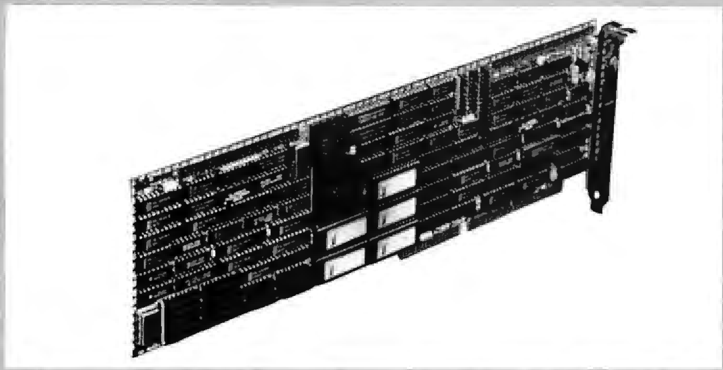
Thomas-Conrad's first token-ring product, an MAU, has twice as many ports as traditional eight-port MAUs. The TC4050 is designed for 4- and 16-Mbps networks and features diagnostic capabilities.

Maximum distance to a workstation is 100 meters, and the company claims you can daisy chain these MAUs without signal degradation.
Price: $985.
Contact: Thomas-Conrad Corp., 8403 Cross Park Dr., Building One/C, Austin, TX 78754, (800) 332-8683; in Texas, (512) 836-1935.
Inquiry 1152.

continued

Rupp Corporation Presents

Power Products Showcase No.19



PM3011 CACHING CONTROLLER

Up to 16MB of hardware implemented cache for ESDI, RLL of ST506 drives.

Product Profile: The PM3011 caching controller is the single most effective performance improvement tool available for disk-intensive applications. The PM3011 accesses data in as little as 0.5ms; that's 50 to 150 times faster than a random disk access.

Advanced Caching Algorithms: Such advanced caching features as disk read ahead and elevator sorting during cache write-back increase disk performance to levels unattainable by non-caching controllers. The controller's on-board 68000 microprocessor enables it to access the disk drive at the same time as the computer reads or writes to the controller cache.

Compatibility: Since PM3011 caching controllers operate transparently to the operating system, special software drivers or ROM BIOS changes are not required.

Up to 16MB of Cache: The PM3011 Cache RAM is expandable from the on-board 512KB to 16MB with the optional Cache Expansion board. The cache is totally independent from system memory and does not require device drivers.

PM3011/70 Caching Controller With 512KB cache. **$1150**

DPT Introduces Hardware Disk Mirroring

Distributed Processing Technology, the leader in the field of Caching Disk Controllers, has announced a long-awaited addition to it's product line—Hardware Disk Mirroring.

Hardware Disk Mirroring provides true fault tolerant disk storage for PC/AT systems regardless of the application and operating system environment. It is available for all DPT PM3011 Caching Disk Controllers supporting ST506, RLL, and ESDI drives.

Disk mirroring is important in environments where disk data integrity is vital, such as network fileservers, multiuser systems, and CAD workstations. Since the DPT caching disk controllers operate without special software drivers, the mirroring feature is transparent.

The Hardware Disk Mirroring can be added to PM3011 controllers as a field upgrade by installing a DM3011 Key Card directly onto the controller.

DM3011 **$795**

FAST HARDDISKS

Wren V Full-Height 5¼" Disk Drives Product Profile Wren V and WREN IV Full-Height disk drives offer the utmost in capacity, performance and reliability. You can get unformatted capacity up to 766 megabytes, seek time as fast as 14.5ms and transfer rates up to 15MHz.

CDC drives are known industry wide for their reliability and performance. Manufacturers such as Compaq have been using CDC drives for years.

WREN V SPECIFICATIONS

Model No.	WREN V 94186	WREN V 94186	WREN VI 94196
Capacity (Mbytes)			
Unformatted	383	442	766
Disks	8	8	8
Data Surfaces	15	15	15
Average Latency	8.3	8.3	8.33
Average Seek	14.5	16	16.5
Interface	ESDI	ESDI	ESDI
Transfer Rate	10	10	15
MTBF (hours)	40,000	40,000	40,000
Price	**$2800.00**	**$2900.00**	**$Call**

*For pricing on RLL, ST506 controllers and other options please call

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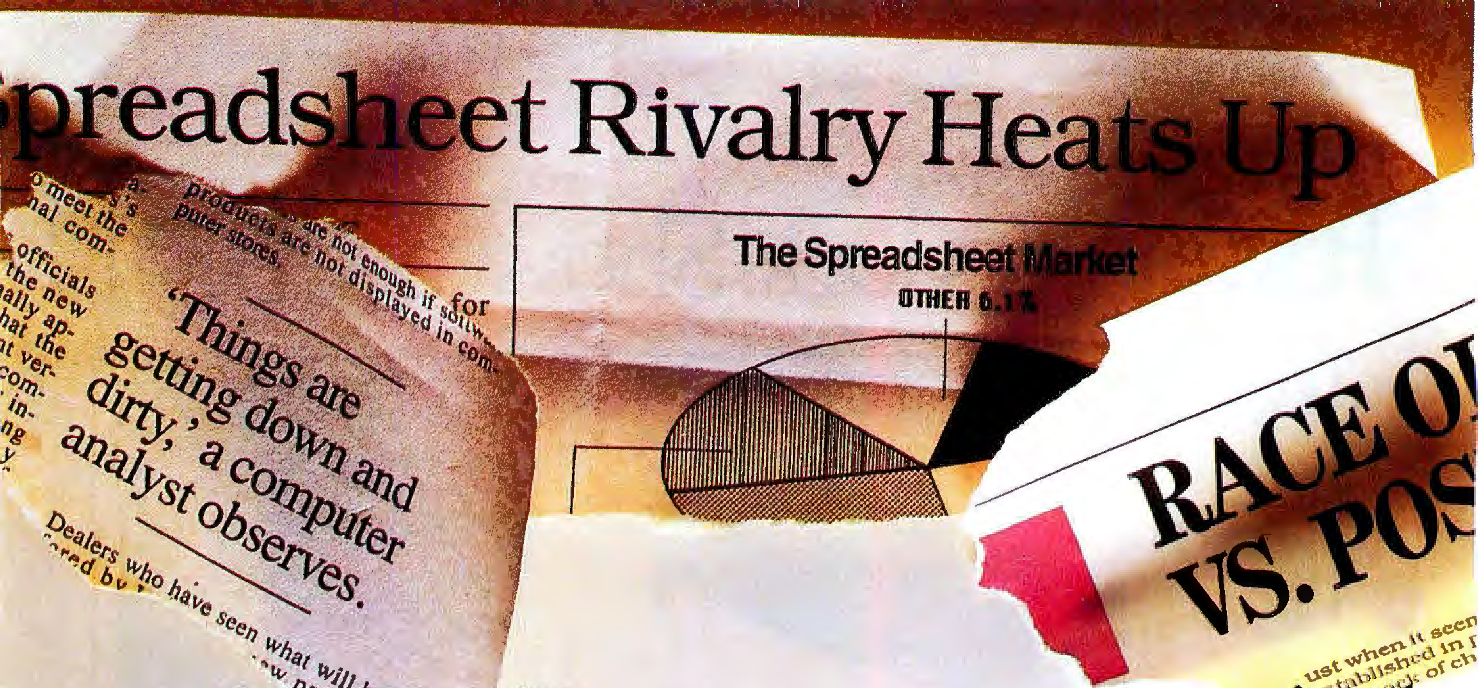
Circle 244 on Reader Service Card



We Interrupt T War For This Im

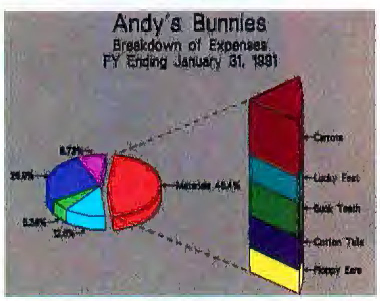
To all those unlucky enough to be stuck smack in the middle of the current spreadsheet confusion, take heart.

There is, at last, a viable alternative to war: revolution.

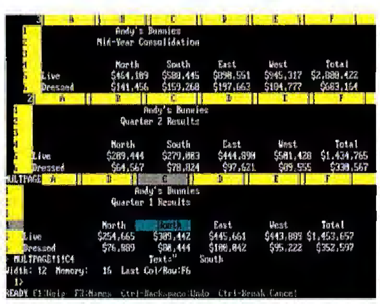
One that delivers even more performance than you have (ahem) been waiting for, but without demanding expensive new hardware or extensive retraining. And without abruptly cutting you off from any user in your company, even those on mainframes.

The name of the spreadsheet is SuperCalc®5.

And what it can do for you is, frankly, quite revolutionary.



Present a state-of-the-art picture of your work.



Link just about everything in sight.

Let's begin at the end. Stand-alone quality graphic capabilities have been built in. Offering hundreds of presentation treatments from word charts to three-dimensional bar, pie, scatter, and polar graphs.

And with SuperCalc5, you select fonts, lines, boxes, grids and shading. All of which can be used to produce the highest quality customized reports.

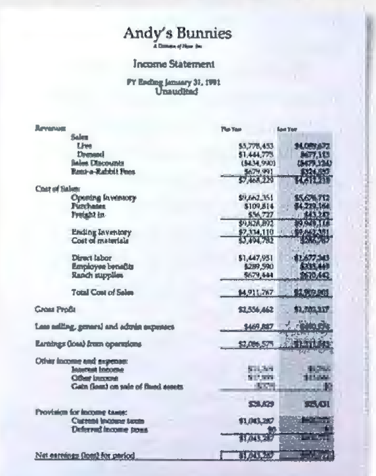
Plus, SuperCalc5 actually makes productivity easier. An integrated Undo feature simply reverses unwanted commands. And a truly comprehensive system of debugging highlights costly errors and analyzes macro logic.

Perhaps even more impressive is the way SuperCalc5 can link spreadsheets. Up to 255

Catch bugs before they come back to bite you.

he Spreadsheet
portant Update.

to be precise. Linking either in memory or on disk, either pages of the same spreadsheet or independent, either SuperCalc5's files or Lotus® 1-2-3®'s.



Produce annual-report quality output everyday.

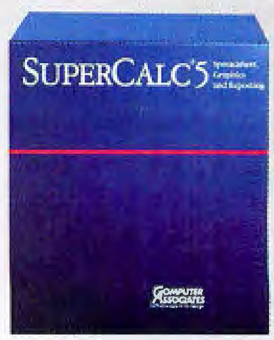
Which brings us to the "L" word. SuperCalc5 not only reads and writes Lotus® 1-2-3® files, it totally coexists with Lotus. Letting you easily move 1-2-3 macros into SuperCalc5 and back again. Even toggling between menus is a snap for SuperCalc5.

But not for Excel®.

Which now brings us to the "E" word. Unlike Excel, SuperCalc5 runs on all IBM® and compatible computers but also takes full advantage of 286 and 386 machines when *you* decide to make that transition.

And if all that isn't enough to make you run out today and join the revolution, there's even more incentive.

Like our free demo disk offer through July 31, 1989. And our $100 upgrade offer for just about any spreadsheet you're using. Call 1-800-531-5236. In Canada call 1-800-663-6904.



Which finally brings us to our admittedly biased outlook for the much touted spreadsheet war.

With SuperCalc5, peace is at hand.

COMPUTER® ASSOCIATES
Software superior by design.

Microsoft. IBM is a registered trademark of International Business Machines.

Circle 64 on Reader Service Card

Mouse Features 40 Programmable Keys

PowerMouse combines the functions of a mouse with the utility of a programmable calculator. It has 40 programmable keys, and you can program up to 240 functions.

The PowerMouse is designed to work with Lotus 1-2-3 with preprogrammed tables, for example, but also works with other spreadsheets, desktop publishing software, and hardware design programs.

You can define a row or column of numbers, or a section of a row or column, and move it, copy it, or even highlight it. Keys such as Row, Copy, Column, and others speed up the functions even more, because the programmed buttons in the PowerMouse replace keyboard and mouse click sequences.

PowerMouse works with the IBM PC and compatibles and most graphics adapters. Simply connect it to your computer through the serial port and run the TSR software.

The encoding is opto-mechanical with 200-dpi resolution. Tracking speed exceeds 800 mm per second.
Price: $195.
Contact: ProHance Technologies, Inc., 1558 Siesta Dr., Los Altos, CA 94022, (800) 345-9111; in California, (415) 967-5679.
Inquiry 1137.

PowerMouse can be programmed with 240 functions.

SCSI488 for Bidirectional Data Communications

The SCSI488 is a smart peripheral that bridges SCSI and IEEE 488 interfaces for bidirectional communications at data transfer rates of 800K bytes per second.

This speed is achieved with a microprocessor in the SCSI488 that converts data between the different protocols. A high-speed data channel within the unit bypasses the microprocessor during block data transfers.

As a SCSI-to-IEEE 488 instrument controller, one SCSI488 on your SCSI port can communicate with up to 14 IEEE instruments, peripherals, or other computers that have the IEEE 488 interface.

With the daisy-chaining capabilities of the SCSI controller, you can connect up to seven SCSI488 devices to a single SCSI port on your computer, each controlling 14 IEEE instruments.

You can use the command channel to issue commands to the SCSI488 for control of the SCSI bus, while the data channel allows passage of data to and from the SCSI bus.
Price: $795.
Contact: IOtech, Inc., 25971 Cannon Rd., Cleveland, OH 44146, (216) 439-4091.
Inquiry 1138.

When Power Fails, RAM Your Data into Memory

UniSaver 100 is a backup power supply that combines the usual standby battery backup with surge protection.

But it also includes a full-length card that plugs into your IBM PC or compatible. When power fails, UniSaver 100 transfers the data in RAM and the actual "state" (e.g., registers and controllers) of the machine into its megabyte of nonvolatile RAM.

If the power failure continues, the UniSaver 100 keeps the system running until its internal battery begins to fail. Then it shuts itself down. When power is restored, the system is returned to the exact point where it was before failure.
Price: $1195.
Contact: Universal Vectors Corp., 580 Herndon Pkwy., Suite 400, Herndon, VA 22070, (800) 777-7860; in Virginia, (703) 435-2500.
Inquiry 1139.

VideoShow for Your Mac

The latest VideoShow is an intelligent presentation system that lets you capture, edit, combine, and display photographic- and computer-generated images on a Macintosh.

Proprietary MacroVision graphics software combines with a 10-MHz 80186 CPU and 512K bytes of memory that works with your Macintosh computer, software, and monitor. Outputs are analog RGB or TTL-RGB. There's a SCSI port, a parallel port, and a port for connection to General Parametrics' SlideMaker, which is a peripheral for making slides of computer-generated images.

The lowest-priced model, VideoShow Companion, connects to the Mac II, Plus, or SE. It generates 1000 simultaneous on-screen colors and can be manipulated with an optional infrared remote control.

The VideoShow Executive comes with the remote control and features a 1.44-megabyte 3½-inch floppy disk drive. It also includes a Genlock function (for synchronizing with other video equipment), 128K bytes of RAM, composite video output, and an AppleTalk port.

VideoShow Professional can display up to 100,000 colors simultaneously in computer-generated images.
Price: Companion, $1795; Infrared Remote, $150; Executive, $2695; Professional, $9435.
Contact: General Parametrics Corp., 1250 Ninth St., Berkeley, CA 94710, (415) 524-3950.
Inquiry 1140.

continued

QNX vs. OS/2 UNIX

QNX®: Bend it, shape it, any way you want it.

ARCHITECTURE If the micro world were not so varied, QNX would not be so successful. After all, it is the operating system which enhances or limits the potential capabilities of applications. QNX owes its success (over 75,000 systems sold since 1982) to the tremendous power and flexibility provided by its modular architecture.

Based on message-passing, QNX is radically more innovative than UNIX or OS/2. Written by a small team of dedicated designers, it provides a fully integrated multi-user, multi-tasking, networked operating system in a lean 148K. By comparison, both OS/2 and UNIX, written by many hands, are huge and cumbersome. Both are examples of a monolithic operating system design fashionable over 20 years ago.

MULTI-USER OS/2 is multi-tasking but NOT multi-user. For OS/2, this inherent deficiency is a serious handicap for terminal and remote access. QNX is both multi-tasking AND multi-user, allowing up to 32 terminals and modems to connect to any computer.

INTEGRATED NETWORKING Neither UNIX nor OS/2 can provide integrated networking. With truly distributed processing and resource sharing, QNX makes all resources (processors, disks, printers and modems anywhere on the network) available to any user. Systems may be single computers, or, by simply adding micros without changes to user software, they can grow to large transparent multiprocessor environments. QNX is the mainframe you build micro by micro.

PC's, AT's and PS/2's OS/2 and UNIX severely restrict hardware that can be used: you must replace all your PC's with AT's. In contrast, QNX runs superbly on PC's and literally soars on AT's and PS/2's. You can run your unmodified QNX applications on any mix of machines, either standalone or in a QNX local area network, in real mode on PC's or in protected mode on AT's. Only QNX lets you run multi-user/multitasking with networking on all classes of machines.

REAL TIME QNX real-time performance leaves both OS/2 and UNIX wallowing at the gate. In fact, QNX is in use at thousands of real-time sites, right now.

DOS SUPPORT QNX allows you to run one PC-DOS application at each computer on a QNX network. With OS/2, 128K of the DOS memory is consumed to enable this facility. Within QNX protected mode, a full 640K can be used for PC-DOS.

ANY WAY YOU WANT IT QNX has the power and flexibility you need. Call for details and a demo disk.

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Multi-Tasking	64 (150) tasks per PC (AT).	**Flexibility**	Single PC, networked PC's, single PC with terminals, networked PC's with terminals. No central servers. Full sharing of disks, devices and CPU's.
Networking	2.5 Megabit token passing. 255 PC's and/or AT's per network. 10,000 tasks per network. Thousands of users per network.		
Real Time	4,250 task switches/sec (AT).	**PC-DOS**	PC-DOS runs as a QNX task.
Message Passing	Fast intertask communication between tasks on any machine.	**Cost**	From US $450. Runtime pricing available.

For further information or a free demonstration diskette, please telephone (613) 591-0931.

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Codecheck analyzes code for portability between DOS, OS/2, Unix, VMS, and the Macintosh environments.

The expert system lets you modify its rules, allowing you to tailor it for just one platform that you want to port to, or to conform to corporate or individual standards. You can also alter the program to work in a foreign language.

Abraxas claims Codecheck works on all C compilers. It is available now for DOS-, OS/2-, and Macintosh-based systems. Under DOS, it requires DOS 3.0 or higher with 512K bytes of RAM. The OS/2 version works in both Standard and Extended editions and requires 2 megabytes of system memory. The Mac version requires System 6.0 or higher and 1 megabyte of memory and is compatible with MultiFinder and Finder.
Price: $295.
Contact: Abraxas Software Inc., 7033 Southwest Macadam Ave., Portland, OR 97219, (503) 244-5253.
Inquiry 1106.

Develop dBASE Applications for Windows

If you're a developer for dBASE III Plus/IV and Clipper applications, you can use dBFast/Windows to create database applications by using standard dBASE commands and syntax and adding a Windows-style interface. You can run the application under Windows or, using the company's dBFast/Mac program, the Macintosh environment. The program, a stand-alone development environment, includes an interactive editor, compiler, and run-time library.

Language extensions let you create multiple windows, pull-down menus, dialog boxes, buttons, bit-mapped pictures, and other graphics features. Bumblebee Software, the program's developer, reports that dBFast/Windows compiles up to 15 times faster than interpreted dBASE. You use the program to create, compile, and execute programs without leaving dBFast/Windows; when running the application with the compiler, you can run an application without linking it to dBFast/Window's run-time library.

The program supports the Dynamic Data Exchange, which allows you to send and receive data from other Windows applications.

dBFast/Windows works on the IBM PC XT or compatibles and requires Windows 2.0 or higher or Windows run-time version, a hard disk drive, and 640K bytes of RAM. The program supports dBASE III/IV and Clipper commands.
Price: $249.
Contact: Bumblebee Software, Inc., 1715 114th Ave. SE, Bellevue, WA 98004, (800) 356-6356; in Washington, (206) 462-0130.
Inquiry 1101.

Symbolic Debugger for Motorola's DSP56001

Ariel's BUG-56 is a symbolic debugger designed specifically for PC programmers working with peripherals that use Motorola's DSP56001 digital signal processing chip. The debugger loads a monitor program into the DSP; this monitor then works in concert with the debugger to provide memory, control, and trace functions.

BUG-56 features full-screen symbolic debugging, symbolic breakpoints, tracing, and patch assembly. BUG-56 allows you to place symbols and labels in the DSP's P (program), X, and Y memory spaces.

The menu-driven debugger dynamically updates the DSP register display, and permits you to modify the contents of the registers or memory on the fly as your program executes. For music work, BUG-56 lets you display the signal's waveform.

BUG-56's most powerful feature is its ability to play the signals, either as a dump from a section of memory, or from the DSP's data stream as a program runs.

BUG-56 supports a 43-line mode for EGA and VGA owners. The debugger will also do block transfers from the DSP56001's memory to a PC disk. This lets you build double-buffered processing systems or data acquisition to the PC's hard disk drive.

The debugger works with Ariel's DSP56001 boards, including the PC-56 board. BUG-56 requires about 350K bytes of available RAM and DOS 3.0 or higher.
Price: $395.
Contact: Ariel Corp., 433 River Rd., Highland Park, NJ 08904, (201) 249-2900.
Inquiry 1103.

Translating in AWK

The PolyAWK developer's toolkit includes MS-DOS and OS/2 ports of the AWK data translation language. The toolkit includes a translator that lets you create and distribute stand-alone executable programs from AWK script files. The translator compiles PolyAWK source code into C and binds it with a run-time version of PolyAWK, resulting in a DOS .EXE stand-alone file.

With the toolkit, you can use PolyAWK to write customized development tools or data conversion utilities with a few lines of code.

The toolkit includes both DOS and OS/2 versions of PolyAWK and requires OS/2 or DOS 2.0 or higher, an IBM PC or compatible, and 256K bytes of RAM.
Price: $295.
Contact: Polytron Corp., 1700 Northwest 167th Place, Beaverton, OR 97006, (800) 547-4000; in Oregon, (503) 645-1150.
Inquiry 1104.

Paradox, dBASE IV at Your Command

AccSys for either Paradox or dBASE IV are software libraries for programmers who need to modify or build from scratch a database application in C or in QuickBASIC. The program allows you to create, read, write, and update Paradox or dBASE IV files without having to learn the relational database manager's complex internal file format.

AccSys provides a full set of tools to control table files, primary index files, and secondary index files. The stand-alone programs that you write with AccSys create files that you can access from your application or from within Paradox or dBASE IV, the manufacturer reports.

AccSys for Paradox works with versions 2 and 3 and is now available for single-user operation. A multiuser version for Paradox will ship this summer.
Price: AccSys for dBASE IV or Paradox, binary only, $395 each; binary and source code, $795 each.
Contact: Copia International Ltd., 1964 Richton Dr., Wheaton, IL 60187, (312) 665-9830.
Inquiry 1102.

continued

Power

T5200: 20MHz 386 processor, 2 internal IBM® compatible expansion slots, VGA gas plasma display with VGA monitor port, 40MB or 100MB hard disk, 2MB RAM standard expandable to 8MB, 1.44MB 3½" diskette drive.

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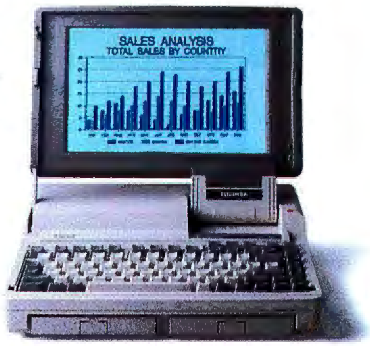

T1600: Battery-powered 286/12MHz, coprocessor socket, 20MB hard disk at 27msec, 1.44MB 3½" diskette drive, 1MB RAM expandable to 5MB, detachable backlit EGA compatible LCD, removable rechargeable battery pack.

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And it's by anticipating the growing needs of our users that we have continually found ways to make our machines weigh less and do more. So you can work wherever you want and however you want.

All of which might make it tempting for some people to abandon their desktop for the convenience of portability. Go ahead.

We've given you the power to do it.

T3100e: 12MHz 286 with 80287 co-processor socket, internal half-length IBM slot, 20MB hard disk with 27 msec access, 1MB RAM expandable to 5MB, gas plasma display, 1.44MB 3½" diskette drive.

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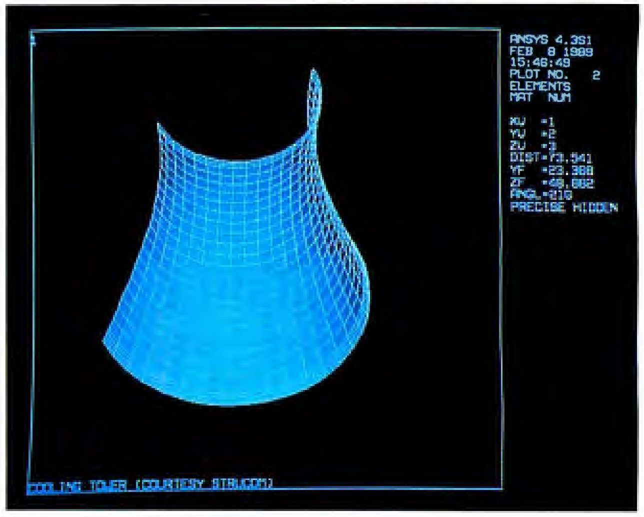
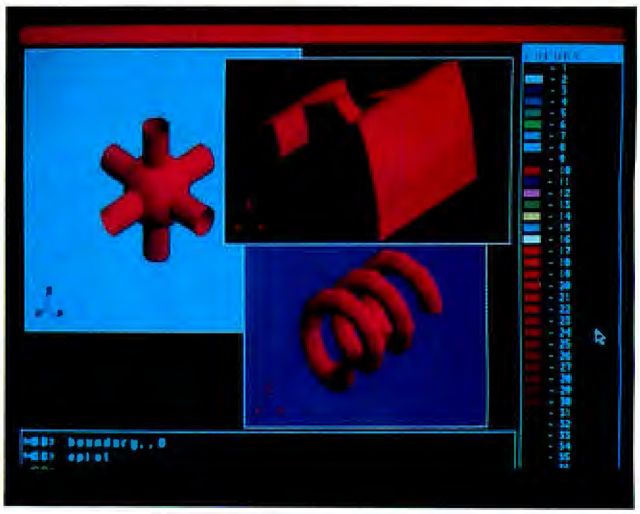
SCIENCE AND ENGINEERING



This Ansys-PC/Intro/Lin element display of a power plant cooling tower is made up of 520 quadrilateral shell elements and 140 three-dimensional elastic beam elements.



Cosmos/M provides finite-element-analysis capabilities for the Mac II.

Two from the Finite Front

In recent months we've seen scads of announcements of new and updated finite-element-analysis programs. Here are two: one for the PC and one for the Mac.

Ansys-PC/Intro/Lin is an introductory version of the Ansys-PC/Linear program. It gives you a sampling of the effect that finite-element analysis will have on your product development.

The program lets you perform static and modal analysis in one, two, or three dimensions. The element library contains 16 elements, including beams and pipes, shells, and three-dimensional solids. The program has a wavefront of 200 and a problem size of up to 10,000 nodes, so you can use the program to model and analyze substantial structures, according to Swanson.

Most of the preprocessing capabilities found in the Ansys

continued

IN ALL FAIRNESS, YOU SHOULD READ WHAT ASHTON-TATE® IS SAYING BEFORE YOU PURCHASE ORACLE.

Ashton-Tate Fights SQL Bugs

Same Query Run Twice Can Result in Different Replies

Ashton-Tate last week acknowledged that the Structured Query Language (SQL) portion of dBASE IV can produce inconsistencies and inaccurate results.

The crux of the SQL problems lies with three anomalies that occur when data is structured in a specific way, according to Knox Richardson, a spokesman for the Torrance, Calif., firm. As a result, the same query run two different times can result in two different replies, for example, or a query can retrieve incomplete information from the database. (See Chart, Page 8.)

Ashton-Tate does not plan to issue a diskette to fix the problem; it is, however, offering work-around solutions to users through its support lines and bulletin board, and on CompuServe, Richardson said.

Though Ashton-Tate is characterizing dBASE IV's SQL problems as "minor" and confined to specific circumstances, database experts claim their impact is more serious.

"The SQL in dBASE IV is unstable, unreliable and unpredictable," said Richard Finkelstein, president of Performance Computing Inc., a database consulting firm in Chicago.

"I don't see how anyone can use it," he added. "They'd have to know the answer to the SQL query ahead of time."

Surprisingly, the majority of dBASE users were unfazed by dBASE IV's SQL glitches.

"The drawbacks in SQL are an

See DBASE Page 8

PC Week. January 9, 1989

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SCIENCE AND ENGINEERING

program are included in this introductory version. Parametric language is available for user-specified parameter values. A database language is also included, which lets you manipulate model data.

The program runs on the IBM PC with 640K bytes of RAM, a 20-megabyte hard disk drive, DOS 3.1 or higher, and a math coprocessor. It is also available in a Mac II version.
Price: $2000.
Contact: Swanson Analysis Systems, Inc., Johnson Rd., P.O. Box 65, Houston, PA 15342, (412) 746-3304.
Inquiry 1111.

Cosmos/M, the finite-element-analysis program for the IBM PC, now runs on the Mac II and can solve problems of up to 25,000 degrees of freedom. The program takes advantage of the 256 colors available on the Mac II to generate color-filled stress and thermal-contour plots.

Cosmos/M also solves nonlinear problems by using an incremental solution technique and by using isoparametric elements that increase accuracy where boundaries are curved or where high stress variations exist, according to SRAC. The program also offers nonlinear buckling analysis, a capability that the company reports has previously been available on only mainframes.

Unlike other Mac II finite-element-analysis programs, Cosmos/M was written specifically for the PC environment, which, the company claims, makes it much more efficient than programs ported down from mainframes. The program is divided into modules that you can load into memory and remove as needed.

File I/O routines are written in Mac II assembly language.
Price: $2995.
Contact: Structural Research and Analysis Corp., 1661 Lincoln Blvd., Suite 100, Santa Monica, CA 90404, (213) 452-2158.
Inquiry 1112.

NKR Research Offers Languages Under A/UX

NKR FORTRAN is a globally optimizing compiler that offers Unix integration through the use of C calling conventions. It runs under A/UX on the Mac IIx.

NKR FORTRAN includes VAX/VMS FORTRAN extensions and conforms to ANSI 78 and military 1753 standard. The optimizer was built exclusively for FORTRAN, according to NKR, and the optimizer and library modules were built exclusively for NKR FORTRAN.

The company also recently began shipping NKR BASIC, which it reports is the only BASIC running under A/UX. The language comes in both compiler and interpreter versions, which you can use separately or as a matched set. They conform to the ANSI X3.113 and the European ECMA-116 standards for the BASIC language. The BASIC interpreter includes a Help facility and a debugger. The compiler produces native machine code on A/UX.

NKR's compilers are written in C and use Unix calling conventions.
Price: FORTRAN, $495; BASIC compiler and BASIC interpreter, $395 each (25 percent discount if purchased as set).
Contact: NKR Research, Inc., 4040 Moorpark Ave., Suite 209, San Jose, CA 95117, (408) 249-2612.
Inquiry 1108.

continued

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Performance Comparisons using PC Labs Benchmark Series Release 4:

	NOP	80286 Instruction Mix	Floating Point Calculation	Conventional Memory
ZEOS 286/12 Desktop	2.81	4.78	18.84	0.72
IBM PC AT (8MHz)	4.23	8.96	35.60	1.32
IBM PS/2 Model 50	3.35	7.20	28.34	1.05

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PC Resource Magazine put it this way "ZEOS... provides quality comparable with the IBM or Compaq and does so for about 70% of the cost." *Personal Computing* simply says "The best value we've come across so far."

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- *101 Key ZEOS Tactile/Click keyboard.*

Performance Comparisons using PC Labs Benchmark Series Release 4:

	NOP	80386 Instruction Mix	Floating Point Calculation	Conventional Memory
ZEOS 386/16 Desktop	2.10	3.58	13.62	0.58
IBM PS/2 Model 70-E61	2.09	4.11	16.14	0.77
Compaq Deskpro 386/16	2.09	4.12	15.47	0.75

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24-bit Color with QuickCapture

ColorKit works with Data Translation's 256-gray-level frame-grabber board for the Mac II to capture, display, and store images with 24-bit color.

With the QuickCapture board, you capture images from RGB video cameras. The ColorKit software then grabs separate RGB signals in real time. You can adjust the focus on the Mac II screen as you watch and then tell the software to acquire the image, which it does in less than a second, according to Data Translation.

Since the Mac II uses the standard 8-bit color display, which can show only 256 colors at a time (24-bit color can have up to 16.7 million colors), the software offers you a choice of color mapping routines: uniform, biased, dithered, adaptive, and monochrome.

ColorKit is compatible with PhotoMac, PixelPaint, and Studio/8 paint programs. Data Translation reports that the program will work with any previously stored 24-bit color image.
Price: $295.
Contact: Data Translation, 100 Locke Dr., Marlboro, MA 01752, (800) 522-0265; in Massachusetts, (508) 481-3700.
Inquiry 1119.

Rotate AutoCAD Files

SpinCAD lets you rotate, translate, and scale two- and three-dimensional AutoCAD .DXF files in real time.

The program runs on the IBM PC with at least 256K bytes of RAM, DOS 2.1 or higher, and a CGA, EGA, VGA, or Hercules card.
Price: $140.
Contact: Aptech Systems, Inc., 26250 196th Place SE, Kent, WA 98042, (206) 631-6679.
Inquiry 1121.

Image created with Data Translation's ColorKit and Avalon's PhotoMac on the Mac II.

Graphics for the Database Developer

Originally, dGE was created to add graphics capabilities to dBASE II. Version 2.0 adds graphics to dBASE II Plus, dBASE IV, Clipper, FoxBASE Plus, Quicksilver, dBFast, Eagle, and C compilers.

Graphing functions include pie charts, bar graphs, high-low-close, polar, time series, Cartesian, polyvector, and more. The program is capable of performing statistical functions as well. You can also mix and overlay as many graphs as you want on a page.

To run dGE, you load a 30K-byte TSR graphics kernel into memory. The dGE commands are added to the application by a linkage module. You need an IBM PC with DOS 2.0 or higher. The program also supports Windows, Pinnacle reports. And you can use CGA, EGA, VGA, or Hercules graphics.
Price: $195.
Contact: Pinnacle Publishing, Inc., P.O. Box 1693, Tacoma, WA 98401, (206) 383-4396.
Inquiry 1120.

Mechanical Design with FastCAD

Mechanical Design Environment (MDE) is a set of integrated macros, menus, external procedure modules, and symbol libraries that work with FastCAD to speed up mechanical drafting and layout.

MDE includes multiple dimensioning modes and formats, ANSI Y-14.5 tolerancing symbols, libraries of standard fasteners, and parametric drawing of common components.

FastCAD lets you perform associative ordinate dimensioning, associative radii and diameters with optional text, scaled dimensions for expanded views, infinite horizontal and vertical construction lines, and a variety of standard symbols.

MDE works with FastCAD 2.05 or higher on the IBM PC with a math coprocessor.
Price: $395.
Contact: Evolution Computing, 437 South 48th St., Suite 106, Tempe, AZ 85281, (602) 967-8633.
Inquiry 1122.

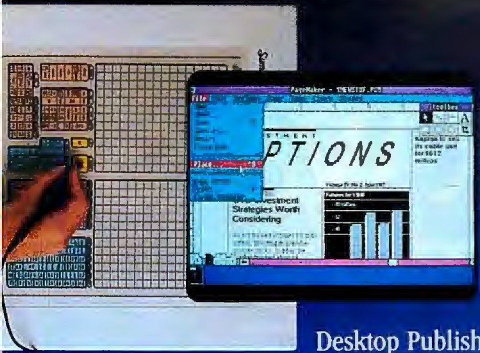
Upgraded Generic CADD for the Mac

Generic CADD Level 1 version 1.1 includes a Mac-to-MS-DOS translator utility, the ability to save files in PICT or EPS format, the ability to open a PICT file without using the Clipboard, a select-all capability, and new design capabilities.

Drawings produced with CADD Level 1 have floating-point precision to 16 decimal places. Drawing tools include points, lines, rectangles, regular polygons, circles, arcs, ellipses, Bézier and spline curves, and text. You can place objects on 256 layers, rotate them to any angle, and change their scales. You can also import files from other applications as PICT files, or export as PICT or EPS files.

Generic CADD Level 1 version 1.1 runs on the Mac Plus, SE, or II with at least 1 megabyte of RAM. A math coprocessor is recommended.
Price: $149.95.
Contact: Generic Software, Inc., 11911 North Creek Pkwy. S, Bothell, WA 98011, (800) 228-3601; in Washington, (206) 487-2233.
Inquiry 1123.

continued



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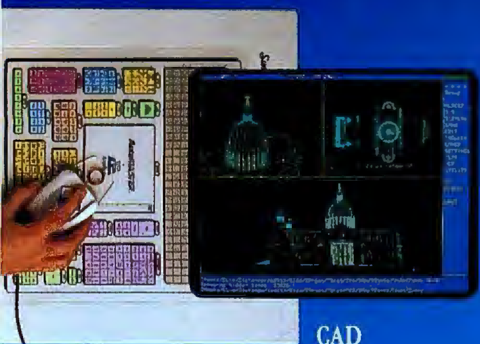

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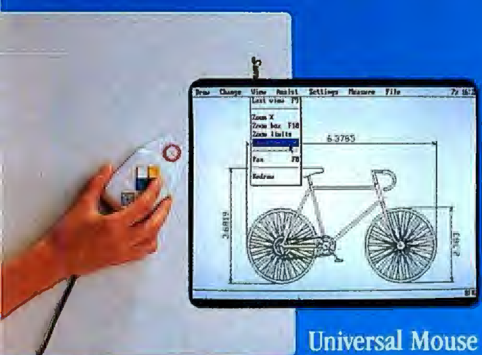

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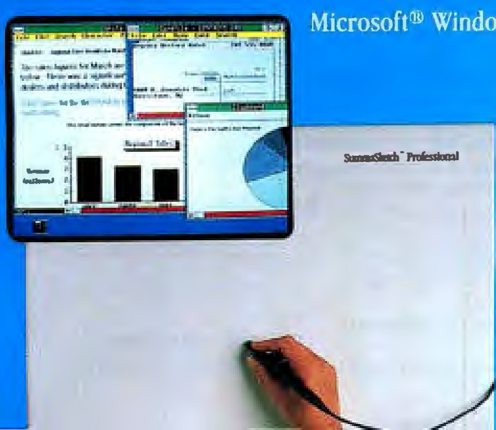

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Ours only wins in three of them.

1. How fast does it install.

We have no competition in this category. LANLink 5X installs in about fifteen minutes, and it doesn't take a technician to do it. Since LANLink 5X uses standard parallel or RS-232 serial ports, installing a network means little more than connecting the cable and loading the software.

With hardware LANs, installation can easily take two days–one to set it up and one to tweak it. And it also takes someone who really knows what he's doing. That is, someone expensive.

2. How fast does it transmit.

Okay, this is the category we don't win; the hardware LANs are generally a little quicker. At least, they are under optimal conditions, which is how they rate themselves.

But LANLink 5X is pretty quick, too. At half a megabit per second, it's way out ahead of any other software LAN, and right at the heels of the hardware types. Which, of course, are far more expensive.

3. How fast does it maintain.

The real cost of a network is not so much the initial price as it is the continuing outlay for maintenance–adapting it to changing needs.

That's something LANLink 5X does practically on its own. Running under PC-MOS/386™ or PC-DOS, it turns your server PC into a multi-tasking controller, driving a truly expandable LAN that is easily and quickly upgradable.

A hardware LAN, on the other hand, becomes obsolete as new technology is introduced. And, to keep the network up and running as applications change, you need the attentions of a technician, on a continuing basis. A very well-paid technician.

4. How fast can you pay for it.

Now we've arrived at the bottom line, where LANLink 5X is toughest to beat. You can install a five-user LANLink network for about the same cost as the LAN board in a board-driven network. On top of that, factor in what you save on installation and maintenance time, and the difference is pretty dramatic.

LANLink 5X is available immediately, and it comes with a money-back guarantee. Its price of $595 includes a server and a satellite module plus the network operating system. Additional satellites are available for $125.

For complete details on the fastest software-driven network available, call 800-451-LINK.

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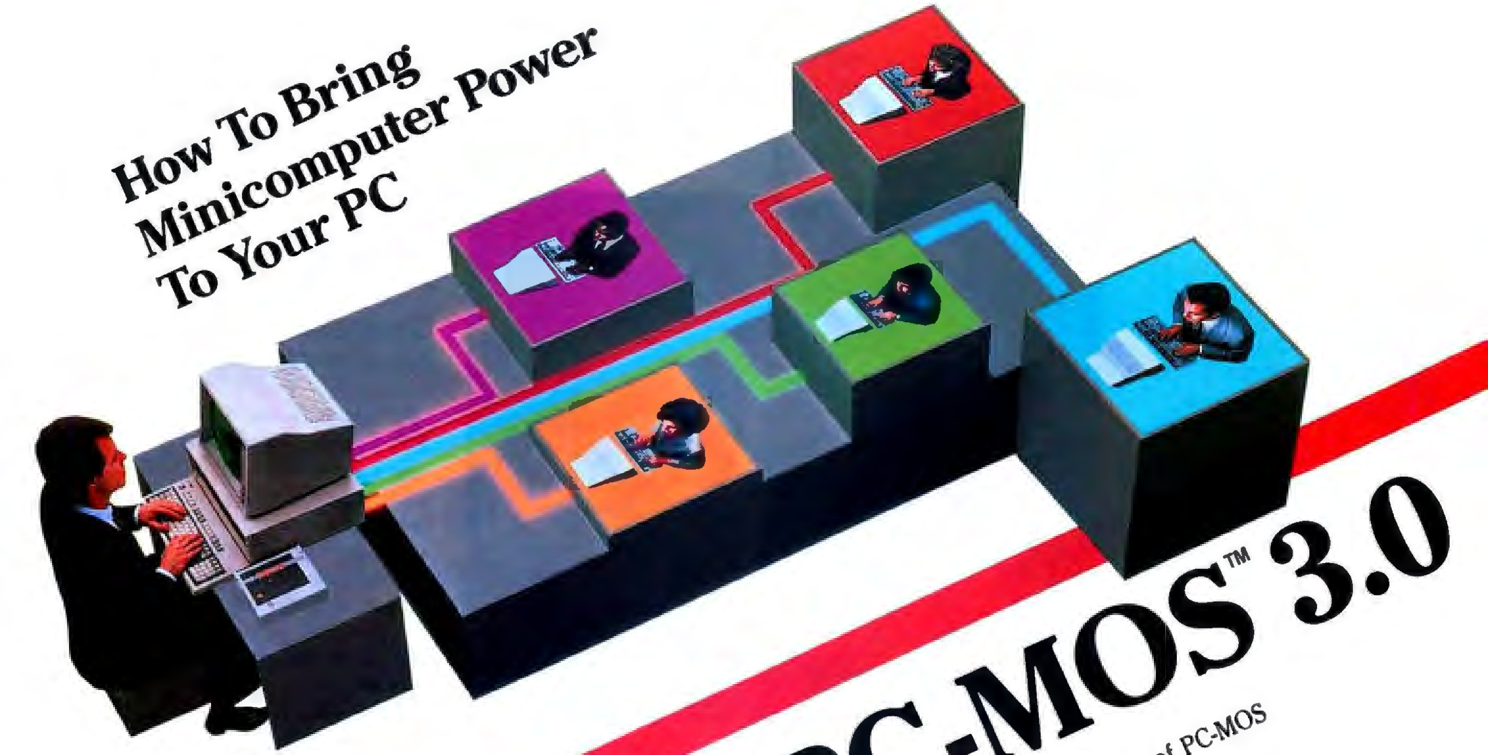

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That's why you need PC-MOS 3.0. It harnesses the power of your 386- or 286- based PC and turns it into a powerful multiuser, multitasking computer. PC-MOS is the multiuser operating system that lets you run popular DOS applications such as Windows,™ Lotus 1-2-3,™ dBase IV™ or WordPerfect™—without modification.

PC-MOS is the perfect solution for a small business or a department of a large company that needs users to easily and affordably share programs, databases or peripherals. It takes full advantage of the hardware's power—and saves you money in the process! For example, instead of replicating PCs, each user can have an inexpensive terminal or monitor that acts like a PC.

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Since PC-MOS is DOS compatible—unlike UNIX™ or OS/2™—there's no need for users to learn a "new" operating system or be retrained on the application programs they already know. And unlike most LANs, PC-MOS is easy to install and even easier to maintain. No hassle, no expensive wiring and no network management headaches.

There are now more than 100,000 users of PC-MOS worldwide, but if you haven't seen it lately, take another look. We've broadened our base of compatible applications and added multi-level security, faster disk performance and larger task sizes. Version 3.0 also interfaces with Novell LANs, 3270 mainframe communications products and The Software Link's LANLink™ local area network.

Call us today for more information about PC-MOS 3.0 and the location of your nearest multiuser dealer. We'll show you how to easily and affordably turn your PC into a powerful multiuser system.

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Lucid 3-D Supports Graphing and Expanded Memory

Version 2.0 of Lucid 3-D now supports three-dimensional graphics, three-dimensional range linking, and expanded memory. It can also directly read and write Lotus 1-2-3's .WK and .WK1 files, as well as dBASE files.

You can do pie, bar, line, and scatter charts in three dimensions, and the program's graph switch feature lets you view data from 25 different perspectives.

Other new features include minimal recalculation and a transpose through the clipboard that handles formulas.

To run version 2.0, you need an IBM PC with 256K bytes of RAM (347K bytes for graphics capabilities). It supports any Microsoft-compatible mouse and IBM-compatible dot-matrix and Hewlett-Packard LaserJet printers.

Three-dimensional Lucid 3-D is no longer a TSR program.

Price: $99.95.
Contact: Dac Software, Inc., 17950 Preston Rd., Suite 800, Dallas, TX 75252, (214) 248-0205.
Inquiry 1114.

Database Power for Nonprogrammers

Alpha Software's Alpha Four is a relational database for users who don't know a database programming language but need to build sophisticated applications to manage data. With the program's outliner, you can build an application in the same way you would create an outline with your word processor, using familiar language.

Up to 10 databases can be linked with a common linking field or equation as a single database.

Alpha Four is written in C and is compatible with dBASE III files, Alpha reports. It works on the IBM PC or com-

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Contact: Alpha Software Corp., 1 North Ave., Burlington, MA 01803, (617) 229-2924.
Inquiry 1115.

HyperPad Goes DOS

HyperPad is a character-based HyperCard-like software environment for PCs running DOS. HyperPad features the same hierarchy as its cousin, HyperCard, and uses similar objects, tools, and menus.

HyperPad is a configurable, object-oriented environment with a scripting language and built-in functions for painting, drawing, and forms generation.

The scripting language, called HyperScript, is similar to Apple's HyperTalk, except that HyperPad is character-based rather than graphical.

HyperPad will run on any IBM PC, PS/2, or compatible with DOS 2.1 or higher. It uses 384K bytes of RAM.
Price: $99.95; limited developer's edition, $495; unlimited license, $3000.
Contact: Brightbill-Roberts, 120 East Washington St., Suite 421, Syracuse, NY 13202, (315) 474-3400.
Inquiry 1117.

A Clean Sweep for Mailing Lists

Ever wonder why your name gets so botched on computer-generated letters? If everyone generating those letters used mailing list utilities, our mailboxes would be cleaner places.

Peoplesmith Software has three utilities that help you enter and clean up lists of names.

DynaKey lets you enter names and addresses in all caps, with special abbreviations and no punctuation. The program converts what you've entered to whatever format you want it in, such as uppercase and lowercase and expanded abbreviations.

DataLift is a program that takes a database of all caps, strange abbreviations, and inconsistent punctuation and converts it to a list you can use. It's similar to DynaKey, but it assumes that you've imported a list from somewhere else, rather than keying it in yourself.

The third program, Personator, takes a list of first and last names and splits them into different fields.

Personator will accept up to three suffixes and recognizes last name prefixes like the Mac in MacDonald. The program contains a first-name table with 7000 first names.

All three programs run on the IBM PC with DOS 2.0 or higher and 512K bytes of RAM.
Price: DynaKey, $199; DataLift, $149; Personator, $129.
Contact: Peoplesmith Software, 18 Damon Rd., P.O. Box 384, North Scituate, MA 02060, (800) 777-2460; in Massachusetts, (617) 545-7300.
Inquiry 1116.

WHAT'S NEW

Information Retrieval Conference

Topics scheduled for the 12th International Conference on Research and Development in Information Retrieval include interfaces, knowledge-based approaches, formal models, hypermedia, and natural-language processing.

The conference, sponsored by the Association of Computing Machinery's Information Retrieval special-interest group, will be held on June 25–28 at Boston's Marriott Cambridge Hotel.
Price: ACM or SIGIR members: registration, $270; one tutorial, $175. Nonmembers: $310 and $185, respectively; students, $80 and $75.
Contact: ACM SIGIR Conference, Professor W. B. Croft, Computer and Information Science Dept., University of Massachusetts, Amherst, MA 01003, (413) 545-0463.
Inquiry 910.

Two Technical Conferences in Rochester

The 1989 Rochester Forth Conference on Industrial Automation will be held on June 20–24 at the University of Rochester. Dr. Sergei Baranoff, from the Leningrad Institute for Informatika and author of the first Forth textbook in Russian, is scheduled to lecture.
Price: $200; IEEE members and University of Rochester staff, $150; students, $50.
Contact: Lawrence P. Forsley, Conference Chairman, Institute for Applied Forth Research, Inc., 70 Elmwood Ave., Box 15, Rochester, NY 14611, (716) 235-0168.
Inquiry 908.

The first PC/FEA (Finite Element Analysis) conference will be held on June 14 at the Holiday Inn on Jefferson Road. Topics will include PC/FEA codes such as Algor/Supersap, MSC/Pal2, Cosmos/M, and PC/Ansys.
Price: $75.
Contact: Dave Hudson, dh Engineering, 200 Buell Rd., Level D/17A, Rochester, NY 14624, (716) 436-5710.
Inquiry 909.

Electronic Circuitry Conference

NEPCON East, the show for the design, manufacturing, and testing of electronic circuitry in assemblies, will be held at the World Trade Center and Bayside Convention Center in Boston on June 13–15.

Planned exhibits will feature equipment and technology for the packaging, production, and testing of electronic circuitry.
Price: $25.
Contact: Cahners Exposition Group, Cahners Plaza, 1350 East Touhy Ave., P.O. Box 5060, Des Plaines, IL 60018, (312) 299-9311.
Inquiry 911.

continued

International Conference on Communications

Of the 320 papers scheduled for presentation at the 1989 IEEE International Conference on Communications (ICC '89), about 120 will be from international experts, according to the conference's general chairman, Edmond Elowe.

Over 2000 people are expected to attend the conference, to be held in Boston on June 11–14. More than 50 technical sessions are planned. The technical thrust of the conference is in four parts: science and technology, architecture and standards, operations and applications, and services and trials.

Price: Full registration, IEEE members, $275; nonmembers, $335. Limited one-day registration is also available.
Contact: Edmond N. Elowe, ICC '89 General Chairman, 56 Maine St., P.O. Box S, Brunswick, ME 04011, (207) 725-1000.
Inquiry 1067.

Technical Communication Seminar

A one-day advanced seminar for trainers, consultants, and managers in technical and scientific communication will be held at Plymouth State College on June 24.

The conference will consist of seven sessions and round-robin discussions on how to write concise documentation, incorporating new technologies into the information development process, how to design a training course to develop competence of communication professionals, the consultant as colleague and vendor, and others.

The conference is directed by the same two people who originated the Plymouth State College Conference on Writing for the Computer Industry, which is now held at MIT.
Price: $325.
Contact: Richard Chisholm, Seminar Director, Plymouth State College, Plymouth, NH 03264, (603) 536-5000, ext. 2301. Reservations cannot be made over the phone.
Inquiry 913.

Users Group Meeting in New York

Although it will be held in the same time frame as PC Expo, the Intergalactic User Group Officers Conference is open to officers and BBS sysops of any users group, no matter which operating system it supports.

The program will include general and technical presentations, panels, discussion sessions, exhibits, awards, and social events. It is sponsored by the New York Personal Computer Group and will be held on June 24.
Contact: Joe Rigo, 1385 York Ave., New York, NY 10021, (212) 249-6418.
Inquiry 1066.

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Circle 513 on Reader Service Card

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Fast, Dependable 9-Track Tape Drives for the Serious Professional

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TDX PERIPHERALS

Circle 514 on Reader Service Card (DEALERS: 515)

MAGIC PC™: It used to be a secret...

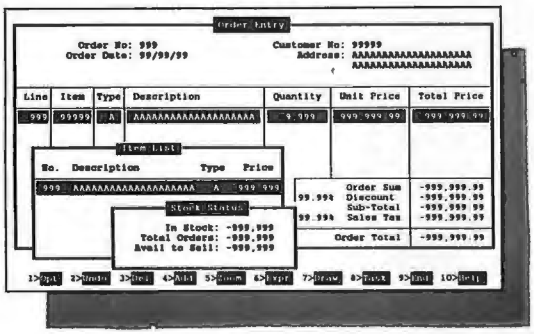
Not Anymore!

Thousands of top Professional and Corporate DBMS developers revealed to **PC WEEK**[1] the secret to their success: Magic PC – The Visual Database Language.

Surprised? We're not. We knew all along that database pro's, consultants and VARs guard Magic PC as a valuable trade secret. No wonder. It gives them a superior competitive edge: powerful applications <u>10-20 times faster</u> than any DBMS or 4GL.

The Story Behind dBASE

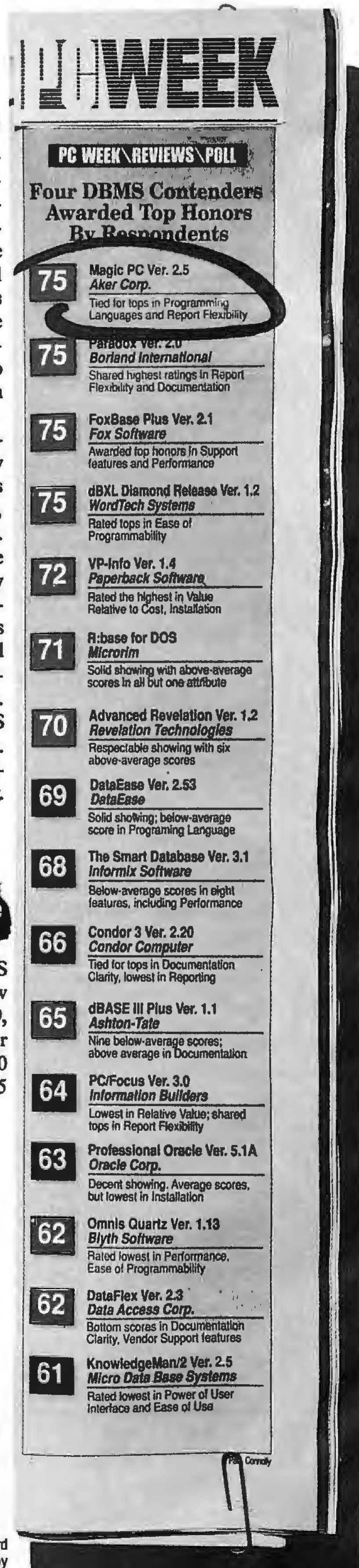
More interesting is how the respondents placed a lesser-known package, Aker Corp.'s Magic PC, in the top grouping and relegated a very well-known package, Ashton-Tate's dBASE III Plus, to eighth place.



Goodbye 4GLs

Magic PC's revolutionary power and programming speed obsoletes conventional database languages, just like CAD obsoletes manual drafting. Magic PC frees you from the entire coding and maintenance responsibility, so you can concentrate on your system design.

You specify dictionaries, processing flow scheme and drawings of screens, reports, windows, menus, etc. Design changes are easily applied on the fly and automatically maintained. Your design is immediately executed by Magic PC's standalone runtime engine. You finish even before conventional DBMS programmers normally begin the coding phase. Imagine saving all those months of tedious trial-and-error coding, debugging, testing and re-coding.


PC WEEK

PC WEEK\REVIEWS\POLL

Four DBMS Contenders Awarded Top Honors By Respondents

75	Magic PC Ver. 2.5 *Aker Corp.* Tied for tops in Programming Languages and Report Flexibility
75	Paradox Ver. 2.0 *Borland International* Shared highest ratings in Report Flexibility and Documentation
75	FoxBase Plus Ver. 2.1 *Fox Software* Awarded top honors in Support features and Performance
75	dBXL Diamond Release Ver. 1.2 *WordTech Systems* Rated tops in Ease of Programmability
72	VP-Info Ver. 1.4 *Paperback Software* Rated the highest in Value Relative to Cost, Installation
71	R:base for DOS *Microrim* Solid showing with above-average scores in all but one attribute
70	Advanced Revelation Ver. 1.2 *Revelation Technologies* Respectable showing with six above-average scores
69	DataEase Ver. 2.53 *DataEase* Solid showing; below-average score in Programing Language
68	The Smart Database Ver. 3.1 *Informix Software* Below-average scores in eight features, including Performance
66	Condor 3 Ver. 2.20 *Condor Computer* Tied for tops in Documentation Clarity, lowest in Reporting
65	dBASE III Plus Ver. 1.1 *Ashton-Tate* Nine below-average scores; above average in Documentation
64	PC/Focus Ver. 3.0 *Information Builders* Lowest in Relative Value; shared tops in Report Flexibility
63	Professional Oracle Ver. 5.1A *Oracle Corp.* Decent showing. Average scores, but lowest in Installation
62	Omnis Quartz Ver. 1.13 *Blyth Software* Rated lowest in Performance, Ease of Programmability
62	DataFlex Ver. 2.3 *Data Access Corp.* Bottom scores in Documentation Clarity, Vendor Support features
61	KnowledgeMan/2 Ver. 2.5 *Micro Data Base Systems* Rated lowest in Power of User Interface and Ease of Use

PC TECH Journal concurs:

"Magic PC's database engine delivers powerful applications in a fraction of the time... there is no competitive product."

<u>State-of-the-art Features</u>

Automatic non-procedural processing

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Multi-file zoom lookups

Easy-to-use user interface

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Proven BTRIEVE® Performance

Magic PC is based on Novell's Btrieve® for maximum performance and reliability. And if you already program with Btrieve®, use Magic PC to create instant customizations of your existing applications with full file compatibility, beyond Xtrieve® and Rtrieve®.

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In CA 714-250-1718
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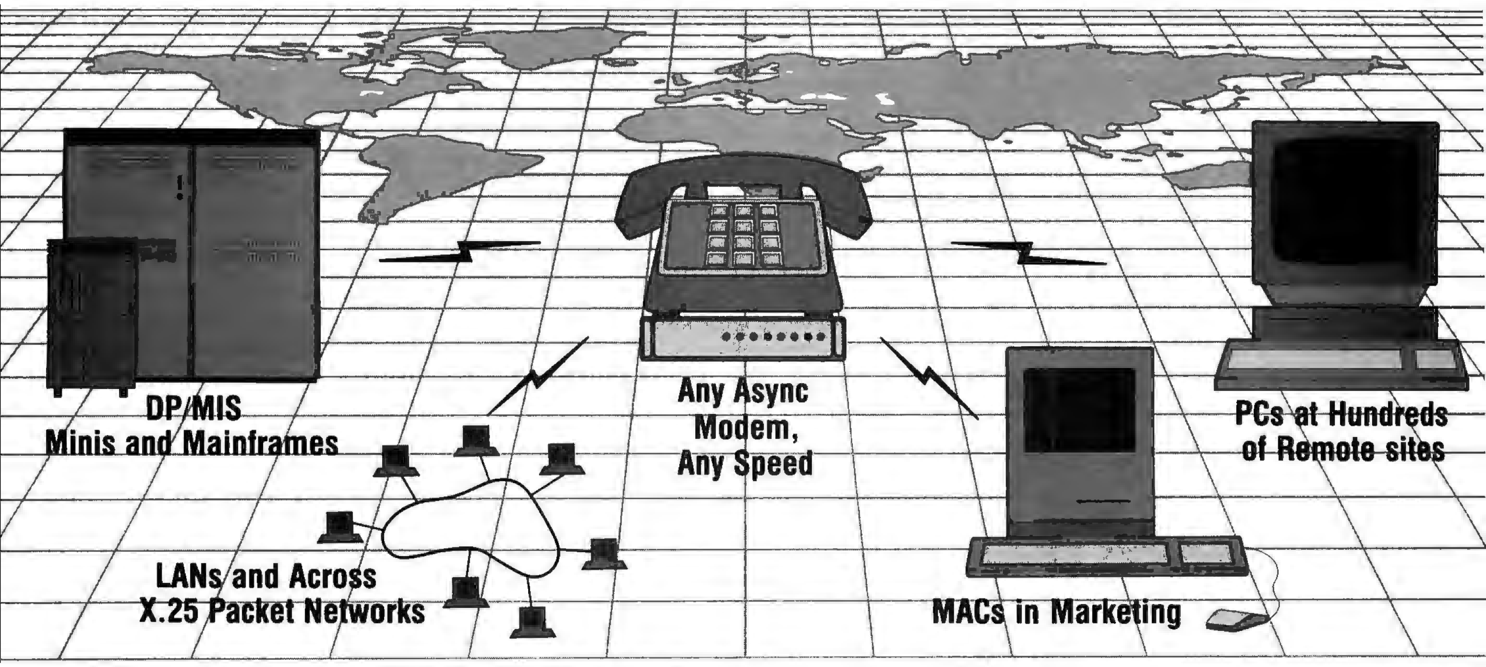
1 PC WEEK, Jan. 16 '89
2 Add $10 P&H, tax in CA. Requires IBM/100% comp., 512K hard disk, DOS 3.1 or later. Includes Btrieve runtime. 5.25" not copy protected. © Copyright Aker, 1989. Btrieve®, Xtrieve®, Rtrieve® are tradenames of Novell.

Circle 501 on Reader Service Card (DEALERS: 502)

Complete Communications, Including Remote Control, All in One Software Package



BLAST Communications Software products allow you to *connect* and intelligently manage all of your operating systems with . . .

One reliable, noiseproof communications program

One powerful script language

One set of commands

One user-friendly interface

to form

One unified company-wide Dial-up Network

You don't need to add boards or other expensive hardware . . . just use any async modem — including new high speeds and V.32s.

With BLAST products linking your system, you'll enjoy features such as Terminal Emulation (VT 100/220, D-200, 3101, etc); Automated, unattended remote polling, formatting and reporting; Remote Control of remote PC keyboards, screens and printers; Unbeatable data transmission performance over static-filled lines, X.25 packets and satellite-routed calls.

So when you're ready to *really* integrate your system, move up to BLAST . . . the fastest, most reliable and connectable communications software in the world today!

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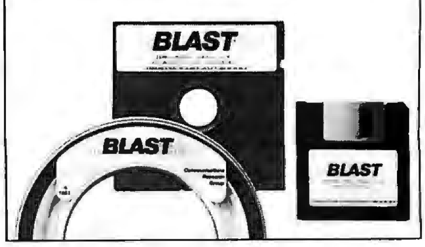
UNIX Systems	UNIX V,V.3,4.2
DEC	VMS,RSX,RT-11,ULTRIX
DATA GENERAL	DOS,MPOS,RDOS,AOS/VS
HARRIS	VOS,UNIX,XENIX
HEWLETT-PACKARD	MPE,RTE,UNIX
IBM	VM/CMS/,MVS/TSO
PRIME	PRIMOS
UNISYS	BTOS,CTOS,UNIX
WANG	VS OS,MS-DOS

. . . plus many more



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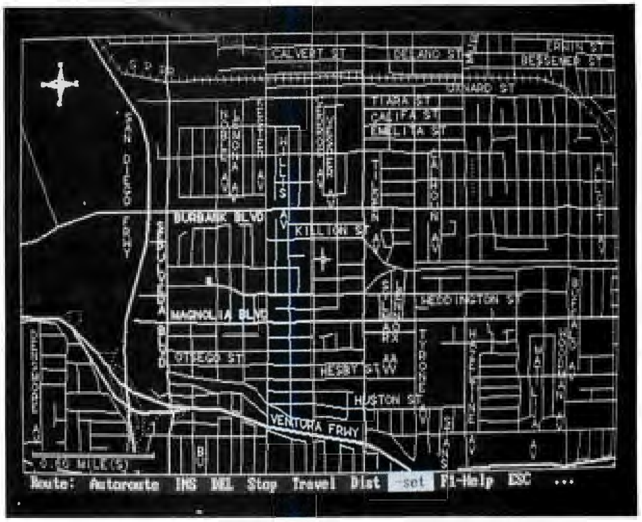
Circle 503 on Reader Service Card (DEALERS: 504)



Streets on a Disk can help you navigate city streets when the shortest distance between A and B is not a straight line.

Taking It to the Streets

Streets on a Disk, the program that lets you plan travel directions and alternate routes in hundreds of U.S. cities, now includes an Autoplace feature that takes a mailing list and positions tokens on the map for each address. Each token contains up to 100 lines of comments and information in notepad format.

Each generated travel route is displayed with full graphics on the street map and as a detailed travel report. To help adjust for traffic variables, you can adjust conditions like average traveling speed. With Streets on a Disk 3.0's editor, you can strip out sections of a map. If you want to travel in one section of a city only, you can edit the map, saving memory on your laptop.

The program's routing capabilities can handle one-way streets, highway exits, and speed settings for seven types of streets. You can zoom from a 100-mile area to an area as small as 26 feet, and you can print out maps and sections of maps as small as 4 square inches. The program also handles rivers, railroads, airports, and boundaries.

Streets on a Disk 3.0 works on the IBM PC and compatibles with DOS 2.1 or higher and 512K bytes of RAM. Because individual city disks can require up to 2 megabytes, the program requires a hard disk drive.

Price: $150; accessory maps, from $20 to $640, depending on the size and detail of the map.

Contact: Klynas Engineering, P.O. Box 499, Simi Valley, CA 93062, (805) 583-1029.

Inquiry 1056.

Database Utility Helps Create Bibliographies

Publish or Perish is a database utility for professional researchers and students who want an alternative to old-fashioned index cards used to create bibliographies. Version 4.0 lets you copy and move cards and perform Boolean searches.

If you already have references saved in text-file form, you can import them into Publish or Perish, or you can create a new set of reference cards. When you're ready to output the references as a text file or to a printer, you can choose the font and formatting options.

A Select option lets you select (or deselect) all references or those references that match a specified keyword or search string. A Sort option can alphabetize your references or put them in the order you prefer. The program can search fields and notes.

Publish or Perish runs on the Macintosh 512KE or higher.

Price: $74.95

Contact: Park Row, Inc., 4640 Jewell St., Suite 232, San Diego, CA 92109, (800) 747-5589; in California, (619) 581-6778.

Inquiry 1058.

Graphical Plotting Subroutines for DOS, OS/2

A library of subroutines that supports C, FORTRAN, and BASIC compilers simplifies the development of charting and plotting applications for programs. The package, GSS*GPS, is available in source code–compatible DOS and OS/2 versions.

The routines implement standard formats for seven types of charts: area, bar, line, scatter, schedule, step, and text-only. You can use these formats, or you can create your own.

The subroutines require DOS 2.0 or higher with the DOS version and OS/2 version 1.1 for the OS/2 version, and they run on the IBM PC and compatibles or higher.

Price: Either version, $395.

Contact: Graphic Software Systems, Inc., 9590 Southwest Gemini Dr., P.O. Box 4900, Beaverton, OR 97005, (503) 641-2200.

Inquiry 1057.

Apple Enhances ImageWriter LQ

Apple's ImageWriter LQ is now quieter, delivers better print output, and is more accessible from within applications, Apple says.

The product is similar to the same 27-pin dot-matrix printer that was introduced last year for the Macintosh and the Apple II. With standard equipment, you still get the 15-inch-wide carriage and paper handling in push-and-pull tractor, friction feed, and bottom feed.

Although Apple claims this model is quieter, it won't comment on specific decibel ratings. Sound-deadening equipment, including a new platen, and changing the print head to work less frequently help reduce noise, Apple reports.

Of course, making the print head work less frequently would slow down print speed if Apple didn't rewrite the software driver. The print head now works when it was previously idle. Using internal fonts, print speed remains effectively at 250 cps in draft mode and at 115 cps in letter-quality mode.

Print quality is enhanced on the top and the bottom of printed documents by increasing the pressure of the paper on the platen. Printer resolution is 216 dpi. The final enhancement involves the HyperCard stack and Quick Setup Guide, which are now shipped as standard equipment.

Price: $1399; LocalTalk card, $139.

Contact: Apple Computer, Inc., 20525 Mariani Ave., Cupertino, CA 95014, (408) 996-1010.

Inquiry 1063.

BYTE editors' hands-on views of new products

A Quality 80386 Machine

THE FACTS	
Dell 325 base system, $4599 *Options:* Weitek 3167 math coprocessor, $1300; Intel 25-MHz 80387 math coprocessor, $1000; 1 megabyte of RAM,	$480; additional floppy disk drive, $130. Dell Computer Corp. 9505 Arboretum Blvd. Austin, TX 78759 (800) 426-5150 **Inquiry 1024.**

It seems like everybody is selling a 25-MHz 80386-based computer these days. Unfortunately, the quality of such systems varies tremendously. The worst machines are mere assemblies of available parts; the best ones are built with regard for performance and reliability. One of the best that I've seen is the **Dell 325**.

Dell has managed to assemble all the most-wanted features into one system. The Dell 325 I looked at contained an 80386 running at 25 MHz and 2 megabytes of RAM, which was composed of eight 256K-byte single in-line memory modules arranged in an interleaved memory architecture to speed memory access.

There is a socket for an Intel 80387 math coprocessor (a Weitek 3167 math coprocessor is optional). An 82385 cache memory controller and 32K bytes of 25-nanosecond static RAM for the cache speed memory accesses. All this is situated on a motherboard that contains the Chips & Technologies chip set, a Phoenix ROM BIOS, two serial ports and one parallel port, and eight slots (two 8-bit and six 16-bit).

The system also came with an 18-millisecond Micropolis Model 1558-14 318-megabyte hard disk drive and two floppy disk drives (1.2-megabyte 5¼-inch and 1.44-megabyte 3½-inch). The drives are connected to a Western Digital floppy disk/ESDI hard disk controller card.

Video output is controlled by a Video Seven 16-bit VGA card and displayed on a Dell VGA Color Plus Monitor. Also included is a Key Tronic 101-key Enhanced keyboard.

The Dell 325's base system comes with 1 megabyte of RAM, a 1.2-megabyte floppy disk drive, and a Western Digital controller card.

Setting up and using the Dell 325 was simple. Every part of the system is documented, and everything was in working order out of the box. It comes with a one-year limited warranty, and toll-free technical support is offered.

In performance, the Dell 325 was as fast as any other 80386 computer I've used. The BYTE benchmarks rate the machine as roughly equivalent to—if not faster than—the Compaq Deskpro 386/25.

All this performance comes in a package that costs one-third less than a comparable Deskpro 386/25. The Dell system I used cost $9308. This low price is partly the result of recent price cuts made by Dell for large hard disk drives and partly because of the decrease in the cost of DRAM chips.

Dell recently announced that it will offer a Unix version of this system. The option includes a merged version of Unix System V 3.2, which can run all Xenix applications, in addition to AT&T System V/80386 programs. This system will also support X Windows.

The Dell 325 is a fine combination of hardware that provides very good performance at a reasonable price.

—Stan Wszola

It's a Word Processor and, Its Also a Grammar Checker

No, that title didn't slip past the copy desk. It did, however, slip past Perfect Grammar, which is the grammar-checking program bundled with Lifetree Software's **Volkswriter 4** word processor. Perfect Grammar is useful for cleaning up carelessly worded text, but it's no substitute for a copy editor or a judicious proofreader.

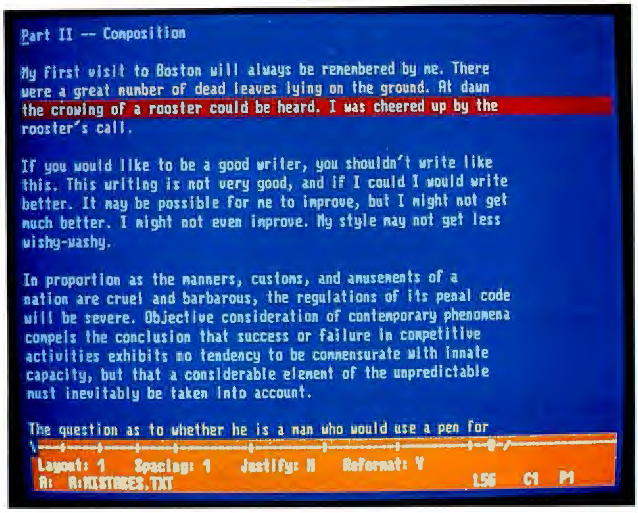
To test Perfect Grammar, I created two documents with the aid of *The Elements of Style* by Strunk and White. The first 2100-word document violated all of Strunk and White's rules, *and the second* document conformed to them.

continued

In addition to common grammatical errors like "its" for "it's," the bad test file included stylistic problems like wordiness and entire paragraphs written in the passive voice.

Perfect Grammar checks grammar and spelling, highlighting mistakes and suggesting corrections. In most cases, you have the option to accept the correction, ignore the suggestion, or edit the offending word or phrase yourself. Since you're given the final say, you always have full control over style; you can even set the checker to never flag unorthodox constructs that you often use.

The program missed obvious mistakes and occasionally flagged correct expressions. No grammar checker can read your mind, but how much stock can you put in software that passes over "Morris's uncle, Albert keeps pet piranha" and suggests "reads" for "read" in "The man unfolded the contract and read it to me"? If you can't rely on the program in simple cases like these, you're not likely to take its suggestions when the grammar questions become more difficult.



THE FACTS

Volkswriter 4 with Perfect Grammar
$199

Requirements:
IBM PC with DOS 2.0 or higher and 640K bytes of RAM with 540K bytes free, or 384K bytes with 328K bytes free to run without Perfect Grammar.

Lifetree Software, Inc.
411 Pacific St.
Monterey, CA 93940
(408) 373-4718
Inquiry 1025.

Perfect Grammar also fails to detect errors that extend beyond one sentence. Varying verb tense in a single paragraph is an example. It doesn't flag strings of passive-voice sentences or paragraphs of sentences that begin with the same word.

While it rightfully takes exception to "the reason why is . . ." as wordy, it doesn't object to repeated sentences containing "the fact that" or "certainly." It also accepts ridiculously complex wording and jargon.

In addition to the grammar checker, Volkswriter 4 adds a few interesting features to the usual word processor's repertoire of editing and block manipulation. These include math functions, sorts, text merges, and an ASCII conversion utility. The package supports over 400 printers and can take advantage of advanced printer features like proportional spacing and PostScript.

Volkswriter 4 is both easy to learn and easy to use. Thus, even if you're fiercely loyal to other word processing software (as most of us are), you won't have much trouble making the adjustment.

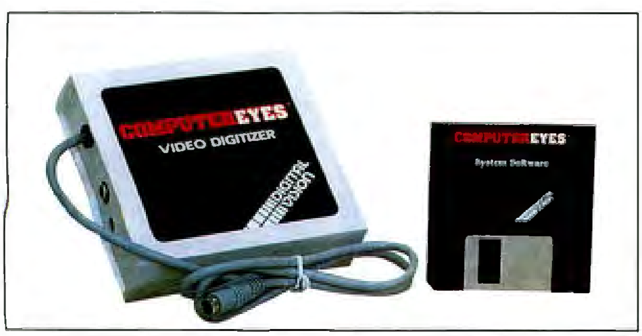
If you expect Perfect Grammar to dramatically improve your writing, you'll probably be disappointed. If, on the other hand, you're looking for a good word processor with a sophisticated diagnostic tool, Volkswriter 4 with Perfect Grammar may be the answer.

—Steve Apiki

Low-Cost Digitizing on the Mac

With the **ComputerEyes** video digitizer from Digital Vision, you can now get 8-bit digitizing with 256 gray levels for the price of 1-bit digitizers. There are some obvious trade-offs, like speed, but even that isn't too bad.

ComputerEyes scans at 300 dots per inch in 24 seconds, or 6 seconds for the fast graphics scan (at about 72 dpi). This is not, however, a frame-capture board that will take one-thirtieth of a second's worth of TV and digitize it. If your subject moves appreciably during the scan, it will show a smear. If you have recorded a moving subject on videotape, you might be able to use this device on the playback for digitization. If you want to digitize nonmoving subjects like plants, it's no problem.



The digitizer measures 5⅛ by 5 by 2 inches. It comes with a small 12-volt DC wall-hung power supply, a cable with an RCA phono plug on each end that you can plug into a printer or a modem, a Macintosh disk, and a manual. You plug the digitizer into a mini-8 Mac serial port.

The manual goes over the basic installation procedures and common troubleshooting areas, but it doesn't go into depth on any subject. The overview section is probably the best part of the manual, since it explains what is being done by the digitizer and how to use the gray-level editing

continued

THE FACTS

ComputerEyes
$249.95

Requirements:
Any Mac with 1 megabyte of RAM.

Digital Vision, Inc.
66 Eastern Ave.
Dedham, MA 02026
(800) 346-0090
Inquiry 1026.

Embedded systems designers have already used **CrossCode C** *in over 357 different applications.*

CrossCode C comes with four powerful tools to help you program your 68000-based ROMable applications

From C source to final object, each tool takes you one step closer to your finished ROMable design

CrossCode C is designed specifically to help you write ROMable code for all members of the Motorola 68000 family. Four powerful tools take you from C source to object code:

1. COMPILER: To get truly ROMable code, you have to start with a truly ROMable compiler. Here are three **CrossCode** C features that you won't find in any ordinary C compiler:

- Compiler output code is split into five independent memory sections that you can assign into ROM or RAM as you please.
- You can optimize the code for your application because *you* control the sizes of data types. For example, you can optimize for speed by using two byte *ints*, or get maximum versatility by using four byte *ints*.
- You can easily write assembly language routines that call C functions and vice versa, because the compiler uses simple, well documented parameter passing conventions.

2. ASSEMBLER: CrossCode C comes with a Motorola-style assembler that has all the features that assembly language programmers require. In fact, you could write your whole application with it:

- The assembler features an advanced macro language, conditional assembly, "include" files, and an unlimited size symbol table.
- Detailed cross references show you where you've defined and referenced your symbols.
- After a link, you can actually convert your "relocatable" assembler listings into "absolute" listings that contain absolute addresses and fully linked object code.

3. LINKER: The **CrossCode C** linker is designed to handle truly huge loads. There are no limits on the number of symbols in your load or on the size of your output file. And you can always count on full 32 bit target addressability, because the linker operates comfortably in the highest ranges of the 68030's address space.

4. DOWNLOADER: CrossCode C comes with a *downloader* that puts you in touch with all EPROM programmers and emulators. It can convert your load into Motorola S-Records, Intel Hex, Tek Hex, Extended Tek Hex, and Data I/O ASCII Hex. You can also produce a binary image and convert that image into any format you might want. In all formats, bytes can be split into EPROMs for an 8, 16, or 32 bit data bus.

Why Wait

Once you start using **CrossCode C**, you may just wonder how you ever got the job done before! It's available under MS-DOS for just $1595, and it runs on all IBM PCs and compatibles (640K memory and hard disk are required). Also available under UNIX, XENIX, and VMS.

CALL TODAY for more information:

1-800-448-7733
(ask for extension **2002**)

Outside the United States, please dial

PHONE: **1-312-971-8170**
FAX: **1-312-971-8513**

SOFTWARE DEVELOPMENT SYSTEMS, INC.
DEPARTMENT 22
4248 BELLE AIRE LANE
DOWNERS GROVE, ILLINOIS 60515 USA

program that is included.

The ComputerEyes program controls the image capturing, as well as the first editing of the image. Brightness and contrast are adjustments that will affect all images, and they are done with small sliders that give numeric values as they move. A "normal" view screen and a "full" view screen are available. Normal view is 1 pixel per sample; the full view shows the overall document. We found this to be a useful setup.

Similar editing programs require you to toggle back and forth between these views to get an idea if a small change works with the entire document. ComputerEyes gives these views simultaneously in their own windows and makes editing much easier.

Files can be saved as MacPaint, PICT, TIFF, or PostScript, although ComputerEyes will not read a PostScript file back into the editor portion of the program.

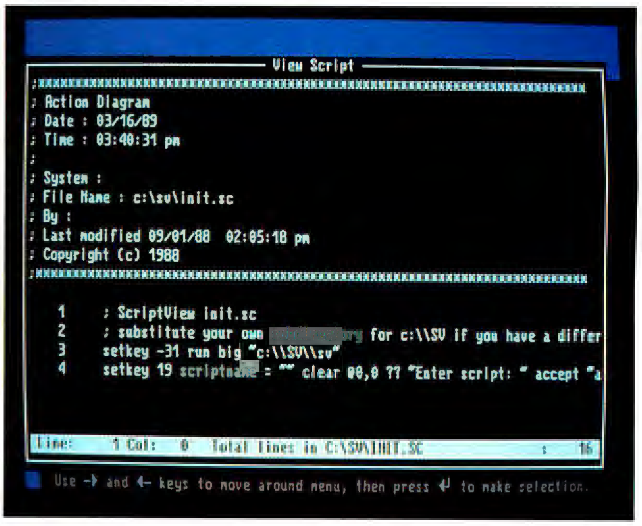
There is also a preview mode that scans a subject and is useful for camera adjustments, like framing the subject. Since the output is not saved in memory, it effectively scans somewhat faster.

You can mirror, flip, or invert all or part of an image with simple menu commands. Also, you can apply halftone, 64-level dither, randomized dither, a vertical venetian-blind effect, and a horizontal venetian-blind effect. These are simple but useful patterns, with the halftone being the one that was our favorite.

All in all, we found a lot to like about ComputerEyes. It is affordable for individual use, while capable of producing no-compromise files that you can use in high-end publishing applications. We think it truly represents a price/performance breakthrough for Mac peripherals, and we can foresee many users wanting a 256-gray-level digitizer at this price.

—*Laurence H. Loeb and Anne Fischer Lent*

A Pair of Paradox Helpers



The power and complexity of packages like Paradox sometimes make them difficult to use, and that has created a large market for utilities like **DataFinder** and **ScriptView**.

TSR Systems' DataFinder is a memory-resident utility that lets me directly manipulate a Paradox file from outside Paradox. When I'm writing a letter, I often need to retrieve an individual's name and address. That requires that I do the following: start Paradox, find the name, put it into a report, and output it in ASCII. I used to think it was easier to use my Rolodex... *until I tried* DataFinder.

I can pop up DataFinder, find the name and address I need, mark it, cut it, and paste it directly into my letter—in mere seconds. I can also extract financial data and paste it into my spreadsheets.

DataFinder also lets me create a new file from data I've marked, and I can quickly edit data in a Paradox file without having to start the main program. In a pinch, DataFinder adds power to Paradox.

Another useful utility that has helped me develop custom Paradox applications using PAL (Paradox Applications Language) is ScriptView. Although PAL is a powerful language, it is complex. When I'm trying to debug a complex PAL script, I've often wished I could have the software tools available in regular programming languages. ScriptView fills the bill nicely.

ScriptView creates a graphical program structure from a PAL script and gives me three types of variable cross-reference listings, procedure call tree diagrams, and procedure usage reports. There are also project lists that document the entire application. If you develop PAL scripts, ScriptView is a necessity.

—*Stan Miastkowski*

continued

THE FACTS

DataFinder
$99.95

Requirements:
IBM PC with a hard disk drive and Paradox (any version).

TSR Systems, Ltd.
1600B Main St.
Port Jefferson, NY 11777
(516) 331-6336
Inquiry 1027.

ScriptView
$95

Requirements:
IBM PC with a hard disk drive and Paradox (any version).

Farpoint Systems Corp.
P.O. Box 13093
Jersey City, NJ 07303
(800) 336-6644; in New Jersey, (201) 659-7613
Inquiry 1028.

Solving the Nearly Unsolvable

NeuroShell from Ward Systems Group is a program that lets you create and solve your own problems using neural-network technology—a way of resolving issues and dilemmas that are difficult to answer with a simple yes or no. Unlike some other computational methods, neural networks don't require programming, because they are based on models of how the brain encodes and processes information. Instead, you "train" them by inputting and outputting desired behavioral information related to your current problem.

You can use neural networks to solve market trends and analysis problems, to decide on certain goods to purchase, to establish people's ability to qualify for or repay a loan, and to handle other dilemmas with several variables that may not have absolutely "correct" answers.

NeuroShell includes binary and analog versions. Generally, the binary version is more useful because you can input words and strings; the analog version requires that you assign numbers. However, you can try your problem both ways.

I installed the program easily and began using its Main and Advanced Options menus. With the Main menu and the manual, I went through some binary and analog examples included on the disk and then ran the sample cases provided. The manual warns you that unless you use a math coprocessor, learning will take a while, and it did—an hour for the simple case I chose.

To set up a new problem, you create a number of sample cases by inputting various defining characteristics above a dotted line and classifying characteristics below the line. Next, in each sample case, you enter certain combinations of defining and classifying characteristics. Then, in order to input your new and unproven questions, you have the program learn these givens by selecting the menu item "Learn the sample cases."

You then sit back and watch as NeuroShell makes your inputs and outputs "converge" to a certain default (or custom-chosen) threshold. Unless and until you override other default criteria (e.g., the amount of hidden nodes and minimum and maximum characteristics and thresholds), the program uses preset values.

NeuroShell gives you screens that show you all your options and ranges and information on how to adjust the data if you find the program's responses to be off a bit.

After its learning period, you can enter certain characteristics and use the F3 key to classify or respond to the various combinations you choose. If the answers are off a bit, you can wipe out the old stuff, start over or modify the data, and have the program learn the new information. The time the program takes to learn decreases with each new try.

I've used many of the other available neural-network simulations, and I'm glad that NeuroShell doesn't include graphics. The only function graphics provide is to let you watch the program's neurons interconnect.

I like the fact that NeuroShell does something.

—***Janet J. Barron***

continued

THE FACTS

NeuroShell
$195

Requirements:
IBM PC or compatible with 256K bytes of RAM and DOS 2.0 or higher. A math coprocessor is recommended.

Ward Systems Group
8013 Meadowview Dr.
Frederick, MD 21701
(301) 662-7950
Inquiry 1029.

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Sleuthing Your Troubles Away

I made the mistake of customizing a new machine with parts cannibalized from my old system. In the end, I had a computer with a decent-size hard disk drive, 1.5 megabytes of RAM, a second communications port, the old monitor I had gotten used to, and a persistent configuration error.

After several failed attempts at reconfiguring the system with the Setup menu, I was seriously considering the possibility that I had a defective piece of equipment.

In the middle of all my confusion, I received a new system utility package, **System Sleuth** from DTG. I quickly read the brief, literate instructions and prepared to give the computer a new lease on life.

What happened next was relatively simple, although still somewhat perplexing. I'd set the video board to "monochrome" for a monochrome monitor and set the configuration menu for "mono." The video configuration that the system wanted was specified on the Setup menu as "EGA in monochrome mode" while leaving the video-card DIP switches still set for "mono." In my haste, I'd overlooked that configuration possibility when I set up the new system and, since the display screen looked just fine, never considered that it could be the source of the problems I experienced thereafter. After all, a component that looks like it's working properly is easier to ignore as a potential source of your problems.

System Sleuth's way of handling the problems it finds is simply to point out what the error is and (sometimes) suggest a course of action. In my case, I ran Setup one more time, reset the monitor type to EGA, and haven't had a failure since.

There may be many programs that will pinpoint a configuration error and suggest a remedy. The ones I'm familiar with, however, require that you have a fairly good idea where to look before you run them. What I like about System Sleuth is that it doesn't require you to know beforehand where the source of the problem lies.

My problem was with a part of the system that seemed to be working perfectly, and it would have been the last place I'd have looked for trouble. By being a generalized package that tests each component, System Sleuth saved me a lot of time. It comes with a suite of tests for memory, peripherals, disks, I/O, processors, displays, and much more.

I also like the fact that System Sleuth is passive. It told me what the problem was and let me go fix it. Packages that try to perform automatic repairs can be effective, but I like pushing the buttons and following along with the progress of a fix myself. Whether it's true or not, I feel as if I'm learning something and doing more than just going along for the ride.

If you don't have a lot of time to waste playing system sleuth yourself, but feel like having at least something to say about your system's repairs, System Sleuth could be worth a look.

—Glenn Hartwig ■

THE FACTS

System Sleuth
$149

Requirements:
IBM PC with 256K bytes of RAM (192K bytes free), DOS 2.1 or higher, PC-MOS/386, and a monochrome/Hercules/CGA/EGA or VGA display adapter with an appropriate display.

DTG
23704-5 El Toro Rd.,
Suite 348
El Toro, CA 92630
(213) 987-2000
Inquiry 1030.

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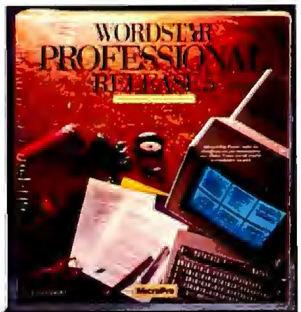

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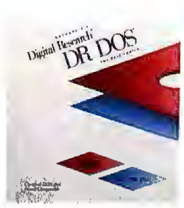

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The Fastest 80386s Ever?

Preliminary tests suggest that ALR will continue to dominate the DOS performance arena

For the better part of a year, the top spot in our DOS benchmark tables has been held by an entry from a small company in southern California. Advanced Logic Research (ALR) has been our performance leader with its FlexCache 25386 tower system. But with a slew of faster 33-MHz 80386-based systems announced recently, the ALR system was sure to be surpassed. However, even though detailed tests have yet to be performed on all these new systems, it's a good bet that the new king of the mountain will be another

continued

The ALR FlexCache 33/386 tower system (right) sports the fastest BYTE CPU index rating to date. The MicroFlex 7000 is at left, and the FlexCache 33/386Z is in the center.

PHOTOGRAPHY: GREG FULTON © 1989

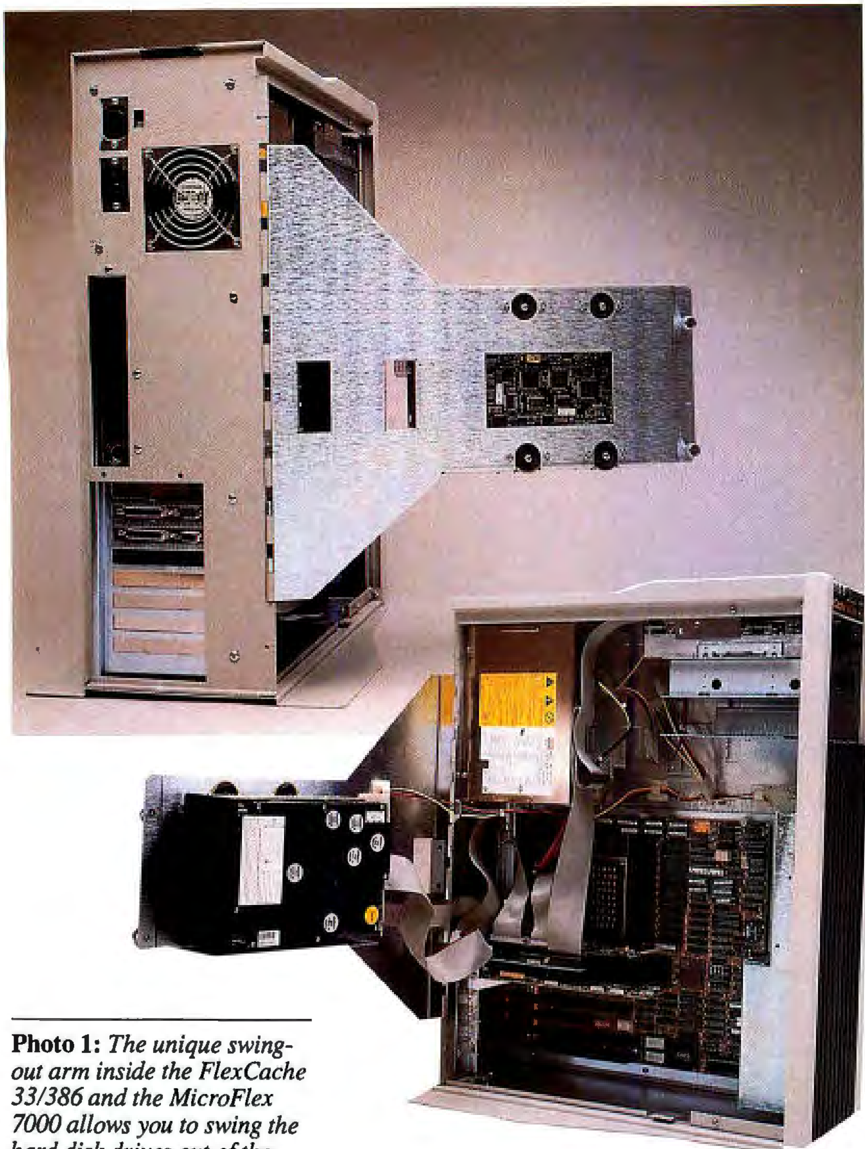

Photo 1: *The unique swing-out arm inside the FlexCache 33/386 and the MicroFlex 7000 allows you to swing the hard disk drives out of the way to add extra memory or a math coprocessor.*

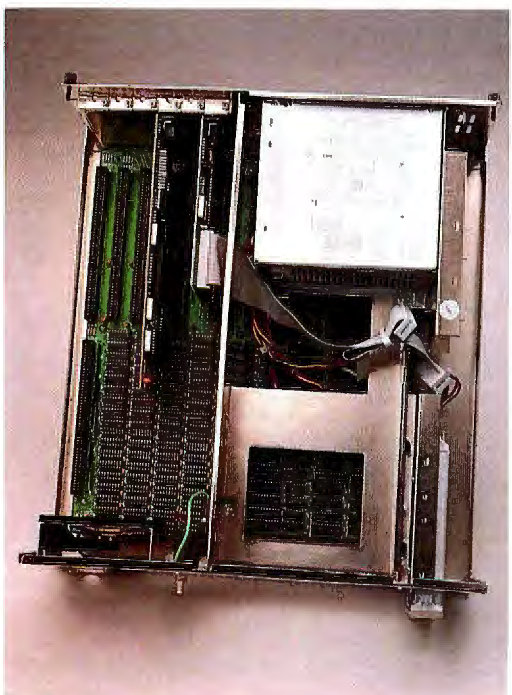

Photo 2: *The ALR FlexCache 33/386Z has its 3½-inch hard disk drive hidden in the rear right corner of the system.*

ALR computer: the 33/386.

What is perhaps even more impressive is that the company appears to recognize that the computer world consists of more than just power users with deep pockets. ALR has also recently announced other systems that will probably each represent the fastest in its own category. The first of these is a compact $4000 version of the 33-MHz system called the FlexCache 33/386Z. Next is the MicroFlex 7000, ALR's 25-MHz Micro Channel architecture (MCA) clone, which recently became available. Rounding out the list are two affordable systems based on the 80386SX: the FlexCache SX386Z and the diminutive VIP SX386, a machine that probably sets a new standard in the DOS world on a performance-per-cubic-inch basis.

For this article, I'll concentrate on the three most recent of these systems: the two 33-MHz systems and the 25-MHz MicroFlex 7000; each of these has some unique features. (For a look at the VIP SX386 and the SX386Z, see the text box "ALR's SX Machines.")

The Swing-Out Disk Drive

The high-end 33/386 looks like a standard desk-side tower system, such as the IBM PS/2 Models 60 and 80. The most distinguishing feature is ALR's traditional wide-finned black plastic grill. And unlike the IBM systems, it has room on the front for both the 3½-inch floppy disk drive that comes standard with the system and a half-height 5¼-inch storage device, such as a floppy disk drive or tape drive.

Inside, however, the situation is different. To get inside, you loosen two thumbscrews that secure a tight-fitting metal cover designed to thwart the considerable radio-frequency interference given off by such a high-speed system. Under the cover is an innovative swing-out bracket that can hold two hard disk drives, one full-height 5¼-inch device and one 3½-inch device (see photo 1).

With the drives swung out of the way, you have easy access to the motherboard. Installing an 80387 or extra single in-line memory modules (SIMMs) should be a snap. The disk drive we saw is also heavily shock-mounted. This is probably required for the swing-out arm mounting, but even if the user never takes advantage of this feature, the shock mounting should provide an extra level of reliability.

The system's motherboard is large and heavily populated. The most interesting part is the system's cache, which is a substantial 128K bytes, four times larger than most other high-end systems. The cache is composed of fast 25-nanosecond static RAM, whereas the main system uses 60-ns DRAM.

For higher speed, ALR has chosen to use its own custom cache circuitry rather than the Intel 82385 cache-controller chip used on many other systems. In addition, the cache is connected to the main memory by a 64-bit-wide bus. Theoretically, this wide bus would require only half as much time as a 32-bit-wide bus on a cache "miss," when data must be moved from main memory to the cache.

ALR also uses an unusual design for its clock circuitry. At 33 MHz, each clock cycle lasts only 30 ns, appreciably less than the 40 ns available in a 25-MHz machine. To get the most out of those 30 ns, ALR has used fast emitter-coupled logic chips to generate the clock pulses. The ECLs are appreciably faster than the more common TTL circuits.

ALR's design appears to have paid off. Based on preliminary benchmark tests, the system easily outdistances all 25-MHz systems. Its CPU performance comes in with a score of 6.57, compared with the IBM PC AT's score of 1 and ALR's 25-MHz record holder's score of 5.07. This is only 30 percent faster than the 25-MHz system, less than the 32 percent you would expect from the increased clock speed alone. But the new ALR system is 56 percent faster than the Compaq 386/25. The only other 33-MHz systems we have tested are the Zenith Z-386/33 and the SIA 386/32; the latter uses a 25-MHz-rated CPU running at 33 MHz. The ALR 33/386 beats them both on the CPU index.

The new ALR tower system also has an attractive price: $9990, which includes 2 megabytes of memory, a 16-bit VGA adapter, and a 150-megabyte ESDI hard disk drive.

Compact Power

The second 33-MHz system from ALR is the FlexCache 33/386Z, a small desktop system about the size of the Compaq 386/20s (see photo 3). ALR also claims it is within a half inch of the size of the IBM Model 50. The system has a standard appearance except for its floppy disk drives. It has two 5¼-inch half-height storage bays arranged horizontally and a 3½-inch floppy disk drive arranged in a peculiar vertical orientation. Although this vertical orientation makes effective use of the front panel real estate, it can be confusing at times: Do you insert a disk with the label to the left or to the right? Nine times out of 10, I inserted

continued

ALR's SX Machines

The low-priced ALR FlexCache SX386Z (right) and the petite VIP SX386. Both use an 80386SX processor and have very reasonable price tags.

So far, we have not been overly impressed with the selection of systems based on the 16-bit-wide 80386SX that we've seen. The systems seem to have combined mediocre 80386 performance with high prices. Two recent Advanced Logic Research systems buck that trend, however.

The ALR SX386Z is about the size and shape of the new 33/386Z desktop system. The VIP SX386 is about the size of an enlongated lunch box. Both systems are compact, especially the VIP SX386 (see photo).

The area in which they are most impressive is in their price/performance ratios. Both systems use the Intel 82385 cache controller with a 16K-byte cache. ALR claims it has created custom circuitry to allow this controller to run on the 16-bit bus of the 80386SX. The circuitry seems to have paid off. In CPU performance, the VIP SX386 is about 2½ times the speed of an IBM PC AT. By comparison, the Compaq 386s system is not even twice as fast, with a score of only 1.86 (see table 1). Although we have not tested the VIP SX386 system, ALR says it has similar circuitry and performance.

Hand in hand with the impressive performance of these systems are their prices. Indeed, ALR claims it is offering them at the same price as its equivalent 80286 systems. With 1 megabyte of memory and a floppy disk drive, the SX386Z costs $1795, while the smaller VIP SX386 sells for $1895.

Table 1: *Performance indexes. The ALR systems seem to be very fast in CPU performance. The new 33/386 is over 6½ times faster than the IBM PC AT. The tests for the 33-MHz systems were performed on prototype systems; production systems should have slightly different values. ALR says it will soon modify the VGA circuitry to enhance video performance on all systems. All test data shows performance relative to an AT, where an AT's performance = 1.*

Machine	CPU	FPU	Disk	Video
80386SX				
ALR SX386Z	2.76	4.36	1.64	1.81
Compaq 386s	1.86	5.03	1.78	1.87
Twinhead Superset 490[1]	1.93	5.91	1.45	1.17
MCA				
ALR MicroFlex 7000	4.96	7.87	2.34	2.95
Tandy 5000 MC	3.71	7.91	1.25	2.26
IBM PS/2 Model 70-A21	4.71	10.23	1.64	2.96
33 MHz				
ALR 33/386Z[1]	5.37	11.17	1.58	3.86
ALR 33/386[1]	6.56	11.13	2.32	1.62
SIA 386/32[2]	5.99	14.20	2.36	3.06
Zenith Z-386/33[1]	4.78	N/A	3.12	3.03
25 MHz				
ALR 25386	5.07	10.55	2.74	2.57
Compaq 386/25	4.22	10.37	2.55	3.38

[1] Prototype; performance of production units might vary.
[2] Uses a 25-MHz CPU running at 33 MHz.
For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

The new FlexCache 33/386Z is the fastest machine for under $5000.

it wrong. The front panel also has a white on/off toggle and a keylock that does not, unfortunately, lock the system case.

Inside is another innovative use of space. A 3½-inch hard disk drive is hidden back in the rear right corner of the case, next to the power supply.

The circuitry that the ALR 33/386Z uses is much more conservative than that found in its faster brother. The 386Z uses an Intel 82385 cache controller with a 32K-byte cache of 25-ns memory and a 32-bit bus.

The more conservative design results in more conservative performance. Its CPU performance score is 5.37—still impressive, but not much faster than ALR's 25-MHz system (5.07). The 386Z was, however, 27 percent faster than Compaq's 386/25.

While not the fastest DOS machine available, the new FlexCache 33/386Z is easily the fastest in the under-$5000 class. The base system with 1 megabyte of memory but no hard disk drive or video card costs just $3995. It seems to be an attractive compromise of power, price, and compactness.

Micro Channel Churner

Rounding out ALR's collection of high-performance systems is the recently introduced MicroFlex 7000. This system not only is one of the few machines compatible with the high-end IBM PS/2s, but will probably also be the fastest such machine for some time to come.

Externally, the system looks almost exactly like ALR's 33/386 tower system. Like the 33-MHz system, it has room for two 5¼-inch storage devices as well as the standard 3½-inch floppy disk drive.

One interesting part of the new system's exterior is a set of eight small LEDs. These tiny lights give an indication of how often the processor is accessing the system's cache. ALR says software developers can use the lights to optimize their software so that it makes the most use of the cache.

Inside, the similarity with the 33/386 continues. The MicroFlex 7000 even has the same unique swing-out arm holding two disk drives. It also features the extra-wide 64-bit bus between the cache and main memory. The cache, however, is only half as large (64K bytes).

One big difference, of course, is the MCA slots. There are eight of them: Three are 32-bit, and five are 16-bit. To drive these slots, the system has an ample 200-watt power supply.

In terms of performance, the 7000 outperformed all other 25-MHz systems and all other MCA clones (see table 1), but it was slightly slower than ALR's 25386. The base system includes 2 megabytes of memory, a 120-megabyte hard disk drive, and a VGA adapter. The list price is $9499. If you need an MCA design, the 7000 appears to offer unprecedented power and expansion options.

Like most of today's high-performance systems, the ALR systems come with disk-caching software—in this case, Multisoft's PC-Kwik. This software dramatically improved the speed of the ALR systems in our disk drive tests.

ALR is also working on increasing the speed of the video. The company plans to modify the BIOS of the systems so they will no longer be compatible with Hercules or AT&T 6300 graphics; thus, they will no longer be register-compatible with CGA graphics. Supporting these additional graphics modes—which are not supported on the VGA boards of either IBM or Compaq machines—is said to significantly slow down video performance. Removing this compatibility gives the user the power to increase the performance of a system at the small cost of losing a level of compatibility that is becoming increasingly unnecessary.

For even faster video, ALR will sell the complete PC-Kwik package for $50. Included is a program that will significantly increase video speed.

Although new systems seem to appear monthly, and being the fastest can change overnight, ALR's 25386 has been dominant for some time. If things proceed as we think they might, new ALR systems will again dominate the upper reaches of the performance spectrum.

Many factors besides CPU speed determine the value of a system. Among them are reliability and overall performance. We hope to have more data on these aspects in an upcoming review of ALR's new machines, but for now, they seem to be a very attractive combination of price and performance. ■

Rich Malloy is associate managing editor of the news and technology section of BYTE and editor in chief of BYTEweek. *He can be reached on BIX as "rmalloy."*

Greased Lightning

Zenith's 33-MHz Z-386/33 paves the way for EISA

Several vendors have pushed Intel's 25-MHz 80386 chip past its rated limits using special cooling techniques. Zenith's new unit—the first that BYTE has seen with an Intel 33-MHz chip—doesn't resort to such measures. The Z-386/33 is a true 33-MHz system. It is also an interesting preview of what next year's Extended Industry Standard Architecture (EISA) machines might look like. Zenith, one of the infamous "Gang of Nine," has extended the industry-standard AT bus in a way that should adapt cleanly to the forthcoming EISA standard.

The prototype system I evaluated came with 4 megabytes of RAM, a 320-megabyte ESDI-controlled hard disk drive, a 200-watt power supply, a serial/parallel board, Zenith's Z-549 VGA card, a single 1.44-megabyte 3½-inch floppy disk drive, and a Zenith 101-key keyboard. No 33-MHz 80387 coprocessors were available yet. When Intel produces 33-MHz coprocessors, Zenith expects to ship the Z-386/33 in a variety of configurations. A system like the one I reviewed will list for about $15,000 and will include Zenith's DOS 3.3 Plus and Windows/386.

A Bridge to EISA

Like its 25-MHz cousin, the motherboard provides four 32-bit SuperSet slots and three standard AT slots. Each slot can accept an 8- or 16-bit board and can run at 8 MHz. The SuperSet slots use an additional connector that, when activated, can boost bandwidth to 32 bits and speed to 33 MHz.

My review system came with a single SuperSet board. It's the I/O board, but Zenith has also placed on it the ROM BIOS, CMOS RAM, and, most interestingly, some bus-control circuitry. The board controls a dual AT/SuperSet bus now, but Zenith expects to eventually build a variant that will control an EISA bus. By separating the I/O subsystem from the memory/CPU subsystem in this way, Zenith simplifies the expected transition to EISA.

What else can you do with SuperSet slots? Well, for now, the same thing you can do with Micro Channel slots—add memory-expansion boards. The eight single in-line memory module (SIMM) sockets on the motherboard can accommodate a total of 32 megabytes of 32-bit RAM. With SuperSet expansion boards, you can boost total RAM to 64 megabytes. That's not an 80386 limit, of course, since the chip can address 4 gigabytes of memory. In order to conserve motherboard real estate and simplify the design, Zenith drew the line at 64 megabytes—a sizable playground for DOS, OS/2, Xenix, and Unix applications.

Of course, SuperSet slots also suggest some other possibilities. A 32-bit disk controller board, for example, could work well in a high-performance file server. In fact, Zenith halted the development of such a board—not because it wasn't a good idea, but because the company expects to bring it to completion under EISA.

Fine-Tuning

To keep pace with the 33-MHz microprocessor, the system buffers its relatively slow 100-nanosecond system DRAM with a 16K-byte, 15-ns static RAM cache. That doesn't sound like a large cache; comparable systems, like the SIA 386/32 (April BYTE), have used a 64K-byte cache. But Zenith's engineers say they've demonstrated that the core instructions for today's operating systems and applications fit into the smaller cache and that a larger one yields no substantial benefits.

In any case, cache memory resides on its own card (see photo 1), and you'll be able to upgrade it. A 16-level write-back queue augments the memory-caching scheme. The system writes to a queue that can hold 16 doublewords, and it updates memory on demand for altered data or when extra CPU cycles permit.

When I ran the BYTE system benchmarks, the Z-386/33's CPU index fell short of the number BYTE reported in April for the SIA 386/32 (see table 1). That's mostly a function of the String Move tests, though. These tests defeat the caching scheme and force systems to fall back on their slower system RAM, and the Zenith machine's 100-ns DRAM chips are slower than the SIA machine's 70-ns chips. However, the remaining CPU tests—Matrix, Sieve, and Sort—don't subvert the caching scheme, and here the Z-386/33 outperformed the SIA 386/32.

A very fast Control Data Corp. hard disk drive (with a 14-millisecond rated access time), coupled with a Zenith-modified ESDI controller, makes for a formidable disk subsystem. Under Ze-

continued

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Table 1: *Benchmark results of a comparison of the Zenith Z-386/33 and the SIA 386/32. For indexes only, higher numbers reflect better performance.*

CPU	Zenith	SIA
Matrix	2.02	2.10
String Move		
Byte-wide	28.98	15.54
Word-wide:		
Odd-bnd.	21.77	17.78
Even-bnd.	14.50	7.78
Doubleword-wide:		
Odd-bnd.	14.50	13.14
Even-bnd.	7.25	3.87
Sieve	10.45	11.02
Sort	8.18	8.26
Index:	**4.78**	**5.99**

DISK I/O	Zenith	SIA
Hard Seek[1]		
Outer track	3.33	3.33
Inner track	3.33	3.31
Half platter	4.98	6.65
Full platter	8.35	9.10
Average	4.98	5.60
DOS Seek		
1-sector	4.43	10.23
32-sector	13.80	18.77
File I/O[2]		
Seek	.02	.04
Read	.79	.85
Write	.65	.76
1-megabyte		
Write	2.75	2.89
Read	4.23	4.28
Index:	**3.12**	**2.36**

VIDEO	Zenith	SIA
Text		
Text average	3.45	3.21
Graphics		
Graphics average	1.87	1.96
Index:	**3.03**	**3.06**

Note: All times are in seconds. Figures are generated using the 8088/8086 and 80386 versions (1.1) of Small-C. For a full description of the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

[1] Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).

[2] Read and write times for File I/O are in seconds per 64K bytes.

nith's DOS 3.3 Plus (which, like DOS 4.0, eliminates the 32-megabyte limit on the size of a disk volume), the primary DOS partition spanned the entire 320-megabyte hard disk drive. To standardize my comparison, I reformatted the disk and installed a vanilla DOS 3.3 in a 32-megabyte partition.

The benchmark times for disk operations were spectacular. According to Zenith, the disk controller employs a pair of 1-sector (512-byte) *swing buffers* that operate in an interleaved manner to boost disk I/O bandwidth. According to the numbers, this strategy works very well, indeed.

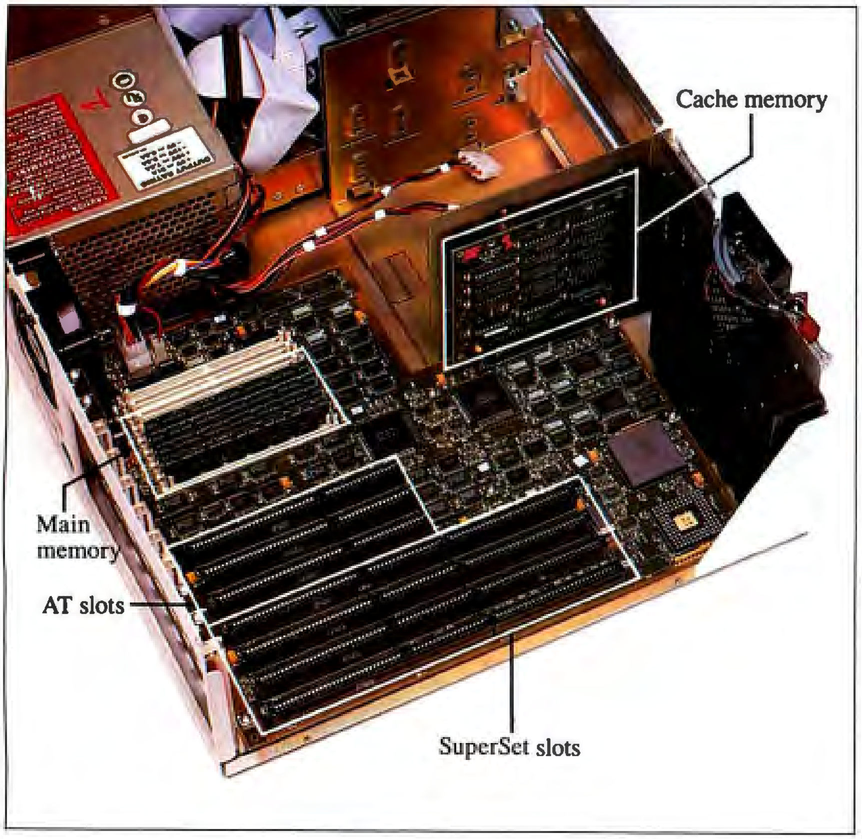

Photo 1: *The Z-386/33 motherboard. SIMM-mounted system RAM and a half-length cache board make memory upgrades a snap.*

However, Zenith again fell short of SIA on the Video index. The company attributes that result to the Z-549's register-level EGA compatibility. The built-in mode-checking required to support that feature incurs a performance penalty. Zenith indicated that the Z-386/33 may ship with a different VGA—a version of Video Seven's FastWrite.

The Fast Track

I could try to coin some speedy terminology appropriate to the new 33-MHz plateau, but I won't. From one perspective, the Z-386/33 is merely faster than most (if not all) 80386 systems available today. The reasons for this are obvious: the genuine 33-MHz CPU clock rate and the panoply of sophisticated subsystems that support operation at that frequency.

This is the first true 33-MHz machine I've seen, but others will appear as the year progresses. And, in keeping with the industry's tendency to be quick to reach for the next plateau, Zenith's engineers told me they've already pushed the 33-MHz chip to 40 MHz in a freon-cooled environment.

From another perspective, though, the architecture of this machine demonstrates Zenith's commitment to build EISA machines and parts at the earliest opportunity. Will that render the Z-386/33 obsolete? Not likely. Most users care about operating systems and applications, not bus architectures. Here's a 32-bit-extensible, AT-compatible system that will deliver excellent performance running DOS, extended DOS, Unix, or OS/2. ■

Jon Udell is a BYTE technical editor. He can be reached on BIX as "judell."

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THE HUNT FOR BAD SECTORS

Like searching for an elusive enemy submarine, Jerry goes after bad sectors on his hard disk drive

This is a first: I'm starting this column one day after turning in the last one. Generally, when I end a column, I list some of the things I intend to write about the next month; but interesting new stuff comes in, I go to shows and see something hot, and even forget what I was interested in. My ready-line pile gets so large that I have to reshuffle. Out comes the next month's column, and half of what I promised isn't there.

This time it's different. The ready line is intact from last month's column, and I haven't been to any new shows.

But First...

I did have one problem. As I mentioned last month, we installed Distributed Processing Technology's new superfast PM3011/70 Caching Disk Controller for ESDI drives. The PM3011/70 runs in Big Cheetah and controls the Priam 330-megabyte hard disk drive. I am now convinced that this may be the best combination of disk drive and controller in the microcomputer world.

I have thrashed this system something awful, what with reformatting the hard disk drive, moving data across logical drives, and moving data to and from the Maximum Storage WORM (write once, read many times) drive. And when I say moving data, I mean a *lot* of data, 25 to 30 megabytes and 845 files in one XCOPY move with the /v option on, followed by verifying the files against the copies in the WORM drive. I ran that in a repeating batch file for hours. Not one glitch, hesitation, retry error, or lost bit; it all works.

Of course, I not only expect but demand reliability. I'm a firm believer in Bill Godbout's old maxim (now shamelessly promoted to one of Pournelle's laws), "If the error rate is high enough to measure, it's too high." Reliability I expect; what's different about the combination of the PM3011/70 and the Priam drive is that it is *fast*.

Indeed, it's fast enough that I began to get obsessed with documenting just how fast. I have a disk-speed-evaluation program from CORE International, Coretest, which measures seek times and data transfer rates. It combines this all into a single figure, the *performance index*; and after I got the PM3011/70 installed, I ran around trying it on my machines. Some relevant performance indexes: Kaypro 386i (2.8), AT&T PC 6300 Plus (3.25), IBM PC XT clone, courtesy of Larry Aldridge (3.81), generic AT 80286 (4.6), Zenith Z-386 with a Smartdrive cache (15.14), and Cheetah 386 with the PM3011/70 (48.50).

That's one set of test runs. I could accumulate others: I have other machines, there are two different versions of Coretest, and you never get the same answer twice anyway. The Cheetah figure goes from as low as 44 to as high as 52, and the Z-386 has once hit 16.8; but this should give you an idea.

Incidentally, this is all single-user, single-task data. The neat part about the Cheetah/PM3011/70 combination is that the PM3011/70 has its own cache memory (and thus doesn't take up system extended memory for a disk cache); and it will serve more than one user or task without measurable loss of performance.

The Problem

You'll notice in the above that I do not have a figure for the Z-386 without a cache. There's a story behind that.

When I first tried Coretest on the Z-386, I got the notice "Read error on drive 0." This was reported consistently. Alas, Coretest doesn't give you any clue as to where the read error happened; it just says there is one.

This was annoying. I knew of two bad sectors on the Z-386's hard disk drive, but they had been marked before I ever got the system. I'd never had the slightest indication that there were any problems with the drive.

Still, maybe it was time to go hunting.

The first thing I tried was Golden Bow's Vmarkbad, which is part of Vopt. This program runs very fast, and when I had some problems with the Priam hard disk drive a couple of months ago, it rapidly found several bad sectors in logical drive E, marked them bad, and got on with the job. I still use Vopt to rearrange my hard disk files; I've been using software from Golden Bow for well over a year now and have never had any reason to regret it.

Vmarkbad reported no bad sectors.

"All right," thought I. "Time for more heavy-duty software; stuff that runs longer."

The next thing I tried was the new Norton Disk Doctor, which comes with the Norton Utilities 4.5 Advanced. This program looks for scrambled boot records, bollixed file allocation tables, and other such problems. It then examines your drive, sector by sector.

Norton Disk Doctor reported no bad sectors. Coretest continued to report read errors.

Next was Mace Utilities Gold. Paul Mace has done a good book (*The Paul Mace Guide to Data Recovery*, Brady Computer Books, 1988) on the subject, and I had just received a new copy of Mace Utilities Gold, which attempts to rival Norton Utilities. Either will do a good job, and competition drives both of them to add new features.

The new Mace Recovery program examines sectors in much the same way (and with much the same visual display)

continued

as Norton Disk Doctor. Mace Recovery runs a bit faster than Norton Disk Doctor. I can't tell you which is the more thorough; Mace Recovery didn't find anything wrong with that drive.

Coretest continued to report a read error. I tried Coretest on all my other machines. It never found any read errors except on the Z-386.

Now I was getting angry. Time for Steve Gibson's SpinRite, which said it could improve my drive performance by changing the interleave factor on the Z-386's hard disk drive. I told it to go ahead. Then it did what it called an "extremely thorough analysis" of the drive. That took all night, and it didn't find anything.

Neither did Disk Technician Plus. Next up to bat was Kolod Research's HTest/HFormat, which is famous for its thoroughness. Indeed, Paul Mace is supposed to have bought the programs to bundle with his utilities. Mace Utilities Gold comes on five disks, but HTest/HFormat isn't on them; I guess you have to get it separately. HTest/HFormat is nondestructive and runs all night. It didn't find anything.

By now I was getting *really* angry. I decided to back up everything to the Maximum Storage WORM drive (I have several WORM controllers and carry the external WORM drive from machine to machine as needed) and then use HTest/HFormat on the drive. *That* ought to solve the problem.

Bugs in XCOPY

In doing the backup, I found a terrible bug in the XCOPY that's distributed with Zenith DOS 3.21. This XCOPY.EXE is 5402 bytes long; my version is dated 5-01-87, and it is *unreliable*. This is the version of DOS that was distributed with all Zenith Z-248 machines to the armed forces, including the service academies, and is still widely used. It also came with my Z-386 and with the SupersPort 286 laptop.

The 5402-byte XCOPY will report that it has copied all files and subdirectories when it *has not done so*. The worst part is that if you don't have too many files and subdirectories—alas, I do not know how many is "too many"—it will work; it's when you use it for large numbers of files that it gets confused.

I found this by accident: I backed up all the files from the Z-386's hard disk drive, and for some reason I decided to look on the WORM drive to be sure they were there. I found a number of empty subdirectories. The subdirectories had been created, but nothing had been copied into them. I had to invoke Norton Commander and go through and copy each subdirectory manually. That took most of an afternoon.

It was then that I decided to install a new version of DOS. I had to: XCOPY is version-sensitive, and simply adding a new version of XCOPY without changing DOS 3.21 won't work.

Media Analysis

I used HTest/HFormat on the drive, then installed DOS 4.01. This took a while: and when it was done, to my horror, I found that DOS 4.01 could not find the WORM drive. This may be a problem with the Maximum Storage software: when DOS 4.01 came out, the Norton Utilities wouldn't work with it. But for whatever reason, I couldn't access the WORM drive under DOS 4.01, and that was far too high a price to pay for the latest DOS.

I started over once more, reformatting the hard disk drive yet again and installing DOS 3.3. By now, I had what very well may have been the best-formatted hard disk drive in the world.

Coretest continued to report a read error.

"Drastic measures," I decided, and got out Storage Dimensions' SpeedStor, which is a set of disk format and test utilities that I've used for some time now. SpeedStor allows you to have drive partitions larger than 32 megabytes if you're so inclined. More to the point, SpeedStor has a series of diagnostics, beginning with a very thorough nondestructive read test, and ending with the Media Analysis test that is guaranteed to wipe out any files on your hard disk drive.

I selected Media Analysis. Once again, it ran all night. Come morning, SpeedStor had found five sectors it didn't like and had locked them out.

Even better, Coretest reported no drive errors, and I was able to get a performance index figure of 4.54 for the Z-386's hard disk drive with no caching. I then let SpeedStor format the disk and installed DOS 3.3. So far, everything works fine.

The moral of this story is that Coretest seems to be as sensitive a test of read errors as any I have, and if you really want your drive to be reliable, back up your data and run SpeedStor's Media Analysis.

The Last Word

Having done all that, Coretest once again reports "Read error on drive 0" if I delete SMARTDRIVE.SYS from the CONFIG.SYS file. Nothing, including Media Analysis, can find an error, and I certainly have had no errors in normal operation.

Does Coretest know something, or is it just unable to work with a Z-386 that is equipped with the PM3011/70 controller? Tune in next month.

continued

Sir Zed

The battle of the portables continues.

Last month, the Citizen's Advisory Council put on some briefings in the White House. Clearly, I wasn't going to take the big SupersPort 286 into that meeting. For a number of reasons, I wasn't inclined to bring the Toshiba T1100 that Roberta prefers. On the other hand, I did have an incentive to take some notes.

The obvious answer was Sir Zed, the Cambridge Z88. Being no thicker than a slab of wood, Sir Zed fits nicely in the leather shoulder bag I habitually carry. He went through the security x-ray system nicely (of course, they were expecting us and I was in the company of a few generals, so they may have been less inclined to reject large, solid objects than they might otherwise have been).

The Z88 is covered with a thin rubber film, and the keys make no sound at all when you type on it. It is thus eminently suitable for taking notes when you don't want to distract anyone. The LCD is a bit small, but I found that the light spill from the overhead projector being used was sufficient to get the job done. All in all, Sir Zed performed heroically. Meanwhile, I have been learning more about the machine.

First, it is really far more useful than I at first supposed. Most of my problems have been due to not knowing how to operate it. In my defense, there are only two ways to learn how to use this machine. First, you can go over the documents a word at a time, making notes as you go; second, you can ask someone who has used it a lot. The first method doesn't always work, because the documents are awful, the index is worse, and the help files are nearly useless.

Sir Clive Sinclair's little machine will in fact do everything it's advertised to do, which is to say just about everything you expect it to; but you will sweat blood learning how to make it do it.

Item: the primary machine has 32K bytes of memory, the same amount as an NEC PC-8201 or a Tandy Model 100; but whereas those machines save files only once, the Z88 has two ways to save its files. The first is that it just saves them: if you exit the combination word processor/spreadsheet called Pipedream, your file is automatically saved whether you want it to be or not. It doesn't have a filename (unless you give it one), but it does have a date and time when last accessed.

You can also explicitly save your file under a filename you provide. When you

continued

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Circle 285 on Reader Service Card

do, the default is to save it on :RAM.0, which is the 32K-byte main system memory. However, the file that it automatically saves when you exit Pipedream hasn't gone away, so you now have *two* copies of your file.

It doesn't take long before that 32K-byte memory is filled, after which an attempt to save gets you an error message. This happened to me in Hawaii in the middle of the Grand Challenges to Computational Science conference. I was listening to a speaker and trying to make notes and trying to keep my file, and I certainly didn't have the Z88's documents with me.

I tried the machine's "help" files, but I needn't have bothered. There's very little help there, at least not about the file system. If you want to use your Z88 during important meetings, *learn it first*; you can't learn while things are going on, and worse, if you're not careful, you may discover you can't save your work. That's precisely what happened to me in Hawaii.

Once out of the conference, I had time to think. My Z88 has a 512K-byte RAM cartridge in it. I surely didn't have any 512K bytes of files on it. Clearly, I was not accessing that cartridge. How to do that? It turned out to be easy: I could save files to the RAM cartridge by explicitly saving the file as :RAM.1\filename after pressing Control-F-S. Actually, the Z88 has no Control key, but there is a key marked with a diamond that works about the same. (There's also a key marked with a square, which works about the way the Apple "Command" or Splat key works.)

Anyway, the only problem is that once you save a file as :RAM.1\filename, the filename doesn't default to that; the default remains :RAM.0. There are two ways out of that. One way is, immediately after you save the file, do Control-F-L and LOAD :RAM.1\filename. Then it will default to that name.

The other way is to do a Control-F-C, which will give you the opportunity to name the file and, as you name it, you can give it the :RAM.1 designation. After that, it will automatically save to that name and "drive" when you do a Control-F-S.

Once you have done that, you need to go to the on-screen Index and enter the Setup Panel. Change the name of the default device to :RAM.1; that done, you aren't finished. Next, go to the Filer (you can press the "Square-F" keys to get there or go through the Index menu). You won't see "Select Device" on the list of options the Filer gives you, but if you go down-arrow, it's there, off the screen. (There are many menu items like that, hidden off-screen, with no indication there's anything more down there. As a general principle, if you use the Z88, try doing a down-arrow off the bottom of *every* menu screen. The results will surprise you.)

Anyway, enter "Select Device" and set the default to :RAM.1. This works until you turn the machine off, after which the device defaults to :RAM.0 again.

The odd part is that you soon get used to doing things this way.

Losing Files

Interesting: in a previous column, I reported lost files, and I immediately received a great deal of mail saying that wasn't possible. One letter from a Z88 dealer in Ada, Ohio, says, "Do you seriously think that a company would put a computer on the market with disappearing files?" To which I can only reply, alas, after 10 years in this business, I *know* that companies, some of them major, will put computers on the market with just about every imaginable defect; and that about half of those companies will then hire PR people to try to convince me, "That's not a bug, it's a feature!"

However, Egil Fjelddahl, a reader in Lerum, Sweden, reports, "I got my Z88 in May last year, and immediately I started to lose whatever I had written just like you did." He discovered the problem was printer drivers, and his conclusion is, "The Z88 should not be filled up too much. When there is little [memory] room left, some procedure may zap the machine." It's a conclusion I agree with. Fortunately, it's a condition remedied by adding a RAM cartridge.

Another possible way to lose files is if the little plastic door covering the cartridge slots gets knocked open. Unless you keep the Z88 in some kind of form-fitted case, this isn't as unlikely as I wish it were; I now believe it's what happened to me the first time I lost all my files. Note that the Z88 documents explicitly say never to open that door when the machine is turned off; the way you change cartridges is to turn on the machine, get to the Index menu, and then open the door.

However, now that I know how to save stuff to the :RAM.1 cartridge (which in my case is 512K bytes, but I'll concede that you can do nicely with 128K bytes), I keep the Z88 in my shoulder bag rather than in an old Wingz bag. I haven't lost any more files. Whatever my problem, it was one of a kind.

Moreover, during the Microsoft Software Seminar, the Z88 performed heroically. I was able to make plenty of notes without disturbing the others; while behind me, someone clicking away on a T1100 was getting periodic dirty looks.

continued

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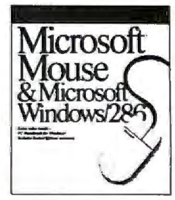

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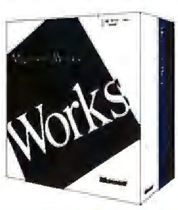

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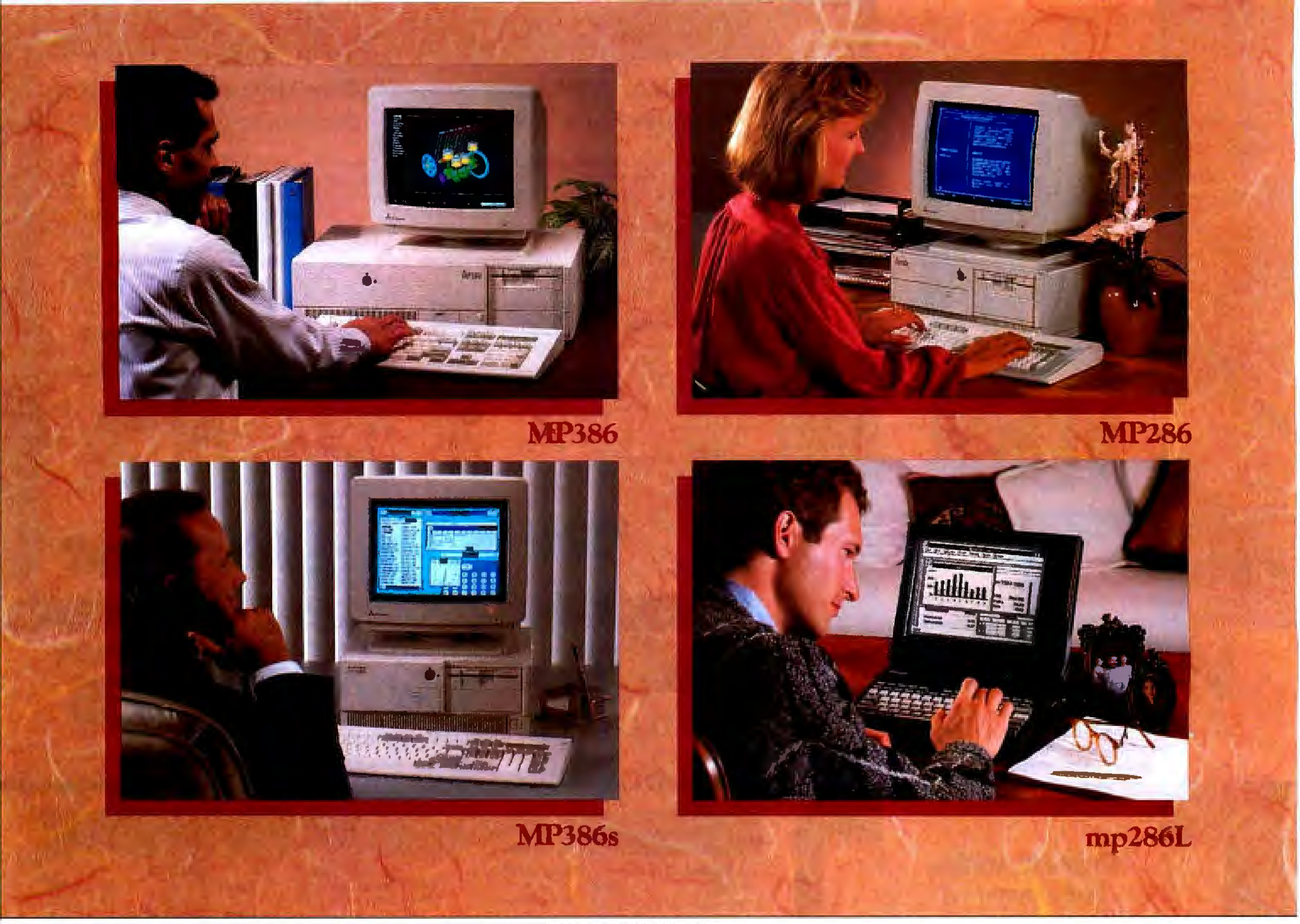

I'm also impressed with battery life. The Z88 uses four alkaline AA batteries, and it seems to get about 20 hours of continuous use from them. I did have one incident. Microsoft gives seminar attendees several huge notebooks and piles of other stuff, as well as a bag to put it all in. I stuffed all that together and put the Z88 between two big notebooks, where it would be safe.

If you leave the Z88 on, it will presently turn itself off to save batteries. You turn on the machine by pressing both Shift keys at once. Next morning in the seminar I did that, and nothing happened. "Aha," I thought, "I have left it where those keys were pressed all night long, and it has used up the batteries. Hardly its fault."

I asked one of the Microsoft PR people if a messenger could go out and get me some batteries and a copy of the *Wall Street Journal*, and then I went back to listening to the presentations, which were interesting but not absorbing. I got to playing around with the Z88 and dumped the batteries out in anticipation of putting in the new ones. But, there being no wastebaskets around, there was no place to put the old batteries, so I stuffed them back into the machine. Then idly I turned it on.

Worked fine. Hadn't lost a file. I don't to this moment know why it didn't work before I removed and reinserted those batteries, but I'm still running on them.

File Transfer

I have both Z88-to-IBM PC and Z88-to-Macintosh file transfer kits. The Z88-to-Mac kit has this problem: the cable Cambridge supplies is a real beast. It works, but only just; you have to struggle to get it connected to your Mac, and often you'll think it's connected when it isn't. The Z88 end of that cable is just as bad: the Z88 output port is a *female* 9-pin jack (unlike the IBM PC AT, which has a *male* 9-pin plug on its serial port). The Cambridge cable thus terminates in a 9-pin male plug, which has two fastening screws on it. However, the Z88 case has no holes for those screws, and in fact the plastic shroud around the output port prevents you from plugging in the cable—a cable supplied by Cambridge—until you remove those screws.

Once you get the cables connected, the software works splendidly. I never did have to refer to the manual. Of course, Pipedream can accidentally put stuff into a text file that will drive MacWrite slightly nuts, but you can edit that out.

You can also transfer files from the Mac to the Z88. Since there is no such thing as a portable Mac (at least not just yet), the Z88 may be the very thing for Mac users who must have a laptop. Alas, although there is a program to convert Pipedream spreadsheet data to PC Lotus 1-2-3, there does not seem to be a conversion for Z88 spreadsheet data to Macintosh Excel format. Text and BASIC files transfer nicely.

The Z88-to-PC link is also straightforward, provided you're talking about connecting to a vanilla PC. If you have an AT, it's a bit more complicated.

The cable Cambridge supplies with their PC link cartridge terminates in a standard 25-pin female RS-232C connector suitable for connecting to the serial port on a PC. The AT, however, has a 9-pin male connector. Recall that the Z88 terminates in a 9-pin female connector, and you'll see the problem. The four-headed LapLink cables, for example, won't work since they're female-to-female. For some reason, a standard 9-pin-male-to-9-pin-female mouse extension cable won't work either.

In fact, almost nothing will work. Before it was over, I had the most incredible lash-up of cables and gender changers you've ever seen, and I still couldn't get the Z-386 and Z88 talking to each other. Eventually, I found an adapter made by MicroSpeed to adapt their FastTrap trackball to a standard mouse cable; attaching that to the cable Cambridge supplied worked fine, once I'd removed the silly screws from Cambridge's plug so that I could get it inserted into the Z88.

That done, the software works fine. No manual needed. You can transfer files back and forth, and indeed, if you have built a spreadsheet in the Z88, you can convert it to a Lotus 1-2-3 file as you transfer. The software is all menu-driven and quite elegant.

Bottom Line

All in all, the Z88 is expensive, sometimes infuriating, hard to learn, at times difficult to operate, and often plagued with silly glitches like the cable screws. The command structure is goofy, and you keep wishing they had given you ways to change many of the defaults. The help files are useless, and the documents are wretchedly indexed and not well organized.

Concede all that, and it's still interesting. If you have a requirement for a small and handy computer, mostly for word processing but with a general-purpose capability, you may find there's no substitute for the Z88. Once you've learned to use it, the little machine looks nearly indispensable.

It's light in weight, small in bulk, and surprisingly powerful. The BASIC in the machine is quite elegant. I have a lot of quarrels with the Pipedream combination spreadsheet and word processor, but in fact it does both jobs well enough to get by. Once you solve the cable problem, it's easy to squirt your stuff into a full-featured machine, PC or Macintosh, for editing. The screen is fairly small, but it's about as readable as a paperback book, meaning that if there's light enough to read by, there's light enough to work by; and the Z88 is handy enough that you can pull it out and work almost anywhere. Moreover, you're more likely to *have* it when you need it.

I wouldn't recommend the Z88 as your only machine, but I'm sure getting attached to mine. I'll never write novels with it, and I doubt it will ever be the only machine I carry on long trips; but I don't know any other computer I could have used in a White House briefing.

Wizard

It may not come as a great surprise to learn that I am a gadget addict, and I particularly like small electronic whizbangs. From the days of the first overpriced Hewlett-Packard scientific calculators to the present, I have been hooked on these things.

Indeed, I regret that my Casio FX-7100 combination scientific calculator and alarm clock is a basket case. Is there anyone out there who either has one in working condition and is willing to sell or can fix mine, starting with a plastic bag of parts? I really miss that little gadget.

Anyway, the Sharp OZ-7000 Wizard Electronic Organiser wouldn't do to

continued

make notes with in a White House briefing or anywhere else, but it is way up near the top on my list of neat gadgets. It's also likely to generate some strong opinions, because if you're not a confirmed gadget lover, you may not care for the Wizard at all.

The Wizard is about the size of an old-fashioned cigar case, small enough to be carried in an inside coat pocket but bulky—and heavy—enough to be noticed if it's there. It has a whole bunch of features: calendar, schedule book, alarm, memo, fairly simple (not scientific) calculator, and home and world clock; and if those aren't enough, you can buy small IC cards that let it do other things (e.g., keep a "Do List" and, more important, record trip expenses).

Alas, while it does all those things, it doesn't do any of them particularly well, nor is it all that easy to remember how to use it. I have just noticed, for instance, that the clock is about 4 minutes slow; but for the life of me, I can't figure out how to set it. I know it's simple, and I did manage it on my last trip; but it's not obvious, and short of going to the documents, I'll never figure it out.

Entering notes in the Wizard is a pain. There's a full alphabetic keyboard, but it's ABC, not QWERTY. The keys are rather awkwardly placed on the right side with the screen on the left, so that you can look at either the screen or the keyboard but not both; and I for one am never going to be a touch-typist on this machine.

It's fairly simple to enter numbers and times and such, but once again, using the scheduler gets awkward as soon as you want to spell out in any detail just what it is you are scheduling. Ditto for entering telephone numbers and addresses: entering those is *work*. The optional expense report manager is easier to use, but so is a notebook.

All in all, the Wizard is more notable for what *can* be done in a small package like this than for what *has been* done. I carry it around to show people, and I like the way it impresses them; but I really have to confess I don't *use* it all that much. If you love gadgets, you'll love this for its own sake. If you're just trying to keep notes and file your trip expense reports, don't throw away your Day-Timer just yet.

Wizard PC-Link

One thing that makes the Wizard a bit more useful is Traveling Software's Wizard PC-Link, which is software and a cable that lets you connect your Wizard to a PCompatible. There's even a Lotus 1-2-3 Expense Manager template: squirt over your Wizard expense files, and you can read them into this template for further analysis and report generation.

You can also generate a lot of notes, phone lists, schedule stuff, and suchlike on your PC, then ship it over to the Wizard, thus saving no end of hunt-and-peck entry on the Wizard's silly little ABC keyboard.

Like all Traveling Software's products, Wizard PC-Link works without surprises. You'll spend a lot more time in the Wizard manual than you will in Traveling Software's. Still, it is worth reading, since it will suggest things you haven't thought of, like sharing Wizard and SideKick files. If you're reading this and you have or are getting a Wizard, you will *need* Wizard PC-Link.

GoScript

Macintosh users with LaserWriters can skip this section. If you're using a PC and have a Hewlett-Packard LaserJet, ThinkJet, or DeskJet (or a 24-pin dot-matrix printer), you know you can't do fancy PostScript printing the way your Apple colleagues can; or at least you couldn't until now.

Comes now GoScript, from LaserGo, a program that understands PostScript output from, say, Xerox Ventura Publisher, Aldus PageMaker, or, for that matter, just Microsoft Word or Borland Quattro; and it can take that PostScript output and translate it into something to drive your printer. Rotation, multiple fonts, and font scaling; it's all there.

That's the good news.

The bad news is that GoScript is glacially slow. First, it has to do the calculations (it helps if you have a math coprocessor, but it isn't required). Then it has to send those instructions, dot by dot (300 dots per inch), out to your printer. This can take long enough for you to have lunch. You may want to start growing a beard.

On the other hand, it works. I don't know of any other way to get that kind of performance out of an ordinary laser printer, much less ink-jet and dot-matrix printers. If you need PostScript output and you're willing to wait while it does the job, get LaserGo's GoScript.

Northgate Omni Key/102

Regular readers of this column know I worry a lot about keyboards. Given the number of words I turn out a month, it's hardly surprising. I pay attention to feel, key layout, sturdiness, and just about everything else.

After several months of testing, we've adopted a new standard keyboard here at Chaos Manor. What we've settled on is the Northgate Omni Key/102.

Understand, there's nothing wrong with our previous DataDesk keyboards. They continue to work just fine, and we like them a lot more than the keyboards that come as standard equipment with most machines.

Northgate keyboards have two superior features. First, there's a definite mechanical click that you can feel as well as hear associated with each key press. I like that. Let me hasten to add that I know some people do *not* like the tactile key-click feature; in which case, I recommend they use a DataDesk keyboard, which has a good feel, but different from the Northgate keyboards.

The second reason I like Northgate keyboards is the key layout. The Escape key is in the upper left, and I especially like the function keys: on the Omni Key/102, all 12 function keys are on the left side of the keyboard, 10 of them in the same place they were on the original IBM PC keyboard, with F11 and F12 above them.

In theory, it ought to be a good idea to put the function keys in a row across the top. That way, the program can do you a little diagram with the explanations of the function keys laid out exactly as are the keys themselves. In practice, I find that it's just plain easier to find and use the function keys when they are bunched over to the left. It's certainly easier to get at them with the left little finger.

There's one more neat thing about the Northgate keyboards. They come with a tiny (about 50 bytes) TSR program called POURVOUS.COM (which was written to suit my prejudices). This program remaps your keyboard so that Shift-comma is a comma, and ditto with periods. If you want the right- and left-arrow symbols, you do Left Shift-Alt-comma or period to get them. POURVOUS.COM works invisibly with all the software I know, including DESQview. I've installed it in all my machines, including portables.

The Northgate Omni Key/102 has become the standard keyboard at Chaos Manor. Recommended.

Models of Doom

Back in March 1972, Dennis and Donella Meadows published *The Limits to Growth*, a highly influential book that grew out of research sponsored by a group of wealthy industrialists calling themselves "The Club of Rome." The book presented a pessimistic view of the future; in contrast to the idea of progress, which had dominated Western intellectual thought through the previous 150 years, it predicted an unending series of disasters: vast upswings in population punctuated with massive die-offs and an unwaveringly steady fall in the "quality of life."

Moreover, there wasn't much we could do. Efforts to stave off one crisis would create an even worse—and totally unavoidable—crisis of another kind.

The Limits to Growth inspired political movements based on the philosophy of "an era of limits." Phrases like "appropriate technology," "limits," "soft paths," and "ecology" became symbols of power. The book was influential in the election of Jimmy Carter as president.

This book was based mostly on a single "systems dynamics world model": a computer simulation developed at MIT by Professor Jay Forrester and presented in considerable detail in his book *World Dynamics* (Wright-Allen Press, 2d ed., 1973). The model consists of some 45 interconnected subsystems: typical subsystems or blocks are NRUR (natural-resource-usage rate), DR (death rate), POL (pollution), CID (capital investment discard), BR (birthrate), and so forth, all of which are interactively connected. That is, agricultural investment increases agricultural output, which increases birthrate but also pollution; pollution decreases agricultural output; and so on. The simulation output includes things like total world population, total pollution, and quality of life (which, incidentally, peaked in 1940 according to the "standard" model).

By today's standards, the systems dynamics world model is not so impressive, but in 1970 it certainly was. In those days, there was a natural awe and respect for computers—and perhaps even more for those who could persuade computers to do something useful. *World Dynamics* and, even more so, *The Limits to Growth* captured the imaginations of many respected social thinkers. Isaac Asimov popularized many of the conclusions in a *Penthouse* magazine essay concluding not only that humanity was doomed, but that the doom would happen rapidly, probably before the end of the century.

There were counterarguments. I made some of them in a book called *A Step Farther Out*. Members of the faculty of the University of Sussex analyzed *The Limits to Growth* in a scholarly counterblast called *Models of Doom*. Herman Kahn's Hudson Institute published *The Next Two Hundred Years*, with a picture of the future nothing like what you found in *The Limits to Growth*. However, in most academic institutions, there was strong support for the conclusions and recommendations in *The Limits to Growth*.

One thing was lacking in this debate: most of those who were doing the dis-

continued

cussing, whether for or against *The Limits to Growth*, had no means of doing simulations of their own. Computers large enough to handle models of this complexity weren't all that widespread, and time on computers of any size wasn't easy to get. While (to Forrester's great credit) *World Dynamics* presents a thorough mathematical description of the world model, it doesn't give source code except in the language DYNAMO. In those days, few social scientists had means for producing computer programs in DYNAMO or any other language, even if they had access to suitable machines and compilers. Most of the analyses of *The Limits to Growth* and the *World Dynamics* model on which the book was based had to be done in words and on paper.

By 1978, that wasn't so true. It was then possible to get source code in BASIC for the *World Dynamics* model. I wrote one program myself. Running that program demonstrated quite dramatically just how sensitive the *World Dynamics* model was to a key pair of assumptions: that NR (natural resources) was monotonically dwindling and did so at a rate proportional to CI (capital investment), and that birthrate does not fall with increasing wealth.

Moreover, the model had no provision whatever for "resource substitution," although history shows that when a resource becomes scarce, the price rises, and another resource—often one not previously thought useful—is substituted. (The classic example is the use of coal after Britain's timber resources had been exhausted.) I attempted to add such features to the model, but doing that work in BASIC on Old Zeke (my 64K-byte CP/M Z80) and plotting the output on a Diablo daisy-wheel printer was clumsy and time-consuming. Before I finished that work, the intellectual community had found a new fad to scare themselves with.

Extend

The Limits to Growth phenomenon—the extraordinary popularity and influence of a single computer simulation—could happen again, but it seems less likely now that nearly everyone has a desktop computer far more powerful than the one Forrester used. Building up dynamic simulation models—whether of the world or of far simpler systems—is much easier now.

If you're using Extend on your Macintosh, simulation can even be a lot of fun.

Extend is a simulation program that makes use of the Mac's best features. Like the Mac, you can learn to use Extend in a couple of hours. All you need to do is take a bunch of predefined subsystems; connect their inputs and outputs in interesting ways; set the initial conditions; and launch the simulation. Extend will plot the results for you. You can then go back and change anything you like to see what effect, if any, that has on the outcome of whatever you simulated. Extend comes with libraries of subsystems relevant to simple models of electronics, earthquakes, ecology, manufacturing, and other such stuff. There's also a neat tutorial that shows you how to get started.

Once you've learned the basics of Extend, you can do almost anything you like. You can draw new boxes in any shape you like (e.g., one of the tutorials is a model of heating your house; naturally, there's a house, while the roof insulation "box" looks like a roof, and so

continued

ITEMS DISCUSSED

Coretest $20
CORE International
7171 North Federal Hwy.
Boca Raton, FL 33487
(407) 997-6055
Inquiry 1031.

Extend $495
Imagine That, Inc.
7109 Via Carmela
San Jose, CA 95139
(408) 365-0305
Inquiry 1032.

GoScript
13 fonts $195
35 fonts $395
LaserGo, Inc.
9235 Trade Place, Suite A
San Diego, CA 92126
(619) 530-2400
Inquiry 1033.

HTest/HFormat $89.95
Kolod Research, Inc.
P.O. Box 68
Glenview, IL 60025
(312) 291-1586
Inquiry 1034.

Mace Utilities Gold $149
Paul Mace Software, Inc.
400 Williamson Way
Ashland, OR 97520
(503) 488-2322
Inquiry 1035.

Norton Utilities 4.5 Advanced ... $150
Peter Norton Computing
2210 Wilshire Blvd., Suite 186
Santa Monica, CA 90403
(213) 319-2000
Inquiry 1036.

Omni Key/102 .... $99
Northgate Computer Systems, Inc.
13895 Industrial Park Blvd.,
Suite 110
Plymouth, MN 55441
(800) 526-2446
Inquiry 1037.

PM3011/70 .... $1150
Distributed Processing Technology
132 Candace Dr.
Maitland, FL 32751
(407) 830-5522
Inquiry 1038.

SpeedStor $99
Storage Dimensions, Inc.
2145 Hamilton Ave.
San Jose, CA 95125
(408) 879-0300
Inquiry 1039.

SpinRite $59
Gibson Research Corp.
22991 La Cadena
Laguna Hills, CA 92653
(714) 830-2200
Inquiry 1040.

Vopt $59.95
Golden Bow Systems
2870 Fifth Ave., Suite 201
San Diego, CA 92103
(619) 298-9349
Inquiry 1041.

Wizard $299.99
Sharp Electronics Corp.
Sharp Plaza
Mahwah, NJ 07430
(201) 529-8200
Inquiry 1042.

Wizard PC-Link $149.95
Traveling Software, Inc.
18702 North Creek Pkwy.
Bothell, WA 98011
(800) 343-8080
In Washington, (206) 483-8088
Inquiry 1043.

Z88 .... $599
Cambridge North America
424 Cumberland Ave.
Portland, ME 04101
(207) 761-3700
Inquiry 1044.

forth). You can define the boxes in any detail you want: number of inputs, number of outputs, relation of input to output, and so on. You can make things as simple as adding two integers, or as complex as multiplying two complex matrices and getting their eigenvalues.

I've been using the program for only a few weeks, and I estimate that if I really wanted to put up the *World Dynamics* model in Extend, I could probably get it done in two weeks of part-time work; after which, I could test that model for sensitivity to its assumptions in an hour and add new features almost without limit. I'm not likely to do that, but I'm pretty sure I could.

Last night, Jim Ransom, Mike Hyson, and I worked on refining the SSX (Space Ship Experimental) documents so that we could get a new briefing off to Washington. After we got that done, we started playing with Extend and managed to chew up a few more hours just having fun: we were modeling a pond in which piranha eat goldfish, and goldfish eat dead piranha; we wanted to add a third critter and get stable populations. That turns out to be hard to do: we got to see just what a tough job God has.

I sure wish I'd had Extend back in the days when a few of us space enthusiasts tried to insist that Forrester modeled the wrong system: the resource base for the human race consists not merely of this finite earth, but a full system of nine planets, 35 moons, a million asteroids, and a billion comets, all orbiting a very large and benign thermonuclear power plant that needs no maintenance.

Next time someone shouts "Doom!" and points to a computer model, I'll haul out Extend.

Highly recommended.

Winding Down

There's still an enormous stack of stuff on the ready line. The flood of good hardware and software for both PCompatibles and the Mac amazes me.

The book of the month is by Nathan Glazer, *The Limits of Social Policy* (Harvard University Press, 1988). The game of the month is The Halls of Montezuma (Strategic Studies Group, 1747 Orleans Ct., Walnut Creek, CA 94598, (415) 932-3019). I had a lot of fun playing the Battle of Inchon.

Next month, OS/2 versus Unix, unless someone else has said it all better than I can. ■

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 "jerryp."

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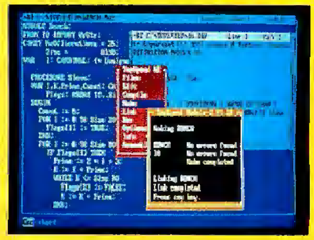

TopSpeed's seamlessly integrated environment.

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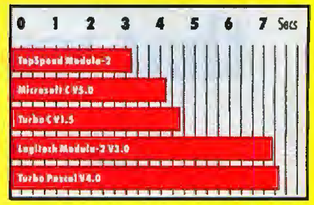

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Kent Porter
Dr. Dobbs Journal

"JPI Modula-2 looks like another classic in the making. It generates code as good as or better than leading C compilers and the programming environment is a genuine pleasure to use."

Dick Pountain
BYTE Magazine

In England and Europe contact:
Jensen & Partners UK Ltd., 63 Clerkenwell Road, London EC1M 5NP. Phone: (01)253-4333. DOS Compiler: £59.95, TechKit £34.95, VID £34.95, DOS 3-Pack £119.95, OS/2 Compiler £124.95.

Handling charges: In UK please phone for VAT & P&P. In Europe, add £6 for up to 3 products, £2 for each add'l product.

TopSpeed Modula-2 is a high-speed optimizing compiler (3,000-5,000 lines/min. on a PC AT 8MHz), integrated menu-driven environment with multi-window/multi-file editor, automatic *make,* fast smart linker. All Modula-2 sources to libraries included. BONUS: Complete high-speed window management module included with source. 258-page User's Manual and 190-page Language Tutorial.

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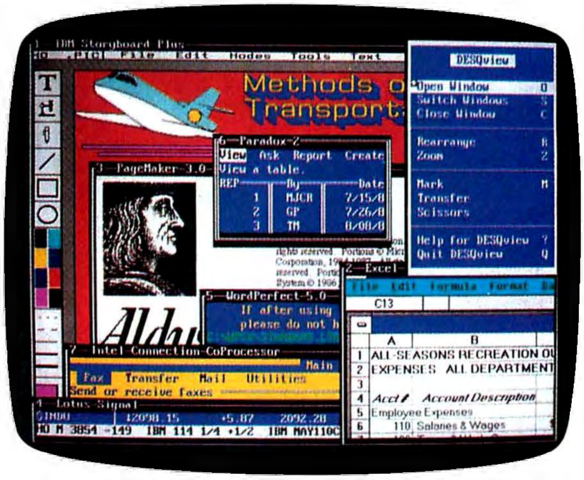
Quarterde

DESQview 2.2 and DESQview 386. The multitasking, windowing environments that work with your favorite software.



DESQview lets you run your favorite programs in windows side-by-side.

DESQview™ is the operating environment that brings OS/2™ power to DOS. And it lets you, with your trusty 8088, 8086, 80286, or 80386 PC, leap into the next generation in PC productivity. For not much money. And without throwing away your favorite software.

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Like being able to fine tune DESQview performance "on the fly." Run Lotus Express and Metro. And the Intel Connection Co Processor. Even use the DOS 4.0 shell with DESQview. Have DESQview automatically install Quattro, Sprint, Aldus PageMaker, Microsoft Excel, Word Perfect, Dataease and as many as 80 other programs. And using the DESQview API, be able to dynamically link them.

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While other programs get bigger, we've worked to make DESQview smaller. And we've succeeded in a big way on PCs and PS/2™s with extended, EMS 3.2 (AboveBoard), EEMS and EMS 4.0 memory—as well as on 386 PCs and PS/2s. For example, DESQview overhead on EMS 4.0 and 386 PCs can be as low as 10K on EGA/VGA PCs. And DESQview actually *increases* memory 30K on CGA PCs; 20K on monochrome and Hercules PCs. That's good news for users of big desktop publishing, CAD and database programs.

Introducing DESQview 386

For users of 80386 PCs and PS/2s (or PCs with 80386 add-in boards, such as the Intel Inboard 386), there's DESQview 386 (a combination of DESQview 2.2 and the new QEMM-386 Quarterdeck Expanded Memory Manager, version 4.2).

DESQview 386 gives you extraordinary power. Run text, CGA, EGA, VGA, and Hercules programs in windows and in the background. Run 32-bit 386 programs, like Paradox 386, and IBM Interleaf simultaneously with your favorite DOS programs. All with the speed and performance you expect out of your 386. And with protection against 'misbehaved' programs.

Promise and performance

And, of course, both DESQviews have all the features that made prior versions the popular choice in operating environments. The ability to multitask in 640K and beyond. View programs in windows or full screen. Transfer data. Access DOS via menus. Dial your phone. And create keystroke macros within and between programs.

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If there's any doubt about our commitment to your PC and PS/2 productivity, just look at our accomplishments over the years. We think you will understand why GE, Ford, Aetna, Monsanto, and so many other major corporations use DESQview.

And why PC Magazine twice gave DESQview its Editor's Choice Award for "The Best Alternative to OS/2," why readers of InfoWorld voted DESQview "Product of the Year" three times. Why, by popular vote at Comdex Fall for two years in a row, DESQview was chosen "Best PC Environment" in PC Tech Journal's Systems Builder Contest, and just won their "Professional Solutions" Award.

DESQview lets you have it all now.

INFO WORLD 1986 87 88 PRODUCT OF THE YEAR

PC MAGAZINE 87 88 EDITOR'S CHOICE

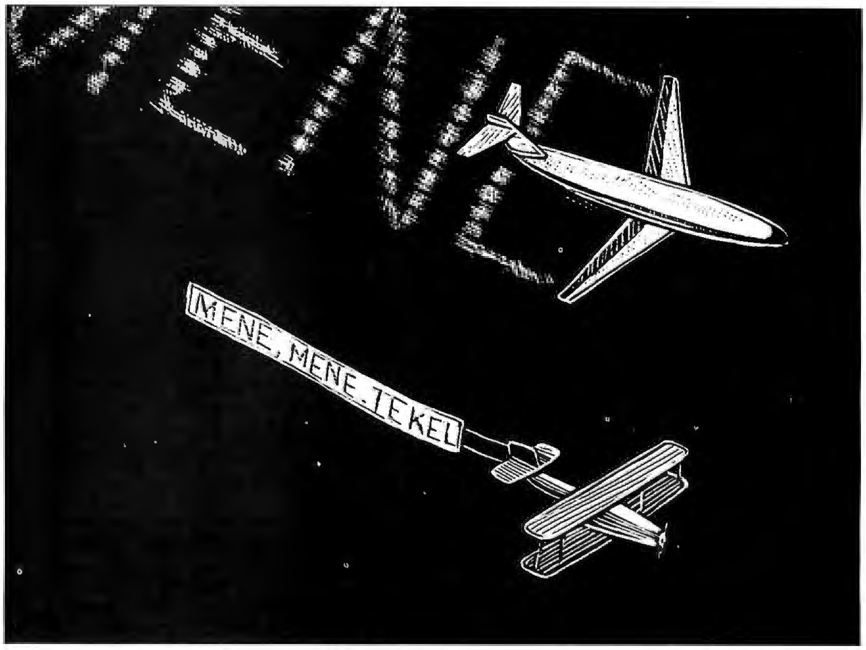
TECH Professional Solutions Award 1989 Best Operating Environment

PC WORLD BEST BUY

1988 BYTE AWARD OF DISTINCTION

THEN AND NOW IN WORD PROCESSING

New developments in Mac word processing bode well for users of other computer systems, too



Back half a dozen years ago, when MS-DOS was still slugging it out with CP/M and the Macintosh was but a mere rumor, word processing was fraught with peril for the unsuspecting user.

Software reviewers had to warn their readers about products like the original release of Perfect Writer, which required that paragraphs be separated by blank lines. If you merely indented your paragraphs without adding an extra carriage return between them, the program would happily reformat your document into one big, undifferentiated glob of text. It also had a spelling checker that would accept "nosal" and "nosation" as legitimately spelled words derived from "nose."

Then there were those ghastly "page-oriented" word processors. Once you typed past the bottom of page 1, your goose was cooked. If you went back and decided to add something, the resulting extra lines wouldn't push their way onto page 2; you had to remember to highlight the excess and move it to the top of the next page.

These types of products were fine for a limited set of projects, but you had to match your requirements to product specifications with extreme care. Nowadays, there's no longer much need for the same sort of vigilant zeal. I haven't seen a truly horrendous word processor in a year or two. Almost every available program performs the essential functions with little hassle.

There are some programs I don't like, and sometimes I can't understand why a manufacturer has brought an undistinguished product to market, but it has been a while since I've felt the urge to drive a digital stake through a word processor's binary heart. I have no qualms about telling an MS-DOS user to go out and buy any of the best-selling products—WordPerfect, WordStar, Microsoft Word, XyWrite, PC-Write, Sprint, Q&A Write, and so forth. There are excellent choices among the integrated packages—Framework, Enable, and Smart, for instance. Some lesser-known programs, like Celebrity and Nota Bene, are also good choices. I'll hold my remarks on Mac software for a moment, but again, most of the programs do provide basic functionality.

My recommendation to a total novice would be to go to a retailer, compare lists of features on product boxes, spend a few minutes watching demonstrations of those programs that claim to do what you want to get done, and then go with your gut feeling. You don't have much chance of making a terrible mistake.

It's slightly complicated to advise a more sophisticated user, simply because the reasons for selecting one product over another one are now largely determined by comparing specific features for specialized functions or by defining intangibles like "feel." In the IBM PC-compatible arena, I'll suggest Lotus Manuscript for its handling of technical documents, XyWrite for nifty macro programmability, Sprint for the ease with which you can reconfigure its command set, and WordPerfect for the overall sense of well-being it gives its users. Other programs, of course, answer other demands. Even at this level, it's difficult to blow it completely. You can still get things done, even if it's a tad more awkward with one program than it might be with another.

Why have we reached this amazing state of grace? There are two reasons. First, programmers and users alike have been slogging away at microcomputer

continued

ILLUSTRATION: MARC TAFFET © 1989

word processors for more than a dozen years now, and we have all reached a tacit consensus on what the fundamental operations are and how they should be implemented.

Second, I think we've hit the natural limit of what a single user can do with 640K bytes of RAM and a 25-row by 80-column text-only display. (I'm discounting the possibilities of hypertext access to reference sources, network support, and AI-based grammar checking, but I see these options as peripheral to the primary business of pounding out words.)

However, as pleasant as this moment of peace may seem, it will be relatively short-lived. Higher-resolution output devices (e.g., laser printers) and the related hunger for desktop publishing tools are rapidly pushing word processing into a new stage of graphics orientation. Better output has made yesterday's concept of WYSIWYG nearly obsolete.

Even if you're not interested in creating newsletters with your word processor, wouldn't it be nice to see what your document will look like without having to enter a special preview mode? If there's a next generation of personal computing in the wings, this factor alone could be enough to drive the changeover.

Coming Attractions

For better or worse, the future of word processing is currently being played out on the Mac, although the focus may shift in time to the Presentation Manager or some windowing form of Unix. Many developers see the Mac as an ideal testing lab for products or concepts they hope to port to other environments. Why? The Mac already has an acceptable graphics interface and seamless access to oodles of RAM, that's why. Thus, watching the word processing wars on the Mac is an entertaining and important spectator sport, even if you never intend to have anything to do with any computer bearing an Apple logo.

In its early days, the Mac was a terrible machine for word processing vendors. MacWrite, a utilitarian program at best, was given away with every computer sold. Even mighty Microsoft couldn't break this stranglehold; my spies in Redmond tell me that during the Age of Bundling, Microsoft Word never achieved more than a 30 percent share of the market for Mac word processors. Few other software developers bothered to think about invading Apple's turf; Mac word processing lay stagnant.

But today, with MacWrite stripped away and desktop publishing acting as a motivating force, word processing devel-

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opment has begun to heat up. The Mac now boasts a wide panoply of editors, representing quite divergent strategies for survival in the graphical universe.

I've been concerned because this opening up of the market has resulted in "kitchen-sink" word processors, ones that have followed the traditional microcomputer path of creeping featuritis. Microsoft Word and Ashton-Tate's FullWrite Professional are the leading representatives of this approach, boasting a huge number of features. They're impressive but cumbersome, having sprouted many elements of layout programs without borrowing desktop publishing's paste-up metaphors.

Coming from the opposite direction, a second group of products is comprised of the page-layout programs that have evolved into word processors, including Quark XPress, Ready-Set-Go!, and Ragtime. PageMaker remains unique among these products in that it has not added word processing features.

However, three recent programs have given me some hope that there's room for other paradigms.

A Nifty New Entry

First, there's Nisus, a full-featured word processing powerhouse from Paragon Concepts. [Editor's note: *See Don Crabb's Macinations column in the May BYTE.*] Nisus is a direct descendant of the company's top-notch programming editor, QUED/M, but Paragon Concepts has done a lot more than merely bolt on typeface controls. Although there are familiar overtones, this word processor is a much bigger and spiffier product, about four times the size of its progenitor.

There are many unique features, but the two most obvious are found in the program's search-and-replace and macro functions. Nisus contains a thorough implementation of the Unix grep command, with which you can locate not only words and phrases, but also nonprinting characters, type attributes, tightly specified character patterns, and physical locations within a file. You can write search expressions in the cryptic grep "language," or you can opt for Nisus's Easy-grep commands, which let you build your search parameters by selecting items from pull-down menus, much like some of the query systems available in database managers.

Coupled with macros that can be generated either by having the program follow your actions as you work or by editing code in a macro file, you wind up with more precise control of editing operations than in any other Mac word processor. The program comes with over 80 macros already installed, ranging from simple operations like transposing words all the way to a full mail merge that will extract variable data from an independent text file.

Although Nisus doesn't have style sheets per se, you can create macros that accomplish the same thing. These macros can prompt for user input, peel data from desk accessories or any of Nisus's 10 clipboards, set and remove markers, and manipulate the Mac file system, which puts a pretty incredible set of tools at your disposal.

Other features include a 32,000-level "undo" stack, multiple columns, the slickest draw mode I've seen in a text editor, file comparison with synchronized scrolling, a Merriam-Webster dictionary and thesaurus, and a reduced-size preview mode for adjusting page setup.

For better or worse, the future of word processing is currently being played out on the Mac, but this focus may shift.

Nisus also offers search-and-replace capability throughout a list of unopened files, automatic backup, and an information command that gives not only word and character counts, but two readability indexes as well. That's only a partial list; there's a lot more to the program. It's also fast.

Since this is a new product, there are still some rough edges; there's no easy way to print out your macro file, and I've noticed some jumpiness at the bottom of the screen occasionally. There are a few more trivial glitches, but this is rapidly becoming my favorite Mac editor.

And on Your Right...

If you don't need the grep or the macros of Nisus, you would do well to check out T/Maker's WriteNow for Macintosh 2.0, which is now a fully mature product. In its first incarnation, I wasn't particularly impressed with WriteNow. It added a spelling checker, multiple columns, and better font sizing and leading (line spacing) to the basic MacWrite model, but not much else. However, at this point, I'd argue that WriteNow is the leader in its price range. In the category of lower-priced, relatively simple Mac word processors, this is the program to beat.

My favorite new feature is WriteNow's global style-change command. You select a region of text, starting with the first example of the type attributes you want to modify. Any changes you make affect the first paragraph in the block and any other paragraph with identical formatting. This isn't quite a style sheet, but it's close enough.

And WriteNow is as good as—or better than—any comparable program at letting you set up your document for printing, with headers, footers, footnotes, odd/even binding margins, smart quotes, and the like. The program is quick and stable. Also, what you see on-screen is invariably what you get when you print documents. It accepts huge files, understands all the keys on an extended keyboard (something that Nisus doesn't do), allows conditionals in mail merge, and does everything with notable rapidity.

Son of Word Processing

Finally, there's Preferred Publishers' Vantage, a word processor in the guise of a desk accessory. It's an enhanced version of McSink, a shareware desk accessory designed for preprocessing text for page-layout work. McSink lets you massage data left on the Clipboard and then repastes it into the original document in the foreground application. Vantage adds true word processing, spelling checking, and file handling to this model.

In some ways, Vantage represents a handy subset of Nisus. It comes with a long list of macro-like functions that enable you to sort, number lines, insert prefix and suffix strings, change case, adjust line length, convert tabs to spaces and back, strip control characters, and add or delete linefeeds. There are true macros, too; although you can't create them by turning on a recorder, you can write your own miniprograms and save them as loadable macro files.

Vantage may be a harbinger of the lean, mean programs we might see when the Mac gains true multitasking and data exchange. A nice little word processor, it makes a wonderful adjunct to other sorts of programs that require text input.

Better Choices Are Here

What I really like about these three programs is that they are all nicely designed

continued

ITEMS DISCUSSED

Nisus $395
Paragon Concepts, Inc.
990 Highland Dr., Suite 312
Solana Beach, CA 92075
(619) 481-1477
Inquiry 1021.

Vantage $99.95
Preferred Publishers, Inc.
5100 Poplar Ave., Suite 617
Memphis, TN 38137
(901) 683-3383
Inquiry 1022.

WriteNow for Macintosh 2.0 .... $195
T/Maker Co.
1390 Villa St.
Mountain View, CA 94041
(415) 962-0195
Inquiry 1023.

for writing; the page-layout and formatting mechanisms don't get in the way of the primary task. They all make good companions to desktop publishing software packages, as well as standing admirably on their own.

It's becoming obvious that the Mac environment, once so poor in word processing, will eventually have a constellation of programs that rival those in the IBM PC-compatible sector in richness and personality, if not in quantity. That's good news for writers who like the Mac.

By extension, the better news is that the coming era of windowing interfaces will not reduce everyone else to using countless clones of early MacWrite, as I certainly once feared when I first looked at those clumsy editors provided with Microsoft Windows and Digital Research's GEM. I'm positive that we'll be using the products I mentioned, or ones much like them. What this means is that we'll be able to select word processing programs that accurately reflect our habits and preferences from a decent array of choices. This is very good news indeed for all of us. ■

Ezra Shapiro is a consulting editor for BYTE. You can contact him on BIX as "ezra." Because of the volume of mail he receives, Ezra, regretfully, cannot respond to each inquiry.

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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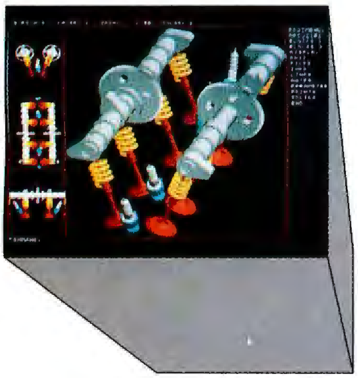

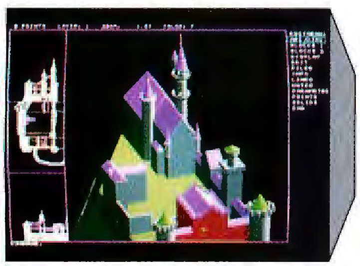

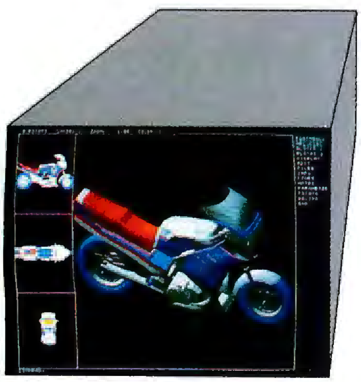

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DON'T TAKE OUR WORD FOR IT

Here is what other people have to say about DesignCAD 3-D:

"After you've worked with DesignCAD, the single keystroke commands are simple to remember and it becomes easy to "flick one key" to execute a command. An extremely ergonomically designed program."

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DR. STEVENS, NASA Space Scientist/Engineer

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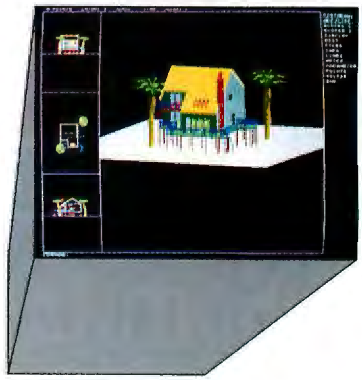
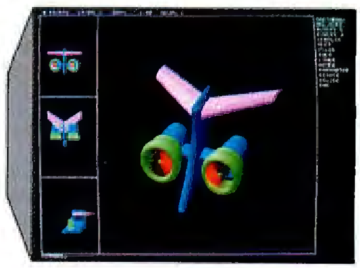
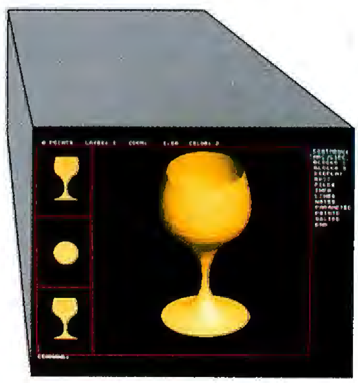
The first question asked by many people is, "Why is DesignCAD 3-D priced so low?" The answer? After developing DesignCAD 3-D version 2.0, we were unable to decide how the product should be priced. We consulted experts. We used the finest spreadsheets on the market. We took employee polls. Finally, in the great American Tradition, we said, *"Aw . . . What the Heck! Let's see the other guys beat this price!"* DesignCAD 3-D version 2.0 sells for $399.







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DesignCAD 3-D version 2.0 is available from most retail computer stores, or you may order directly from us. DesignCAD 3-D is available in a number of foreign languages from distributors throughout the world. All you need to run DesignCAD 3-D is an IBM PC Compatible and 640K RAM. DesignCAD 3-D supports most graphics cards, printers, plotters and digitizers. Free information and a demo diskette are available by contacting us at:

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Circle 19 on Reader Service Card

JUST A FEW FAX

Can personal computer fax boards cut it in the real business world?

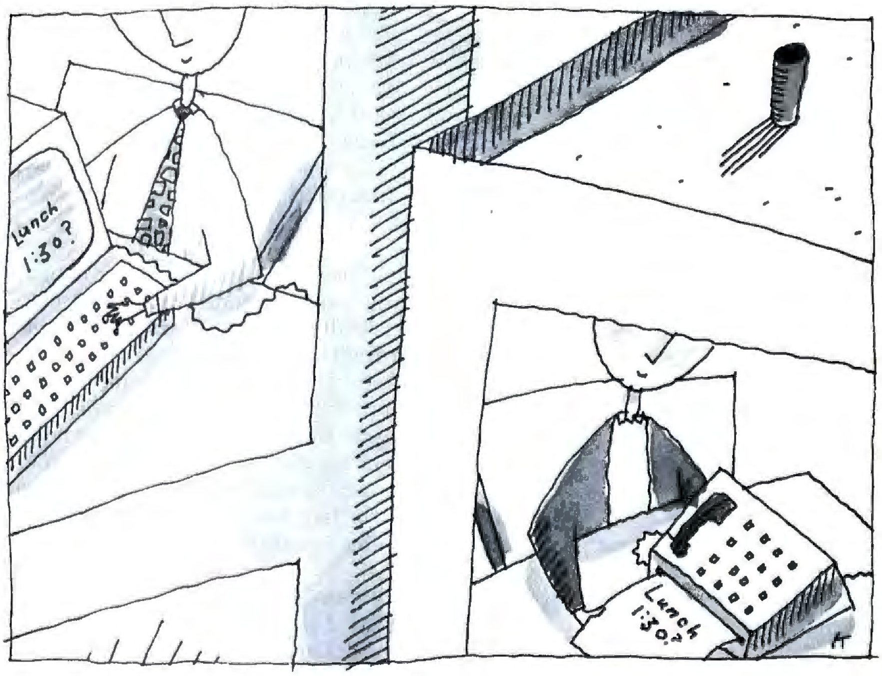
In the past year or so, the question "Can you fax it to me?" has become ubiquitous. The office fax machine, once a curiosity, has suddenly become a necessity. And now that nearly every office has one, nearly every office is *expected* to have one. If you don't, people think there's something wrong with you.

Of course, the standard tabletop fax with its built-in telephone is a familiar sight, but personal computer owners have an additional way to join in the fax landslide. A number of companies, including Quadram and Brooktrout Technologies, make fax cards for personal computers. These are cards that plug into the expansion bus on your IBM PC compatible or Mac II and allow the computer to communicate with another fax machine. Other cards include a built-in modem or fit into the expansion bus on a laptop computer.

These products have been around for several months. Clearly, they work. The question is, how well? More important, how well do they work in conjunction with a standard tabletop fax machine?

The Rest of the World

The ability to work with the world of tabletop fax machines is important for one simple reason: The vast majority of other fax units in the world are of that type. You want the documents sent by your business to look good, and you want the people at the other end to be able to send and receive just as they would with any other machine. This is one of the few areas in computing where you must plan on the ability to communicate routinely with non-users.



To find out how well these cards worked, I sent documents to and from them, using an inexpensive Murata M1200 fax machine. This is a full-featured, 9600-bps machine that sells in the Washington, DC, area at a discounted price of less than $700. The Murata M1200 has a built-in scanner, a thermal printer, and a telephone handset. You can set it for either normal-resolution (200 by 98 dots per inch) or high-resolution (200 by 196 dpi) modes, and you can set it to answer the phone automatically or manually. The Murata can also respond to polling by other fax machines, and it will make copies for you.

The Cards

I looked at two popular fax cards, the Brooktrout Technology Fax-Mail 96 and the Quadram JT Fax 9600. Both are full-featured 9600-bps cards that work in an IBM PC- or AT-compatible computer. They include support software that lets you transfer ASCII files. They also have methods of capturing printer output destined for Epson printers and converting that to a fax file. Both support a variety of printers, including the LaserJet II. Finally, both have the ability to convert PC Paintbrush graphics files to fax format.

Neither card is difficult to use. Installation normally consists of plugging the card into an empty slot in your computer, attaching the telephone cables, and installing the software. The Quadram JT Fax is addressed through a location in memory, while the Brooktrout card takes the place of a COM device, usually COM2. Quadram provides a variety of alternate memory address settings in the event that the card conflicts with existing hardware. With the Brooktrout Fax-Mail 96, you can change the COM port assignment. There's little else that you need to do to the hardware to install either of these boards.

The two machines are also much the

continued

same in use. A memory-resident program monitors incoming calls and has the fax card answer if you've turned on the automatic answering feature. This can happen without user intervention. Likewise, you can set a fax for transfer at a particular time, and that will take place in the background. You can send a fax manually at any time, of course.

The Brooktrout Fax-Mail 96

This is a full-size card that retails for $599, or slightly less than the Murata. It uses the Rockwell fax modem chip set and is accompanied by software that includes a text editor and a graphics image editor. This graphics editor is especially useful, because it will let you edit a fax you've received from elsewhere. Brooktrout suggests this as a way to append your letterhead and signature to your faxes. Essentially, this means that you can use a standard fax machine as a scanner for the computer-based fax. If you don't want or need to buy an expensive scanner, this is a pretty handy way to do an occasional scan.

The Fax-Mail 96 lets you reduce images before printing them. This is important because fax machines normally add a couple of lines to the top of an image when they send it so that there is room for the ID information of the sending machine. When the fax is received and printed, it will frequently cause a half inch or so of the bottom of each page to be printed on the following page unless the image is slightly reduced. With the Fax-Mail 96, you can choose the amount of reduction you need.

The Fax-Mail 96 also lets you specify a reasonably wide variety of graphics adapters for your computer, although it does not support VGA graphics resolution. This is too bad, because the documents on the screen are not always legible when viewed in EGA mode. You can enlarge the screen image and read it that way, however.

When I used the Fax-Mail 96 to send a document to the tabletop Murata M1200 fax machine, it delivered a remarkably clear image. In fact, it causes the fax machine to produce text closely resembling laser-printed output. I tried sending faxes to the Murata from several other fax machines, including some expensive Xerox telecopiers. The images were never as clear as they were from the Fax-Mail 96.

Other people who have used the PC fax cards tell me that the output usually looks good on the receiving end. This is because the printer part of a fax machine generally has a higher resolution than the scanning part; if you're not scanning the input document, you get cleaner output. If you want to impress your correspondents with the quality of your output, the Fax-Mail 96 is a good way to do it.

One of the few weak points of the Brooktrout Technology Fax-Mail 96 is the lack of a speaker to monitor the progress of the call. A status screen on your computer shows the call's progress, but a speaker like the ones found on most fax machines would be nice.

ITEMS DISCUSSED

Fax-Mail 96 .... $599
Brooktrout Technology, Inc.
110 Cedar St.
Wellesley Hills, MA 02181
(617) 235-3026
Inquiry 981.

JT Fax 9600 .... $795
Quadram
One Quad Way
Norcross, GA 30093
(404) 923-6666
Inquiry 982.

Murata M1200 .... $899.95
Murata Business Systems, Inc.
4801 Spring Valley Rd.
Dallas, TX 75244
(214) 403-3300
Inquiry 983.

Quadram JT Fax 9600

The JT Fax 9600 is a two-thirds-size board designed to fit into IBM PC and AT compatibles. It's more expensive than the Brooktrout Technology board, listing at $795, but it also uses the Rockwell chip set. Slower versions of this board are considerably less expensive.

For most of its operations, the JT Fax 9600 is as easy to use as the Fax-Mail 96. Like the Fax-Mail, it supports the LaserJet II and will print received faxes on that printer and a variety of dot-matrix printers. Realistically, a dot-matrix printer would be terribly slow, however. Like the Fax-Mail 96, the JT Fax 9600 sends exceptionally clean text to a standard fax machine. The output looks almost as good as laser-printed output and much better than output received from standard fax machines.

In one area, I found the JT Fax 9600 preferable. It had a speaker, so I could hear the call go through. On the other hand, the software had no way to monitor the progress of the transmission, so I had no idea what the transfer speed was. As it turns out, I was able to monitor this with the Murata. Although the JT Fax sent documents at 9600 bps with no trouble, it was not able to receive a fax from the Murata at a speed higher than 4800 bps. (It would receive from some other fax machines at 9600 bps.) This was not a problem with the Fax-Mail 96.

Are They Worth It?

If you already have a scanner and a laser printer, adding a fax card instead of buying a fax machine would be a logical move. It would gain you the capability of a fax machine at a slightly lower price. On the other hand, if you have to buy any of those parts, it's cheaper to get a standard fax machine like the Murata.

There are a couple of other settings where these devices make sense. If the quality of output is a significant factor, the ability of the fax cards to produce superior output, even in the remote fax machine, might indicate a requirement. If you need to use the machine on a LAN, then you will have to use a card, because fax machines don't attach to LANs. In addition, the fax cards can handle sophisticated calling lists and deliver faxes while unattended. Only the most expensive fax machines will do this.

Of the two fax boards considered here, the Brooktrout is both less expensive and more trouble-free. I had problems with the ability of the Quadram board to handle my VGA-equipped AT clone. The Fax-Mail 96 had no such problems; though it doesn't support VGA resolution, it worked fine with my VGA monitor, emulating EGA resolution.

This isn't a full-fledged review, but if I had to choose between the two fax boards considered here, I'd take the Brooktrout. I should add, though, that the *first* choice for me, and for many in small business, would probably be a standard fax machine like the Murata. It doesn't tie up the computer, and the quality of output isn't all that important for most of what I do. Fax cards remain specialized devices that can meet some needs very well, but for general-purpose, light-duty fax service, I question their value. ■

Wayne Rash Jr. is a consulting 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.

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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Circle 61 on Reader Service Card

A MACINTOSH WHO'S WHO

A chart that details the features of each member of the Macintosh family

Editor's note: *This month we've kept Don Crabb quite busy with reviews and a special column for the Macintosh Special Edition in this issue. To give him a break in the action, we've decided to use his column to supply general information about Apple's growing line of Macintosh computers. Don't be alarmed; Don will be back next month.*

Like the variety of colors Henry Ford offered with his Model T ("You can have any color you want, as long as it's black"), in 1984 Apple gave you a range of hardware options for the Macintosh computer: You had a choice of 128K bytes of RAM in a sealed case, a 400K-byte floppy disk drive, and nothing else.

How times have changed. With six different Macintosh computers now on the market, a new buyer has to sort through a bewildering array of CPUs and hardware combinations. Here's our scorecard to help out: Table 1 summarizes the features of each machine and should help you determine which Mac is best for you.

Note that the machines fall into two groups. First, there's the "compact" family whose trademarks are a small footprint and a built-in monitor. Expansion capabilities are limited to a single slot for both the Mac SE and the SE/30.

Then there's the "modular" family. Although these machines take up more of your desktop, they compensate by providing more slots. These NuBus slots let you plug in peripheral or coprocessor boards that expand the capabilities of the machine in any direction you see fit.

However, be careful when you expand your system: There are some minor differences that can turn into major problems if you're not aware of them.

Table 1: *A comparison of the system features for Macintosh computers.*

Machine	CPU	FPU	Clock speed	ROMs and mounting	Maximum RAM	Memory management hardware
Mac Plus	68000	None	7.83 MHz	128K-byte socketed DIP	2.5 to 4 megabytes[1]	None
Mac SE	68000	None	7.83 MHz	256K-byte socketed DIP	4 megabytes	None
Mac SE/30	68030	68882	15.68 MHz	256K-byte SIMM-mounted	8 megabytes	Part of CPU
Mac II	68020	68881	15.68 MHz	256K-byte socketed DIP	8 megabytes	Optional 68851 PMMU
Mac IIx	68030	68882	15.68 MHz	256K-byte SIMM-mounted	8 megabytes	Part of CPU
Mac IIcx	68030	68882	15.68 MHz	256K-byte soldered DIP[2]	8 megabytes	Part of CPU

[1] RAM expansion is determined by the limits of the Mac Plus power supply. Beige-colored Macs should be expanded to only 2.5 megabytes; platinum-colored Macs can be safely expanded to 4 megabytes.

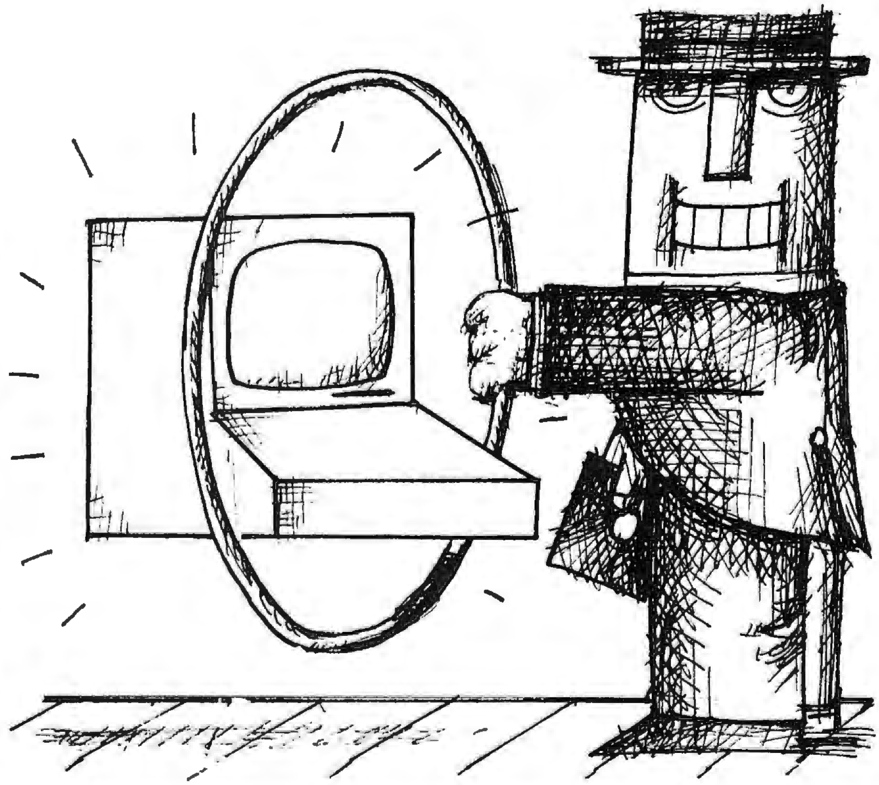
[2] A SIMM socket is available for future ROMs. A jumper must be removed for the CPU to address the SIMM socket.

First, the Mac SE/30 can't use SE expansion boards, because the slot connector and form factor are different.

Second, when you expand the memory on these systems, check the access time of the RAM single in-line memory modules you buy. The Mac Plus and SE use 150-nanosecond SIMMs,while the rest use 120-ns SIMMs.

Finally, old-timers who own the original Hard Disk 20—the one with the external floppy disk drive connector—should consider selling it or obtaining a SCSI port for it; the Mac SE/30 and IIcx don't support this type of drive. ■

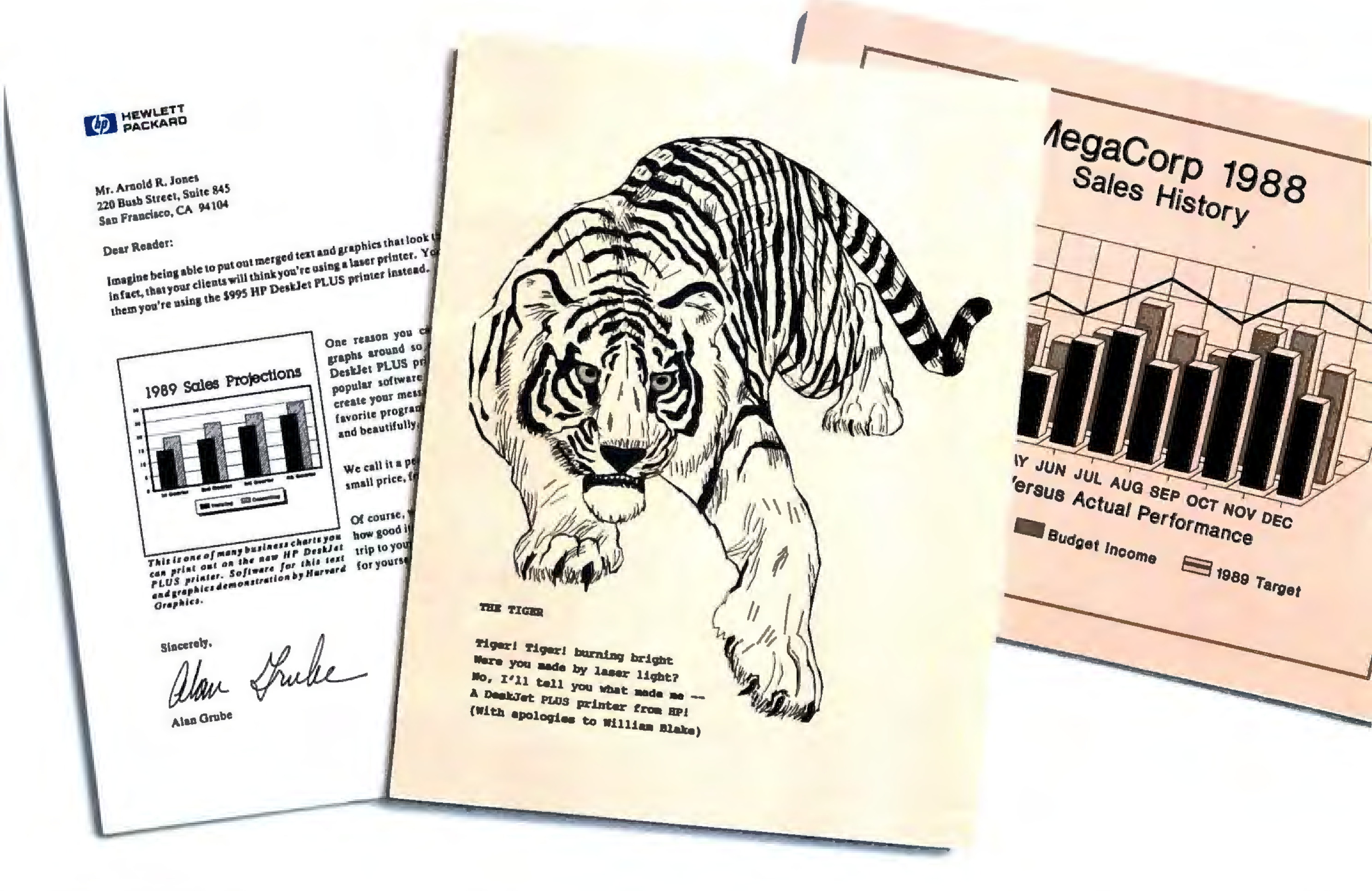
Tom Thompson is a BYTE senior technical editor at large. He has a BSEE from Memphis State University. He has used Macs for many years and has coauthored many of the First Impressions of Macs. He can be reached on BIX as "tom_thompson."



Slots	Floppy disk drive	External storage	Keyboard/ mouse	Supports Color QuickDraw?	Sound
None	400K/800K	SCSI, floppy	Mac Plus keyboard, Mac mouse	No	Monophonic using software drivers
1—SE bus	400K/800K	SCSI, floppy	ADB Standard or Extended keyboard, ADB mouse	No	Monophonic using software drivers
1—030 Direct Slot	FDHD[3]	SCSI, floppy	ADB Standard or Extended keyboard, ADB mouse	Yes	Stereophonic using custom chip
6—NuBus	FDHD[3]	SCSI	ADB Standard or Extended keyboard, ADB mouse	Yes	Stereophonic using custom chip
6—NuBus	FDHD[3]	SCSI	ADB Standard or Extended keyboard, ADB mouse	Yes	Stereophonic using custom chip
3—NuBus	FDHD[3]	SCSI, floppy	ADB Standard or Extended keyboard, ADB mouse	Yes	Stereophonic using custom chip

[3] The FDHD (floppy disk high-density) drive can handle a variety of machine formats: 400K-byte, 800K-byte, and 1.44-megabyte Mac; 720K-byte and 1.44-megabyte DOS or OS/2; and 800K-byte Apple II ProDOS.

But they keep looking at the evidence.



You won't believe your eyes (or ears), either. The HP DeskJet PLUS printer gives you the same crisp, black lettering. Clean, sharp graphics. And whisper-quiet operation. But it uses advanced inkjet technology to supply these laser-like qualities for the price of a 24-wire printer.

For just $995, you get 300 dpi in a trim 15-pound package that's twice as fast as the original. What's more, it has built-in landscape and improved font selection. Including ten built-in fonts and over 100 optional fonts, with sizes up to 30 points. And its 20,000-hour MTBF assures a long, happy life.

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HEWLETT PACKARD

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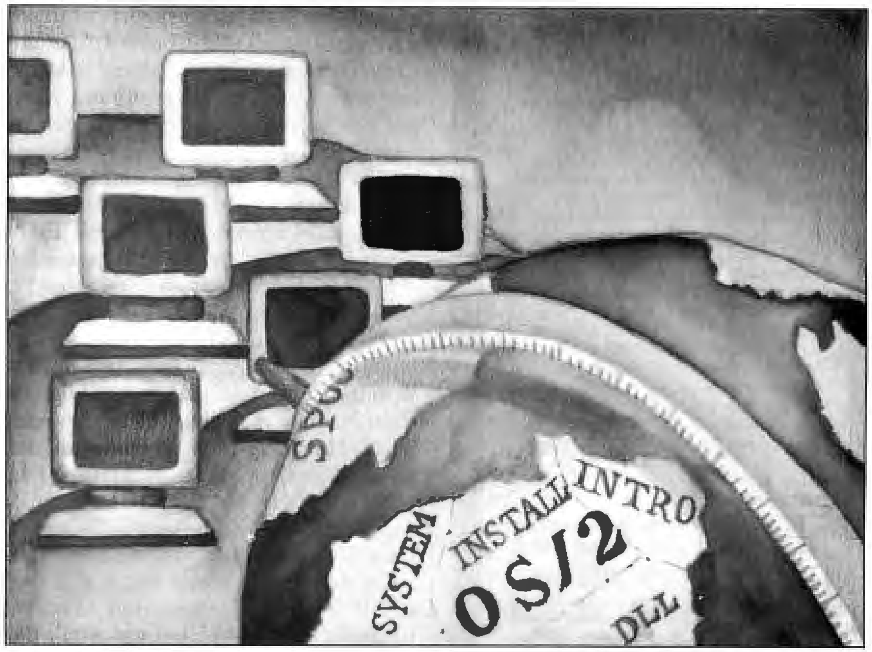
OS/2 DISK GEOGRAPHY

After you install OS/2, it's time to go exploring on your hard disk



Let's continue with the discussion of setting up OS/2. Now that you've loaded those megabytes and megabytes of data on your hard disk, just what is on there? The OS/2 installation created six subdirectories and deposited a few files in the root directory as well.

The Root Directory

The root directory contains CONFIG.SYS—the OS/2 version—and may include a batch file named STARTUP.CMD, a file that serves a function similar to AUTOEXEC.BAT for DOS. This directory also has some files with the extension .SYS: CLOCK01.SYS, DISK01.SYS, KBD01.SYS, PRINT01.SYS, and SCREEN01.SYS. These files are the device drivers that replace the BIOS under OS/2, which needs them because it can't use the real-mode ROM BIOS routines. It can use only protected-mode routines. Also, the ROM BIOS routines are not reentrant—they can be used only in a single-threaded operating system.

In fact, OS/2 uses the IBM PC's BIOS very little. The main use that OS/2 has for the BIOS is in the initialization routine—the code that gets executed when the machine is first powered up. To switch from OS/2 back to the DOS mode, OS/2 must trick the processor by resetting it. Upon reset, the processor executes the initialization routine. A poorly written initialization routine renders a machine incapable of running OS/2. Fortunately, it can be fixed with a simple upgrade of the BIOS.

The .SYS files are the avenue whereby a manufacturer can tailor OS/2 to its machine. These files are the main reason that IBM OS/2 does not run on some clones. It is possible to write a fairly generic set of .SYS files. In fact, Microsoft shipped such a set with the Software Development Kit. But manufacturers might *want* a machine-specific set of device drivers, either to reduce competition or to allow OS/2 to better exploit the special features of that manufacturer's machine.

This means that theoretically you can run IBM OS/2 on a Tandy machine by putting the device drivers from Tandy OS/2 on the IBM OS/2 disk.

The final item in the root directory is a version of COMMAND.COM used by the DOS mode session (the new IBM term for the compatibility box).

Subdirectories

The \OS2 subdirectory contains several subdirectories of its own—INSTALL, INTRO, SYSTEM, and DLL—as well as a number of program files.

This subdirectory contains the usual DOS-like programs (e.g., CHKDSK, COMP, and FORMAT). There's even that old favorite, MORTGAGE.BAS. There are also some new programs. Some of the more interesting ones are

- MOUSEAxx.SYS: mouse drivers
- PMCPL.EXE: the control panel
- E.DEF, E.EXE, and E.MSG: the IBM System Editor (SE)
- OS2.INI: a data file that stores your preferences about screen colors, menus, and so forth. Unlike Window's WIN.INI, it is not ASCII, but some binary format.

IBM included an SE to take the place of EDLIN, something new to OS/2 1.1. It isn't bad, being miles better than EDLIN. It's not quite as good as the IBM Personal Editor, but then, the PE doesn't run under OS/2. Sadly, IBM hasn't announced if the PE is coming out for OS/2. I know I sound a mite crotchety

continued

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Dynamic link libraries improve OS/2 over DOS in several ways.

here, but I have yet to find an OS/2 editor as good as the PE. (And where's that legendary Big Blue user support for us PE partisans under OS/2, IBM?) Text editor preferences are religious issues. Ask anyone what text editor is good, and you'll get not only *an* answer, you'll get *the* answer.

The IBM SE has programmable keys and a fair number of primitive functions. I don't think anyone will leave BRIEF or Vedit in favor of the SE, but you won't draw derisive snickers as you would if you called yourself an EDLIN fan.

The \OS2\INSTALL subdirectory contains the programs that OS/2 used to install itself. You may want to erase these, as they're not used on a day-to-day basis. However, IBM recommends that you use one of these programs—DDINSTAL.EXE—to install new device support disks, like the one that supports the CGA, which was just released. (The CGA drivers are pretty much what you would expect. Presentation Manager under CGA is usable, but you won't like it. It *does* mean that you can get started in PM work for a few less bucks, at least until you can afford EGA—or have to buy stronger glasses.)

At any rate, you may want to pull the programs in the \OS2\INSTALL subdirectory off the hard disk to a floppy disk before zapping them.

\OS2\INTRO includes an automated tutorial introducing you to basic PM operations. If you haven't worked with Windows before, it's worthwhile to work through the tutorial. When you're done, erase it from your hard disk.

The \OS2\SYSTEM subdirectory includes a potpourri of system-support routines and files. The error-trap routine (HARDERR.EXE) and the virtual memory manager (SWAPPER.EXE) are there, as is COUNTRY.SYS, which contains some of the international support. Putting COUNTRY.SYS in this subdirectory doesn't make a lot of sense.

The files that support international keyboards, character sets, currency symbols, date formats, and so forth are

- COUNTRY.SYS: date and time formats, currency symbols, and a collation sequence
- KEYBOARD.DCP: international support for alternate keyboard maps
- VIOTBL.DCP: support for alternate character sets on-screen
- 5202.DCP and 4201.DCP: support for alternate character sets on IBM printers
- KEYB.COM: switches keyboard maps in midsession

For some reason, IBM put all the files but the last in \OS2. I don't know why. By the way, an unsung benefit of OS/2 is the simplification of the international support. I used to dread trips to London to do software seminars because every time I did, I had to relearn a pile of commands to support the British keyboard. Under OS/2, there are only five international commands, and they are consistent in syntax and simple to learn.

Dynamic Link Libraries

Last is the \OS2\DLL subdirectory, which contains the dynamic link libraries. DLLs improve OS/2 over DOS in several ways. To understand how, let's first back up and review how DOS supports communication between applications like Lotus 1-2-3 and the outside world. An application has to print hard copy on the printer, talk to the screen, and read the keyboard, to name just the basics. A well-behaved program doesn't directly access the keyboard, screen, or printer port—it *asks* DOS to do so.

Moreover, a program doesn't merely jump into the middle of DOS—it calls DOS through a well-documented *entry point*, most commonly something called INT 21. Entry points are nowadays called Application Program Interfaces. DOS's API, INT 21, can do any of a large number of things. Exactly *what* you want it to do is specified by a number in a CPU register called the AX register, or its component registers, AL and AH. Here are a few examples of DOS INT 21 functions (description and AH value): read a character from the keyboard (01), write a character to the screen (02), or print a character (05).

So, for example, to put an *A*, whose ASCII code is 41 hexadecimal, on the screen, you would use the following piece of assembly language code:

```
MOV DL,41H
MOV AH,2
INT 21H
```

continued

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The first line puts a 41 hexadecimal in the DL register. The DL register must contain the ASCII code of the character that you want to put on the screen. (How did I know? I looked it up in the *DOS Technical Reference.*) The AH load tells DOS which function to perform, and the INT 21 then calls DOS. On return, many (but not all) INT 21 calls put a *return code* in the AL register to show whether the requested operation succeeded or failed.

This is all simple enough, but it does require the use of assembly language, and that scares an awful lot of people. Also, it's not too descriptive—you've got to look up what "AH=2" implies in a reference manual. Moreover, since you're using AH, an 8-bit register, to identify a function call, you're restricted to 256 function calls. Finally (and this isn't obvious from the example), the DOS code is, like the BIOS code mentioned before, not reentrant. You can't call a DOS function from inside a DOS function. This has led to the most common error for authors of TSR programs—when you write a TSR program, you *dare not* call a DOS function!

OS/2 improves upon this with a different scheme—the DLL. A DLL contains OS/2 APIs. They're similar in nature to the INT 21 interface for DOS, but easier to work with. For one thing, you needn't write assembly language to use the DLLs—they're easily called from C, BASIC, or FORTRAN. The next attractive feature of DLLs is that they use symbolic names, as shown in the following example:

```
...
char msg[]="A"
...
VioWrtTTY(msg,1,0);
...
```

The `1` is the length of the message, and the `0` is the mandatory *handle* of the video I/O subsystem.

DLLs are, of course, reentrant. And because they have symbolic names, there's no restriction on the number of entry points. Microsoft claims that there are nearly a thousand for OS/2, although I haven't counted. Finally, they are dynamic—they load on demand. In other words, the operating system doesn't load every possible piece of code, whether you need it or not—the DLLs load only when a program needs them.

Many DLLs came with the OS/2 kernel, under OS/2 1.0. Version 1.1 brought more DLLs to support the new APIs for the PM. IBM's Extended Edition offers even more. You can even write your own DLLs. For example, you might design a system of programs with much common code and put the common code in a DLL to save space.

Once you remove the Installation Aid and the Introduction tutorial, you'll find that OS/2 has taken a total of about 7.5 megabytes on your hard disk. Now you have some idea of just what all those files are. Next month, I'll show you how to customize your CONFIG.SYS file. ■

Mark 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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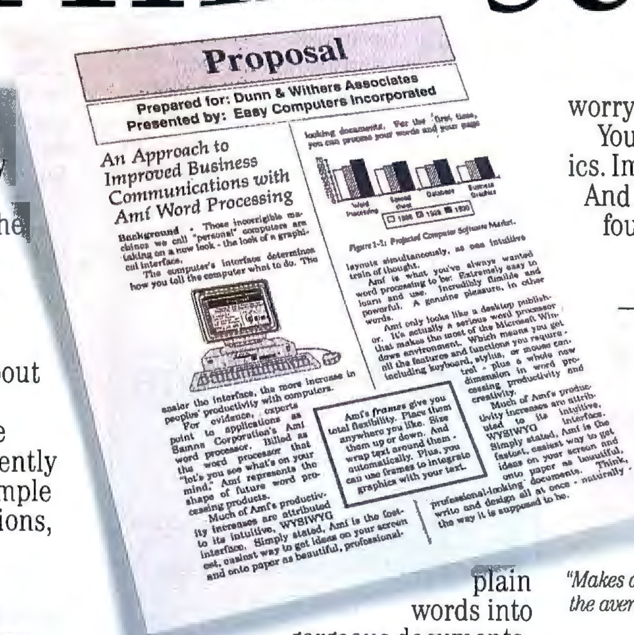

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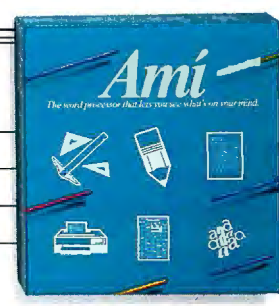

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 Mark L. Van Name and Bill Catchings

ANATOMY OF A LAN OPERATING SYSTEM

To understand LANs, you have to dissect the functional layers of the LAN operating system

Editor's note: *Beginning this month, COM1: becomes Net/Works, a new column with a mandate to address connectivity issues across the full spectrum of system platforms and network architectures. Each month, you'll hear from industry experts on topics ranging from asynchronous communications to LANs to internetwork connectivity. We start with a look at the basics of LAN operating systems.*

At the heart of every LAN is the LAN operating system. This crucial software provides the services required by network applications like E-mail. At the same time, the LAN operating system insulates those applications from the underlying network hardware. To achieve that goal, vendors construct LAN operating systems in layers. We'll concentrate on LANs for MS-DOS systems, but similar elements exist in LANs for everything from Macs to Unix machines to minicomputers like Digital's VAXes.

Basic LAN Services

At the top of any LAN operating system is a set of basic services designed to support LAN applications. All these services tend to follow the same client/server model, in which one machine—the client—needs something from another machine—the server. For example, if you want to copy a file from a remote machine, your microcomputer is a client that needs a file transfer service from the remote server.

Most early LANs required a dedicated server machine. This approach guarantees that when you request something from the server, you will not affect another user's computer. Most high-performance LAN operating systems today still demand a dedicated server. This method is not mandatory, however, and in some LANs every machine can act as a server, a client, or both.

Nearly all servers, dedicated or not, supply two fundamental services: file sharing and remote printing. While these are network applications according to the International Organization for Standardization's Open Systems Interconnection model, to the user they're basic LAN operating-system services.

The ability to share files makes it possible for you to access files on another system just as if they were on your machine. LAN operating systems for different computers provide this ability in different ways. On a Mac, a remote disk appears on your screen as just another disk with its own icon. Sun's Unix Network File System (NFS), on the other hand, makes all the remote files of a server's directory tree appear in a specified subdirectory of your root directory.

In a DOS-based microcomputer LAN operating system, you typically access remote files by treating a portion of a remote disk as your next available disk drive. For example, if your microcomputer has two disk drives and a single hard disk partition—DOS drives A, B, and C—then the remote disk partition would appear as drive D. You can treat the files on this drive just as you would any local files; you can copy them, type them, and even execute them.

Of course, before you can see drive D, you have to tell MS-DOS that you want to access a remote disk drive. The way in which you make this request varies from one LAN operating system to the next, but by way of illustration, we'll take a look at how it's done under Microsoft's MS-NET. MS-NET is a reasonable example for several reasons. First, the

continued

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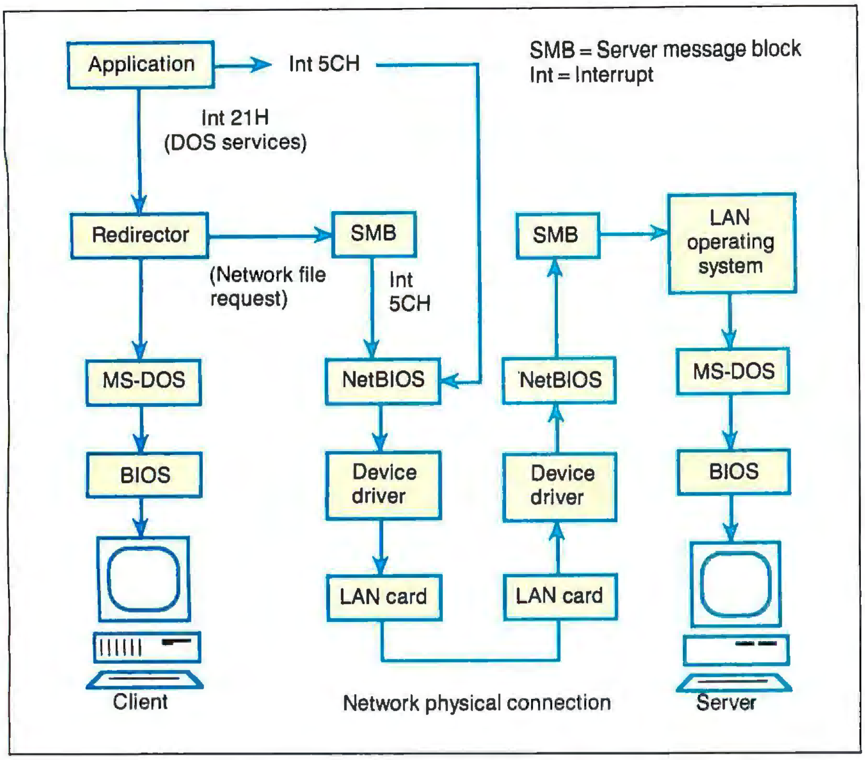

The flow of a network request from a client to a server system in an MS-Net environment.

LAN operating systems from IBM, AT&T, Digital, and 3Com all use some portion of it. Also, these and other LAN operating systems use the bulk of MS-NET's command syntax.

To map part of a remote disk to a local drive in MS-NET, you issue a NET USE command. There are several different NET USE commands, but all establish a link between the client microcomputer and the server. In order to make the files in the DIR1 directory on a server named SERVER appear as drive D, you would enter

NET USE D: \\SERVER\DIR1

This command makes the remote location of all the files on drive D transparent to you and to any applications that you execute. The LAN operating system actually hides the remote location of those files from the underlying operating system. DOS LAN operating systems, including MS-NET, hide this fact with a piece of software known as a redirector (see figure).

When an application or DOS command needs to make a file request, it eventually triggers the DOS interrupt 21H. The MS-NET redirector intercepts that interrupt before DOS gets it. The redirector checks first to see if the requested DOS function is a file I/O operation. If not, the redirector passes the request to DOS's standard interrupt 21H handler.

If the request is a file request, such as an Open File or Read File operation, then the redirector checks whether that request requires a local file or a remote file. If it needs a local file, the redirector once again passes the request to the standard DOS interrupt 21H handler. If the request is for a network file, then the redirector translates that request into the format specified by the next lower level of MS-NET, the server message block (SMB) layer.

The SMB protocol lets a client request services from a server. Its services include network analogs for all the basic DOS file operations. This scheme, by the way, limits network applications to the file- and record-locking functions that DOS provides. That's good in some respects, because it means that developers can write applications that will work the same whether or not they execute over a network. But the DOS locking functions are inadequate for some sophisticated network applications, notably DBMSes. To meet the demands of such applications, many LAN operating-system vendors provide additional file- and record-locking functions.

The other major LAN operating-system service, remote printing, works much like the file-sharing service. First, you tell MS-NET that you want to make a remote printer appear to be your local printer with a command like this:

NET USE LPT1: \\SERVER\LASER

This command maps your local LPT1: printer to the printer named LASER on the remote machine, SERVER.

When you print with a DOS command, the redirector intercepts the request just as it would a file request. It then makes the appropriate SMB calls to send the desired data to the server for printing. Unfortunately, this approach does not help the many applications that bypass DOS for printing and either call the microcomputer's BIOS print functions or talk directly to the printer. Many LAN operating systems handle the first case by intercepting the appropriate BIOS interrupt (17H) and then handling the print request as the MS-NET redirector handles a file request. That still leaves the applications that deal with the printer directly; there's nothing that the LAN operating system can do for them. Fortunately, the number of programs that go straight to the printer is decreasing all the time, so this is not as big a problem as it once was.

When a remote print or file request hits the SMB protocol, that software has to send the request to the SMB software on the server. To do so, it uses the next lower level of the LAN operating system.

Client/Server Communication

The software at this level manages the basic communication between the client and server machines. Perhaps because the services are so basic, they are often defined by the microcomputer vendors, not the LAN operating-system companies. The most prominent set of such services for DOS personal computers is defined by NetBIOS, which both IBM and Microsoft support.

Like the PC's BIOS, NetBIOS specifies a set of basic functions that higher-level programs can access. While it defines those functions, however, NetBIOS does not specify exactly how the LAN operating-system vendor has to implement them. Consequently, different LAN operating-system vendors offer different NetBIOS implementations, which can cause some network application incompatibilities.

Some of the LAN operating-system companies, such as Novell, don't even use NetBIOS to support their higher

continued

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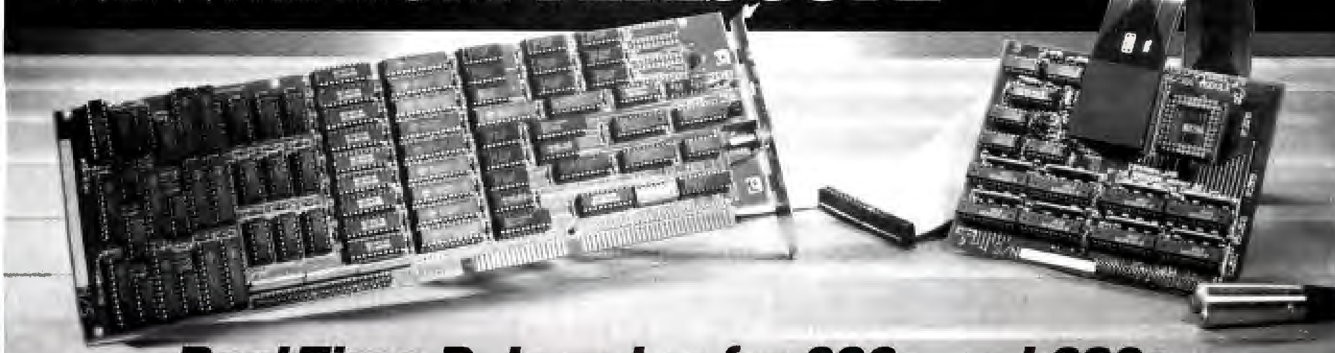

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LAN operating-system levels. Because so many applications count on NetBIOS, however, even those vendors usually offer a NetBIOS emulator that gives applications a standard interface to the proprietary network mechanisms.

NetBIOS offers two basic kinds of communication services: session and datagram. Both are available to programs via interrupt 5CH. The session services let higher LAN operating-system layers, like the SMB, set up a link between the client and the server that is much like a telephone call. A CALL function establishes a session, or connection, with a remote machine. SEND and RECEIVE functions let the two machines transfer data packets. When a machine receives a packet, it automatically acknowledges that fact. When the two machines are done talking, a HANG UP function terminates the session.

The datagram NetBIOS services are more like telegrams than telephone calls. A machine can send a datagram packet (SEND DATAGRAM) without first establishing a session with the target machine, and the target machine doesn't have to acknowledge receipt of the datagram.

Datagrams are good for short messages that do not require acknowledgment. One special kind of datagram, the broadcast datagram, lets a machine send a brief message to all the other machines on the network. Broadcast datagrams are useful when a machine wants to tell all the other systems that either it or a service it provides is available. But because receiving systems need not acknowledge datagrams, datagrams do not give the sender any guarantee that its message was ever received.

For the NetBIOS to manage communication sessions and send datagrams, it must be able to talk to the underlying network hardware and the low-level protocols that hardware supports. Apple's AppleTalk LAN operating system, for one, can work with both Apple's LocalTalk and EtherTalk.

The LAN operating system interacts with the hardware via a device driver. You install this device driver in your microcomputer as you would any other device driver: with a DEVICE= line in your CONFIG.SYS file.

Device drivers hide the underlying hardware so that NetBIOS, and, therefore, the entire LAN operating system above it, can run on a wide variety of network boards. Device drivers know whether those network boards use direct memory access and what I/O ports and interrupts they expect.

The network hardware typically consists of a LAN card in each microcomputer and cabling that links the systems. The two most popular hardware connections today are Ethernet and Token Ring, although many systems also use ARCnet and Apple's LocalTalk.

When all these layers work together, the result is a LAN operating system that can support the LAN services and applications—from file sharing to remote printing to E-mail—that have made LANs an integral part of the modern computing landscape. ■

Mark L. Van Name and Bill Catchings are independent computer consultants based in Raleigh, North Carolina. You can reach them on BIX c/o "editors" and as "wbc3," respectively.

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

4800 Bits, No Errors

Unless you're racing down the Bonneville Salt Flats or jousting for a parking space in Manhattan, some things are more important than speed. In data communication, raw speed without sophisticated control can lead to disaster. No one will argue that fast modems are needed—especially when every minute of connect time translates to dollars and cents. But what's the point of screaming through a high-speed transfer if you lose half your data along the way?

Modems can use compression and correction algorithms to double effective throughput while delivering error-free transmission. But they need even more than speed and accuracy—they must also conform to existing designs and planned standards. And, of course, an attractive price tag always helps.

This month, the BYTE Lab examines 17 external 2400-bps modems equipped with data compression and error correction. Our specific requirements for this review were compatibility with V.22bis (the CCITT standard for 2400-bps modem transmission), some form of error correction, and data compression with a rated throughput gain of 2 to 1 or better.

Alphabet Soup of Standards

Modern modems are often much more than the simple modulators/demodulators that their name implies. At the basic level, all modems convert digital information to analog signals for transmission within the bandwidth of the telephone line. Most modems that are designed for microcomputers, like those in this review, contain additional hardware: an asynchronous/synchronous converter, intelligence for command interpretation, automatic dialing and answering, and memory for configuration storage.

The CCITT's V.22bis recommendation sets the ground rules for 2400-bps modem-to-modem communication. It specifies the data transfer rate, the modulation scheme, and the duplexing technique. This imposed standard ensures that different manufacturers' modems will communicate without difficulty.

V.22bis modems use 16-point quadrature amplitude modulation (QAM) to convert data signals. Each group of 4 bits is encoded as a combination of phase and amplitude changes in carrier component signals. These modems achieve full-duplex transmission by separating the carriers in frequency; one modem's carrier is at 1200 Hz, while the second is fixed at 2400 Hz. With this division, both modems can simultaneously transmit over a two-wire line at the nominal rate of 2400 bps. [Editor's note: *For more background on modulation techniques, see this month's Under the Hood column, "Modern Modem Methods" by L. Brett Glass on page 321.*]

Most of us no longer consider 2400 bps fast, but V.22bis modems squeeze a great deal of information through the limited bandwidth of the telephone line. Unfortunately, limited bandwidth is not the only hurdle to overcome; the public switched telephone network (PSTN) often introduces other barriers to accurate communication. Noise is but one of the significant contributors to error.

The oft-quoted 3002, C2, and C4 telephone-line specifications refer to the different degrees of attenuation distortion and envelope delay distortion. Attenuation distortion interferes with a signal by providing different levels of attenuation at different frequencies; similarly, envelope delay distortion introduces unequal phase changes at different frequencies.

Other error factors—echoes, phase jitter, intermodulation distortion, frequency offset, and gain and phase hits—can have a significant effect on some connections.

Error correction has been available on high-speed modems for some time, and most of us are familiar with software error-correction protocols. Software protocols have a few limitations: You can't use them for interactive sessions where you're typing at the keyboard, and you can use them only if the remote location activates the protocol at the same time. Hardware-implemented error correction can proceed whenever two modems support the same technique. Since most of these modems can take synchronous as well as asynchronous inputs, these protocols can be used in microcomputer-to-mainframe links.

Two hardware error-correction techniques have gained wide acceptance: X.25 and the Microcom Networking Protocol. The X.25 standard is a CCITT protocol recommendation for packet-switched networks, and MNP is a point-to-point protocol developed by Microcom. Both rely on cyclic redundancy checking (CRC) to detect errors. The MNP protocol is more relevant in this discussion of dial-up modem-to-modem

With error correction and data compression, these 2400-bps modems pack double the data

Steve Apiki and Stanford Diehl

communications, but X.25 serves as the basis for both Telcor's proprietary correction and compression scheme and X.PC, a popular protocol used by Tymnet.

The CCITT's recent V.42 recommendation for error control is also similar to X.25. Although V.42 may emerge as a broadly supported standard, as of this writing, only Hayes is shipping a 2400-bps V.42 modem. The protocol comes with some support already in place: All V.42 modems must accept MNP connections if native LAP-M is not available on both ends. This means that modems supporting either MNP or V.42, as all the modems in this review do, will remain compatible with the majority of installed modems for quite some time.

Top of the Line:
(Clockwise from upper left): Fastcomm FDX 2448, Hayes V-series Smartmodem 2400 V.42, Telcor 2496MA, and E-Tech Bullet E2400M.

MNP is divided into classes. Classes 1 and 2 are asynchronous protocols and are rarely used. Classes 3 through 5, like X.25 and V.42, are synchronous bit-oriented protocols. They use a 16-bit CRC polynomial on 64-character blocks to detect errors. Since they are synchronous, they don't need the framing bits used in asynchronous transmission. By tacking a start bit and a stop bit onto each 8-bit stream, asynchronous transfer adds a 20 percent overhead to each transmission. Eliminating these framing bits results in increased throughput. Each protocol adds some bit overhead for error correction, but the additional bits amount to less than the 20 percent savings. The net result is error-free transmission with increased throughput.

Modems supporting class-4 protocols outperform class-3 modems because they use larger blocks and an improved header with fewer bits. Class 4 modems dynamically adjust block lengths to adapt to line conditions. Shorter blocks increase efficiency when poor lines demand retransmission, while longer blocks enhance throughput over clean channels. Class-4 modems can pass up to eight blocks before requiring an acknowledgment.

Modems that support V.42 or MNP classes 3 or 4 have better than 100 percent efficiency; however, the way they achieve this is by eliminating asynchronous overhead and not by compressing the data itself. The majority of these modems employ MNP-5 data compression to reduce the number of bits required to send a given amount of data. Hayes uses a proprietary technique, and Telcor offers both MNP-5 and its own algorithm. The CCITT has not yet completed its V.42bis standard for data compression.

MNP-5 data compression uses run-length encoding and modified Huffman codes in order to achieve compression. Run-length encoding reduces repeated characters to a character symbol and a repetition symbol. As a simplified example, run-length encoding would reduce "AAAAA" to "5A," a much shorter string.

Huffman coding uses fewer bits to encode frequently recurring characters. For English text, the letter *e* could be coded with 2 bits, while the much less common *q* might be coded with 10. The MNP protocol tracks the frequency of characters used in each transmission and adjusts its encoding tables on the fly; effectiveness is not limited to one type of file.

These compression enhancements let you transfer data at greater than the

continued

Table 1: *Price, performance features, enhancements, and compatibility of modems tested (● = yes; ○ = no).*

Modem	Price	COMPATIBILITY							
		Bell 103	Bell 212A	V.21	V.22	V.22bis	MNP levels	ENQ/ACK	Other
Concord Data Systems 224 Series II	$875	●	●	○	●	●	2-5	●	
Data Race Action 24	$595	●	●	○	●	●	2-5	●	
E-Tech Bullet E2400M	$395	●	●	○	●	●	1-5	●	
Fastcomm FDX 2448	$649	●	●	[●]	[●]	●	1-5	●	
General DataComm 224E/MNP	$495	●	●	○	●	●	1-5	○	
GVC Model SM24M	$359	●	●	○	●	●	1-5	○	
Hayes V-series Smartmodem 2400 V.42	$899	●	●	○	●	●	N/A	○	V.42, Hayes data compression
Inmac Clear Signal 2400 SD+	$269	●	●	●	●	●	5	○	
Microcom AX/2400c	$699	●	●	○	●	●	2-5	●	
Multi-Tech MultiModem224E MT224EH	$599	●	●	[●]	●	●	2-5	●	
Racal-Vadic 2400VP	$595	●	●	○	○	●	2-5	○	
Telcor 2496MA	$895	●	●	○	●	●	1-5	●	Telcor
Telenetics TC921S-24	$695	●	●	[●]	●	●	1-5	○	
Universal Data Systems 2440	$550	●	●	○	●	●	2-5	○	
USRobotics Courier 2400e	$699	●	●	○	○	●	1-5	○	
Ven-Tel EC2400-33	$595	●	●	○	●	●	1-5	○	X.PC
Western Datacom 424 Class 5	$595	●	●	○	●	●	1-5	○	

1 Key to other modes: S = synchronous operation, LL = leased-line capability, 4W = four-wire operation.
2 AutoSync (AS), along with Hayes Synchronous Interface (HSI) software, allows the modem to communicate synchronously without an adapter card.
3 7680 bytes translates to 32 pages, the equivalent of 698 passwords, 333 phone numbers, or 144 option sets.
4 Error control buffer/other buffer.

[ ] = Optional feature.
N/A = Information not available from manufacturer.
N = Numbers.
C = Configurations.

Western Datacom

modem-to-modem bps speed. You simply establish a compatible link, set the computer-to-modem speed to at least 4800 bps, and fire away. (Note: The computer is also known as data terminal equipment, or DTE, and the modem is also known as data communication equipment, or DCE.) Each modem buffers data from the DTE, compresses it, and sends it over the phone line. If the rate is too high, the buffer will fill, and the modem may need to control the flow of data from the DTE, using either the RTS/CTS lines or software (XON/XOFF) characters. This configuration—with the DTE sending as fast as it can to the modem, keeping the buffers nearly full—is ideal for data-compression modems; slower DTE speed can limit compression and choke throughput.

Command Sets and Compatibility

The Hayes AT command set has become a fixture in the modem marketplace. Almost any modem, including every one in this review, implements this standard. The standard AT set includes many basic features, such as auto-answer, redial, reverse dial (dial in the answer mode), last-number recall, and status displays. All the vendors except Hayes also offer a set of MNP enhancements to control such options as data compression and auto-reliable mode. Auto-reliable mode will detect a non-MNP modem on the remote end and switch to a normal connection.

Microcom

Proprietary command set additions also trigger special features like number linking and continuous redial (see table 1 above). With number linking, you can string stored phone numbers together; if one line is busy, the modem will automatically ring the next number in the string. Another response to busy lines, continuous redial, will ring the line until a successful link is made or until completing the maximum number of tries. These features are handy, but you can

BUFFERS			Other storage	Other modes[1]	Remote config.	Call-back security	Continuous redial	Number linking	Manual indexed	Warranty (years)
Transmit (bytes)	Receive (bytes)	Number (chars.)								
2K	2K	80	10 N	S,[LL],[4W]	●	○	○	○	●	2
1K	1K	68	10 N 3 C	S,LL	●	●	○	●	●	1
24-30K	Total	40	10 N	S,LL	○	○	○	○	○	2
4K	4K	48	4 N	S,LL,[4W]	●	○	●	●	○	2
2K	2K	40	10 N	S,LL	○	○	○	●	●	1
256	256	40	4 N 2 C	S,LL	○	○	○	○	○	2
N/A	N/A	255	4 N 2 C	S,LL,AS[2]	○	○	○	○	●	2
N/A	N/A	40	4 N 2 C	S	○	○	○	○	○	2
600	600	80	9 N 4 C	S,LL	●	○	○	●	●	1
2K	2K	40	10 N	S,LL	○	○	●	●	○	2
2K	2K	40	15 N	S,LL	○	○	●	●	○	2
2K	2K	70	7680 bytes[3]	LL	●	●	○	○	●	3
1K	1K	40	32 N 9 C	S,LL,4W	●	●	○	○	○	5
1K	1.25K	80	5 N 6 C	S,LL	○	○	○	○	○	1
3.5K/5K[4]	2K	40	1 N	LL	○	○	●	○	●	2
2K	2K	40	9 N	S,LL,4W	○	○	●	●	●	5
2K	2K	64	8 N 2 C	S	●	●	○	○	○	1

General DataComm

usually get them from your communications software.

Some of the vendors include only the standard command set, opting for alternate ways to embellish features. The Racal-Vadic 2400VP's asterisk prompt enables many handy features with a set of single-letter commands. You can link numbers by entering an L, or you can access various memory locations for stored number dialing. This works hand in hand with full manual control of talk/data, transfer speed, auto-answer, data format (synchronous or asynchronous), and self-test loops. Similarly, the Ven-Tel EC2400-33 enters a command mode from the dollar ($) prompt.

The Telcor 2496MA enhances the interface with full menu control. You can step through the menus by entering responses from the terminal or from touch keys. A touch-key combination displays available options, while another key advances through each selection. In this way, you have a full view of all parameters as well as an easy way to change each setting. The Telcor 2496MA also delivers advanced feedback through a numeric display panel and coded responses.

A menu system also drives the Universal Data Systems 2440. Seven main menus control configuration, protocols, testing, and dialing of stored numbers. An LCD prompts you, and you respond from the touchpad with simple "yes" and "no" input. You can lock the front panel

USRobotics

to prevent unauthorized access.

Experienced users may find menu overlays intrusive. After all, the AT command set is simple and direct. Still, a stark screen awaiting commands can be intimidating, and unless you've memorized the full AT repertoire, a comprehensive interface makes configuration chores less trying. When you're reviewing options to ensure compatibility with a remote site, that can save you from some

continued

GVC

Inmac

headaches. The modems from Concord Data Systems, Data Race, Fastcomm, Microcom, Telcor, Telenetics, and Western Datacom make remote configuration even easier by letting you configure a remote modem from the local keyboard.

It takes more than a standard command set to ensure compatibility. Compatibility, though, is a tricky question with this set of modems. They can all speak MNP, except the Hayes 2400 V.42, which cannot decipher level-5 data compression. Yet, with V.42 sure to become a standard, the Hayes modem has a leg up on the competition. Since no other 2400-bps V.42 modems exist, we didn't run V.42 compatibility tests on the Hayes modem. Data Race and Universal Data Systems told us that their 2400-bps modems can be upgraded to V.42 when it becomes available. Ven-Tel includes support for X.PC. Modems from Concord Data Systems, Data Race, E-Tech, Fastcomm, Microcom, Multi-Tech, and Telcor are also compatible with equipment that employs Hewlett-Packard ENQ/ACK pacing.

Securing the Lines

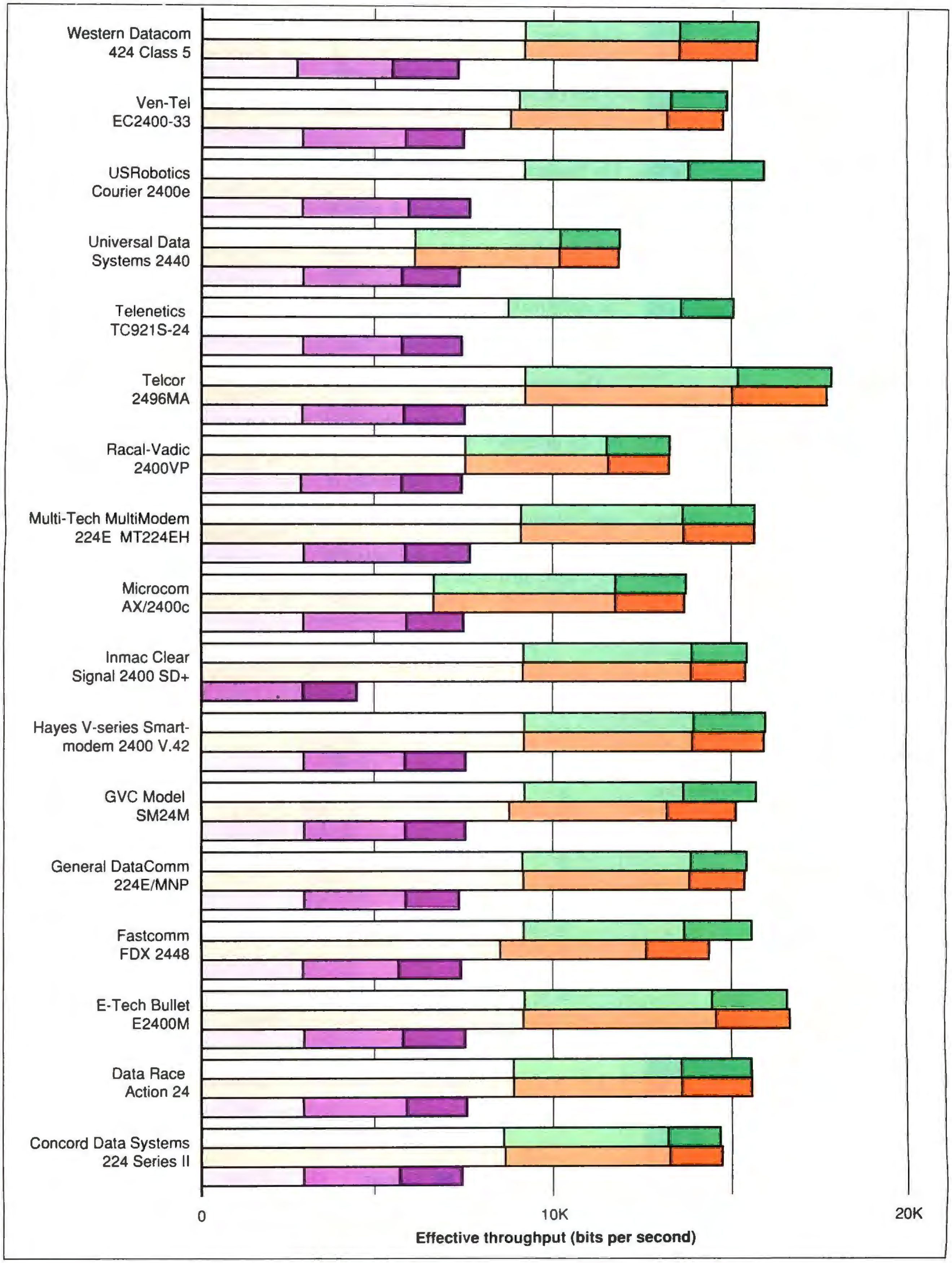
These modems offer a range of security options to suit your needs. The modems with remote configuration will usually restrict the level of remote access. At one level, a remote user can view configuration parameters but cannot change them. At the next level, the remote user can change the configuration. In addition, the Microcom, Concord Data Systems, Data Race, Fastcomm, and Western Datacom modems can require a log-in password to restrict caller access.

The dial-back feature represents a higher level of modem security. When the modem receives a call, it accepts a valid password from the caller, hangs up, and calls the remote modem back. The

continued

Figure 1 (at right): Power of the pump. *The typical line ASCII transfer reflects the quality of compression, while the binary transfer more closely represents the efficiency of the data pump. Transfers across the impaired line test error-correction capability. The bottom bar maps performance under MNP-4. Missing segments indicate transmission failure.*

	dBASE	ASCII	Binary
Typical			
Impaired			
MNP-4			


Western Datacom 424 Class 5
Ven-Tel EC2400-33
USRobotics Courier 2400e
Universal Data Systems 2440
Telenetics TC921S-24
Telcor 2496MA
Racal-Vadic 2400VP
Multi-Tech MultiModem 224E MT224EH
Microcom AX/2400c
Inmac Clear Signal 2400 SD+
Hayes V-series Smart-modem 2400 V.42
GVC Model SM24M
General DataComm 224E/MNP
Fastcomm FDX 2448
E-Tech Bullet E2400M
Data Race Action 24
Concord Data Systems 224 Series II
0
10K
20K
Effective throughput (bits per second)

Multi-Tech

Telenetics

host modem can either prompt the remote user for a phone number or pull a specified number from storage. The password determines your level of access. And if you're really paranoid, a Telcor upgrade delivers data encryption.

In fact, the Telcor 2496MA supplies a full set of security options: An internal password table assigns features depending on the user log-in; access codes determine four levels of local access and two levels of remote access; and a 17-digit master key number composes an encryption key between two accelerators. Telcor's impressive storage capacity lets you store up to 698 passwords or 350 passwords with associated call-back strings.

The Performance Factor

The ultimate performance measure for these modems is throughput. It reflects the level of data compression, the speed and adaptability of error correction, and reaction to line impairments. As long as the modems transfer without errors, we can easily make consistent comparisons. All the modems met this basic criterion. (See the text box "Performance Tests" on page 170.)

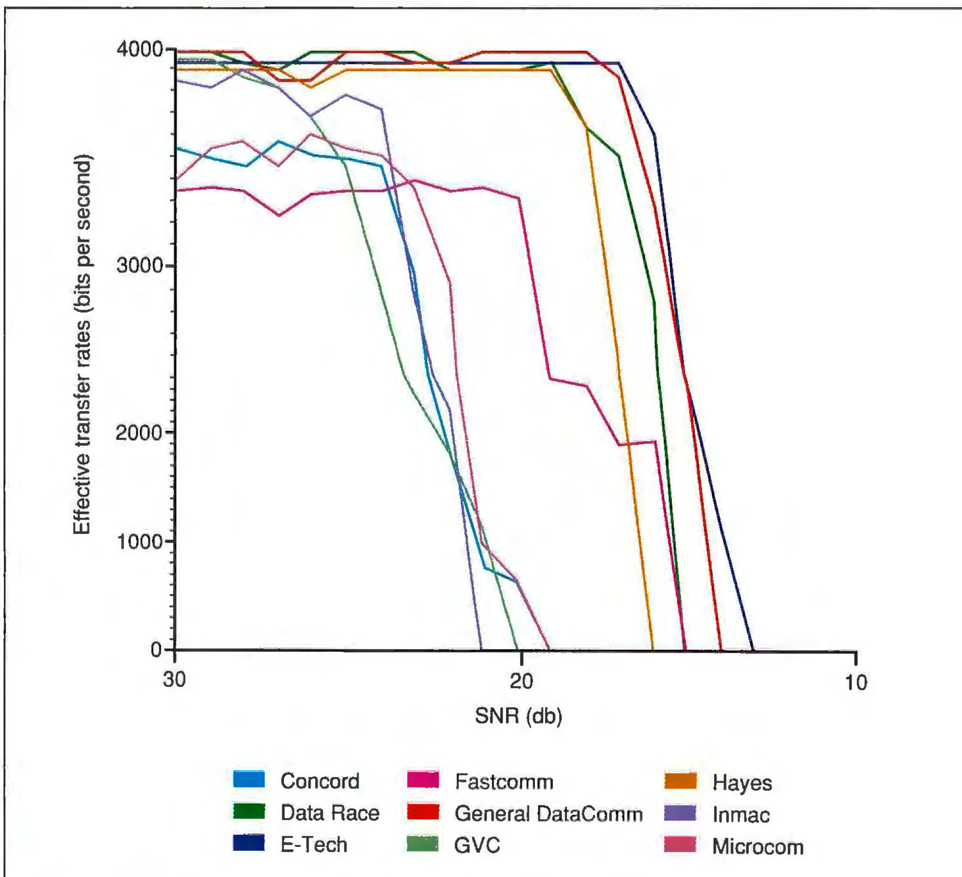
The typical line results shown in figure 1 are probably the best indicators of everyday performance. They also point out the difference in relative compressibility between the three test files. ASCII text best reflects the quality of compression; most of the modems had a gain in throughput of about 2 to 1. As expected, none of the modems compressed the random data of the executable file very well. Sent with the small-block XMODEM protocol, the binary file represents a worst-case transfer. The highly compressible dBASE document, containing data formatted into fixed-length fields, represents the other end of the spectrum. The dBASE file transferred with YMODEM-G is close to the best case, and every modem achieved at least 3-to-1 compression.

The Telcor 2496MA proved outstanding on both the typical and impaired lines. The performance bars shown in figure 1 are for the Telcor modems using Telcor's proprietary compression method; these levels of throughput are possible only with two Telcor modems. We did not graph Telcor performance in MNP-5-compatible mode; it ran about as fast as the Multi-Tech modem.

The power of the E-Tech Bullet E2400M surprised us, given its modest price. It had the second-best ASCII transfer rate and the second-best overall rate on all tested lines. Hayes's V.42 modem with proprietary compression method had better than average throughput for all file types. Some other modems from big-name manufacturers, including Universal Data Systems, Racal-Vadic, and Microcom, turned in disappointing results.

We were forced to test the Inmac Clear Signal modem using XON/XOFF flow

Figure 2: Plotting the performance curve. *Lines starting high on the bps axis reveal outstanding throughput, while those that stretch farthest along the signal-to-noise-ratio (SNR) axis display impressive resistance to noise. The Telcor 2496MA transferred at sizzling speeds but fizzled when the lines turned dirty. The Racal-Vadic 2400VP boasts the best SNR. Note the nonlinear bps axis (the scale was adjusted for clarity).*



Universal Data Systems

control for the ASCII file because the modem's hardware flow control implementation does not work. Inmac called the problem a "known bug" in firmware, and the company is working on a solution. We ran the protocol transfers with flow control disabled.

For most modems, performance was about the same on the impaired lines as it was on the typical line. We used a preliminary draft of EIA-496A to set up the impaired lines. (You can modify the impairment channel specifications of EIA-496A in the final document.) Because the EIA lines stress several different impairments, consistent performance on all of them suggests that a modem can handle almost any real line. Only two of the modems failed to connect on all the impaired lines, and they failed only on EIA-4. On the other four impaired lines, they performed at about the same level as they did on the typical line.

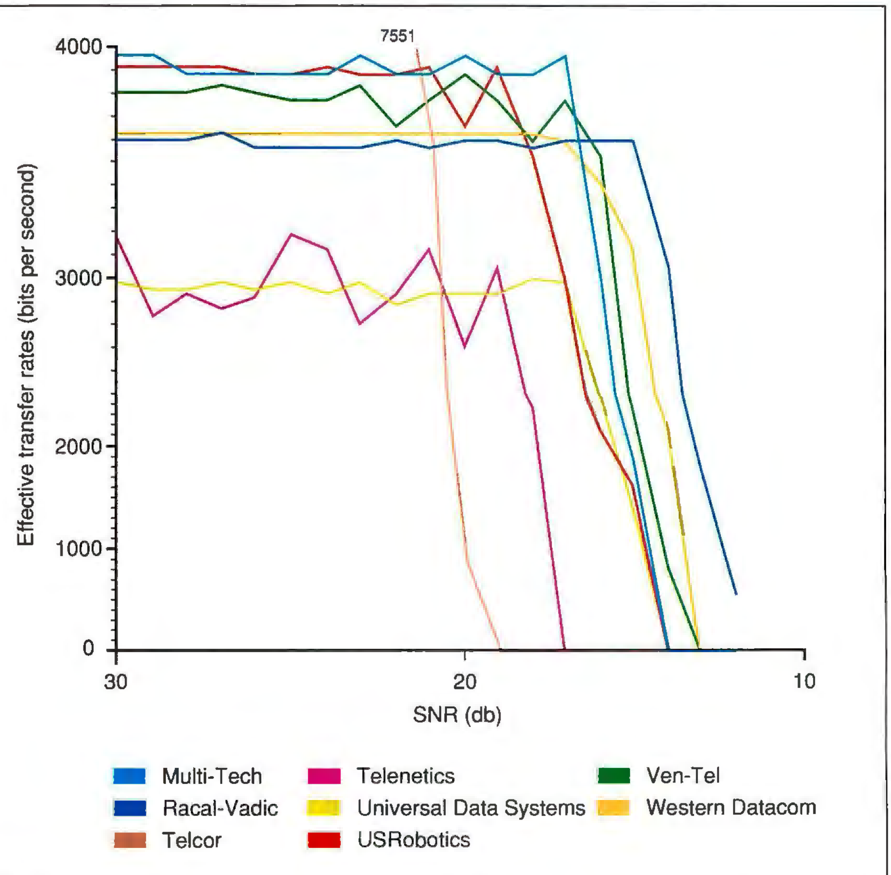
MNP-4 throughput, the last box in figure 1, shows almost no performance difference from modem to modem, so we attributed most of the throughput differences to the data-compression implementation. The Inmac modem could not complete the YMODEM-G protocol transfer without data compression because it lacked proper flow control (XON/XOFF can't be used reliably for protocol transfers). Therefore, no results for the Inmac transferring the dBASE file are shown.

The test we used for non-error-cor-

continued

Data Race

Ven-Tel



Performance Tests

Speed, compatibility, robust execution on noisy lines—all are critical in evaluating performance. We developed a group of tests to isolate and compare each of these critical factors.

Our first suite of tests focuses on a modem's ability to compress data in three file formats: ASCII text, database, and binary. The ASCII document represents the type of file most often transferred without resorting to a software protocol, while the other two contain non-ASCII characters and are usually sent using some form of packet conversion.

For the ASCII test, we used a 32K-byte file containing the text of a BYTE article. The document, though mostly (about 75 percent) nonrepeating English text, included some tables of words and numbers. Our 246K-byte database file was a mailing list created with dBASE III Plus. CC86.EXE, the 39K-byte BYTE Small-C compiler, represented a typical binary executable file.

Because software protocols can have a profound effect on overall throughput, we tested these modems using two of the most common: XMODEM and YMODEM-G. Virtually every communications package supports the widely popular XMODEM protocol, which performs a cyclic redundancy check (CRC) or checksum block error checking on 128-byte blocks. While less prevalent, the YMODEM-G protocol operates on larger, 1K-byte blocks and does no independent error detection, making it ideal for error-correcting modems.

We combined protocols and file formats into one test by sending the database file with YMODEM-G and the binary file via XMODEM CRC. The ASCII file was sent without software protocol.

For these tests, our data terminal equipment (DTE) was two identically equipped 12.5-MHz Dell 200s running Procomm Plus. We set up a Procomm script file to time the transfer of each file; each file was sent to and from a RAM disk to minimize the systems' effect. To find errors in the received files, we wrote a compare utility to check them byte by byte against known good files transferred with the same protocol.

The heart of the test setup was an Autotest switched-line simulator. The unit houses a switched-line simulator, a hybrid transformer, a four-wire impairment channel, and a four-wire attenuator. The switched-line simulator looks to each modem like an ordinary telephone line; it provides loop current and rings the target modem when a call is placed. Transmitted signals pass from the two-wire switched-line simulator through the hybrid into the four-wire impairment channel. The impairment channel can provide noise, attenuation distortion, envelope delay distortion, phase jitter, nonlinear distortion, gain hits, and frequency offset. On the other side of the impairment channel lies another hybrid, another switched-line simulator, and, finally, the receiving modem. Signals sent by the receiving device (e.g., acknowledgments and checksums), while following a similar path back to the transmitter, pass through a simple attenuator rather than through the impairment channel.

For our typical-line throughput test (figure 1), both transmit and receive modems were similarly configured units of the model under test. Each modem had data compression and bidirectional hardware flow control enabled and required an error-correcting link. Procomm set the DTE speed to 9600 bps but did not introduce any line or character delays during the ASCII transfer. The simulator presented a typical line channel to each modem, with 16-decibel 1004-Hz loss and -52 dB_m (decibels referenced to 1 milliwatt) injected noise, and the modems made connection at 2400 bps. If the modems could not establish an error-correcting link, they dropped the carrier and canceled transmission.

All our results are graphed as effective throughput rates in bits per second. These were calculated from the size of each file (bits transferred = bytes × 10) and the times recorded by the Procomm script. Procomm reports times in seconds, and since the shortest time for any file transfer was on the order of 50 seconds, our margin of error is about ±1 percent.

The impaired line results are an average of a modem's performance over five lines specified by the preliminary draft of EIA-496A. The document gives recommendations for standard impairment combinations to be used in testing dial-up modems. Each of the five lines stresses one impairment type over others; EIA-1, for example, has particularly high phase jitter, while EIA-2 has a low receive level and severe attenuation distortion. EIA-4, which seems to be the most difficult, features a very low receive level, large envelope delay distortion, and some frequency translation.

We also tested modem compatibility. Figure 1 shows the results for each modem connected over a typical line to a Microcom modem running MNP-4. The graphs present an average of transmit and receive performance. As an additional compatibility test, we linked each modem with a Hayes Smartmodem 2400, which has neither error correction nor data compression.

Our final test generates a plot of effective throughput versus signal-to-noise ratio (SNR) as a measure of sensitivity to noisy lines (figure 2). Two modems of the type under test were set for data compression and connected over a 3002 channel. We used the Autotest's simulated DTEs to repeatedly generate a 60-character message ("The quick brown fox . . .") and to test for transmission errors on the receive side. We began the test with noise at -79 dB_m and then held every other parameter constant while increasing the amount of noise injected into the channel. Both DTEs sent and received 40,000 characters at each SNR level with the modems operating at 2400-bps full duplex.

rected V22.bis compatibility has no corresponding graph. Except for one trouble spot, all the modems proved compatible, and throughput performance from modem to modem was almost indistinguishable. The problem occurred with the GVC Model SM24M, which had trouble receiving the YMODEM-G transfer file from the Hayes Smartmodem 2400 that we used as a control. This left us unable to complete the transfer.

Figure 2 tracks the results of our noise-versus-throughput test. The best curve encloses the most area, but there's often a trade-off between high throughput under normal conditions and noise resiliency. Racal-Vadic's 2400VP can transmit on lines that are too noisy for any other modems, but it suffers from slow throughput on everyday lines.

continued

COMPANY INFORMATION

Concord Data Systems
45 Bartlett St.
Marlborough, MA 01752
(508) 460-0808
Inquiry 1071.

Data Race
12758 Cimmaron Path,
Suite 108
San Antonio, TX 78249
(512) 692-3909
Inquiry 1072.

E-Tech Research, Inc.
2700 Augustine Dr.,
Suite 275
Santa Clara, CA 95054
(408) 982-0270
Inquiry 1073.

Fastcomm Communications Corp.
12347-E Sunrise Valley Dr.
Reston, VA 22091
(703) 620-3900
Inquiry 1074.

General DataComm
1579 Atraits Tpk.
Middlebury, CT 06762
(203) 574-1118
Inquiry 1075.

GVC-Chenel Corp.
99 Demarest Rd.
Sparta, NJ 07871
(201) 579-3630
Inquiry 1076.

Hayes Microcomputer Products, Inc.
705 Western Dr.
Norcross, GA 30092
(404) 449-8791
Inquiry 1077.

Inmac
2350 Zanger Rd.
San Jose, CA 95131
(408) 435-1700
Inquiry 1078.

Microcom, Inc.
500 River Ridge Dr.
Norwood, MA 02062
(617) 551-1000
Inquiry 1079.

Multi-Tech Systems, Inc.
2205 Woodale Dr.
Mounds View, MN 55112
(800) 328-9717
Inquiry 1080.

Racal-Vadic
1525 McCarthy Blvd.
Milpitas, CA 95035
(408) 432-8008
Inquiry 1081.

Telcor Systems Corp.
12 Michigan Dr.
Natick, MA 01760
(508) 653-3995
Inquiry 1082.

Telenetics
5109 East La Palma Ave.
Anaheim, CA 92807
(714) 779-2766
Inquiry 1083.

Universal Data Systems
5000 Bradford Dr.
Huntsville, AL 35805
(205) 721-8000
Inquiry 1084.

USRobotics, Inc.
8100 North McCormick Blvd.
Skokie, IL 60076
(312) 982-5001
Inquiry 1085.

Ven-Tel, Inc.
2121 Zanker Rd.
San Jose, CA 95131
(408) 436-7400
Inquiry 1086.

Western Datacom
8431 South Ave.
Youngstown, OH 44514
(216) 758-9588
Inquiry 1087.

Racal-Vadic

The Telcor 2496MA, again, had outstanding throughput, but it was weak in handling noisy lines. Telcor's proprietary compression algorithm easily compacted the short, repeating message. For comparison, we also ran the Telcor units using MNP—they had a slightly worse reaction to noisy lines, and throughput close to that of the Data Race Action 24.

We had a little difficulty getting the Telenetics TC921S-24 to run the noise test. The graph shows the erratic performance from noise level to noise level. Flow control was also erratic; the modem would occasionally lock up and never raise the CTS (clear to send) signal. Sometimes it would hang up during the middle of transmission. Telenetics said it could not duplicate the problem in its lab, but the company continues to work on our observation.

Bits for the Buck

If you want to get a head start with the V.42 standard, you have, at the time of this writing, only two choices: You can buy the Hayes V-series Smartmodem 2400 V.42, or you can wait a while longer. The Hayes choice delivers a solid, dependable product along with the expertise and support of an industry leader. You'll pay top dollar ($899), though, and you'll forfeit MNP-5 compatibility.

The Telcor 2496MA also sports a hefty price tag ($895), but its features and performance justify its cost: a menu interface, MNP-5 compatibility, advanced security features, blazing proprietary transfers, lots of storage space, and a three-year warranty. We recommend the Telcor 2496MA, especially if you plan to connect two sites with identical models. A Telcor modem at both ends ensures top performance and total security. With just one unit, you lose some of the perks that make the Telcor modem stand out, including the faster transfers and some of the security safeguards.

The Fastcomm FDX 2448 fills out the feature table nicely, but the E-Tech Bullet E2400M offers solid performance and all the basic features at an attractive price of just $395. It outperformed many of the modems costing $200 to $300 more. You won't get some of the advanced features, such as password protection, but you will get a solid MNP performer at a reasonable price. ■

Concord Data Systems

BIBLIOGRAPHY

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Steve Apiki and Stanford Diehl are testing editors for the BYTE Lab. They can be reached on BIX as "apiki" and "sdiehl."

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6/89

Circle 212 on Reader Service Card

Big Mac Power in a Small Mac Box

What do you get when you cross a Mac IIx with a Mac SE? The Mac SE/30

Tom Thompson

Look inside Apple's newest Macintosh, the Mac SE/30, and you'll see hardware that looks like something out of a Mac IIx: a Motorola 68030 CPU and 68882 FPU clocked at 15.67 MHz, the Apple Sound Chip (ASC), and 256K bytes of single in-line memory module-mounted ROM. Like the members of the Mac II family, the Mac SE/30 can hold up to 8 megabytes of RAM using 1-megabit-density SIMMs. Yet Apple stuffed all this into the housing of what it calls its "compact" family of computers, which includes the Mac Plus and the Mac SE. Like the Mac SE, the Mac SE/30 still has one slot, but the connector and form factor for the plug-in boards have changed. (For more information, see the First Impression of the Mac SE/30, "The Mac SE Takes Off" by Nick Baran, February BYTE.)

I use a Mac II with a SuperMac 19-inch monitor for my work. The Mac II and an IBM PC AT both sprawl over my desk, leaving room for little else. But I'm not about to give up the Mac II's computing power. So I looked forward to seeing if the small-footprint Mac SE/30 could deliver the performance of a Mac II.

Checking It Out

The Mac SE/30 that I reviewed was fully configured with an 80-megabyte hard disk drive and 4 megabytes of RAM. As is typical of the Mac design, system setup was simple—plug and play. It took several minutes to hook up the power cord, keyboard, and mouse. Formatting the hard disk and installing the version 6.0.3 System software took a bit longer.

I next checked the machine's networking capability. There are two reasons for this. First, computers today usually don't operate in isolation; they share resources and data on a network. Second, the BYTE Lab's test suite is about 8 megabytes in size. It's far easier to have the AppleShare network hike the test suite from the file server to the review machine than it is to move that many files by hand using floppy disks.

I initially configured the Mac SE/30 to operate as a file server using AppleShare 2.0. I encountered no problems with the installation, and file transfers showed a lot more zip while the Mac SE/30 was in service.

After a day's testing, I reconfigured the Mac SE/30 as an AppleShare workstation and copied the benchmark test suite to its hard disk. The benchmark results show that although it looks like a Mac SE, the SE/30's performance is on a par with that of the Mac II family. On many of the tests, the Mac SE/30 does as well as a Mac IIx, and in some instances, it outperforms it. Compared with a Mac SE, the SE/30 is about two to five times

continued

Mac SE/30

Company
Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010

Components
Processor: 15.67-MHz 68030; 68882 FPU (standard)
Memory: 1 megabyte, expandable to 8 megabytes
Mass storage: 1.44-megabyte 3½-inch floppy disk drive that reads and writes several different machine formats; 40- or 80-megabyte internal SCSI hard disk drive
Display: Built-in 9-inch diagonal black-and-white monitor; displays 512 by 342 pixels
Keyboard: 81-key standard keyboard with keypad ($129); 105-key extended keyboard with cursor and function keys ($229)
I/O interfaces: Two RS-232C/RS-422 serial ports with mini-DIN-8 connectors; two custom Apple Desktop Bus ports for keyboard and mouse; SCSI interface with DB-25 connector; stereo sound port; external floppy disk drive connector

Size
13½ × 9½ × 11 inches; 21½ pounds

Software
System 6.0.3/Finder 6.1; system installer utility; hard disk backup and repair utilities; font/desk accessory; printer drivers; HyperCard 1.2.1

Documentation
Owner's guide; system, utilities, and HyperCard user's guides

Price
Macintosh SE/30: $4369
Macintosh SE/30 with 40-megabyte hard disk drive: $4869
Macintosh SE/30 with 80-megabyte hard disk drive and 4 megabytes of RAM: $6569
System as reviewed: $6798

Inquiry 861.

faster. It especially shines in the computationally intensive scientific/engineering tests, where the built-in FPU helps with the number crunching.

Putting It to Work

My next text was to substitute the Mac SE/30 for the Mac II in my day-to-day work. I moved about 30 megabytes of files from the Mac II to the file server. Next, I set up the Mac SE/30 on top of the Mac II. (To give you an idea of the size difference between the machines, I placed an external Rodime 140 Plus hard disk drive—built to fit under a compact Macintosh—next to the SE/30 on top of the Mac II, and the Mac II was still easily several inches deeper.) I then copied my files from the server to the Mac SE/30 and went to work.

My usual INITs, such as MasterJuggler, SFScroll, Moire, and Vaccine, installed properly. The TMON 2.8.2 debugger (a patched version that works with the 68030 processor) and THINK C 3.0p4 development software operated flawlessly. I had no trouble editing work using MindWrite 2.1, or connecting to BIX with Red Ryder 10.3. Suitcase II 1.2.2 also worked without a hitch. The one application that didn't was Adobe's Illustrator 88 version 1.6: It threw me into the TMON debugger with a bus error. A beta version of Connectix's Virtual, an INIT that provides 8 megabytes of virtual memory, functioned reliably and let me keep six large applications on call under MultiFinder as I worked.

I was impressed with the Mac SE/30's speed. Some of it is perceived, because the Mac SE/30 has a smaller screen to update, and some of it is due to the processing edge of the 68030. Work under MultiFinder was smooth and responsive, and it was nice to use the background printing facility without causing the machine to seize up.

Except for the small 9-inch black-and-white display, many of the Mac SE/30's characteristics are identical to those of a Mac II. The monitor's cdev, used to set the pixel depth on the Mac II, is operational, although your only choices are black and white. The `SysEnvirons()` trap, used by an application to query the Mac operating system for the machine's characteristics, shows that the Mac SE/30 has Color QuickDraw. Most color applications run on the Mac SE/30, but the colors in a picture map to either black or white, producing posterized images.

I was surprised to find that I didn't miss the Mac II's big screen, although a lot of that has to do with an improvement in third-party software: ALSoft's MasterJuggler let me transfer quickly between applications under MultiFinder while keeping the screen uncluttered. MasterJuggler does this by first providing a pop-up menu of active applications that's invoked at any time with a key combination and mouse-click. As you move among the applications, MasterJuggler hides all the windows except those owned by the foreground application. Thus, what's on the screen belongs

continued

Mac SE/30

Mac SE/30 **17.0** *

APPLICATION-LEVEL PERFORMANCE

WORD PROCESSING

MacWrite	Medium/Large
Load	:03/:05
MultiWord word count	:04/:26
Search/replace	:37/4:06
End of document	:01/:02
Merge small	:07/:08
Store	:06/:23
Spelling check	:45/5:59
Microsoft Word 4.0	
Cursor down	1:21
Search and replace	:41
Store	:12
Aldus PageMaker 1.0a	
Load document	:06
Change/bold	:22
Align right	:20
Cut 10 pages	:16
Place graphic	:05
Print to file	:38
Index:	**2.68**

SPREADSHEET

Microsoft Excel 2.0	
Fill right	:08
Undo fill	4:33
Recalc	:02
Load rlarge3	:12
Recalc rlarge3	:02
Index:	**3.53**

DATABASE

dBASE III+ 1.1	
Copy	:18
Index	:05
List	1:15
Append	:08
Delete	:01
Pack	:04
Count	:02
Sort	:15
Index:	**2.99**

SCIENTIFIC/ENGINEERING

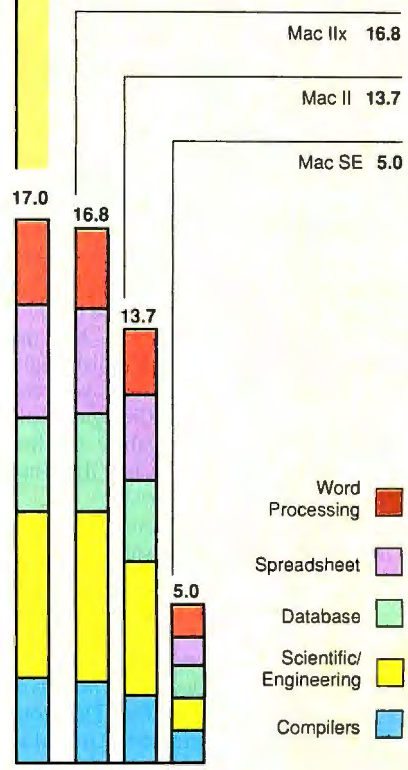
MiniCAD	
Load	:07
Hide and shade	2:29
Redraw	1:51
STATA 1.5	
Regression	:53
Correlation	1:07
Index:	**5.23**

COMPILERS

Microsoft C 5.0	
XLisp compile	:50
Turbo Pascal 4.0	
Pascal S compile	:06
Index:	**2.60**

All times are in minutes:seconds. Indexes show relative performance; for all indexes, a Mac SE = 1

* Cumulative application index. Graphs are based on indexes and show relative performance



LOW-LEVEL PERFORMANCE[1]

Mac SE/30

CPU

Matrix	16.14
String Move	
Byte-wide	81.60
Word-wide	42.10
Longword-wide	22.90
Sieve	31.38
Sort	29.67
Index:	**4.61**

FLOATING POINT[2]

Math	149.10
Error	
Sine(x)	73.67
Error	
e^x	98.34
Error	
Index:	**1.16**

DISK I/O

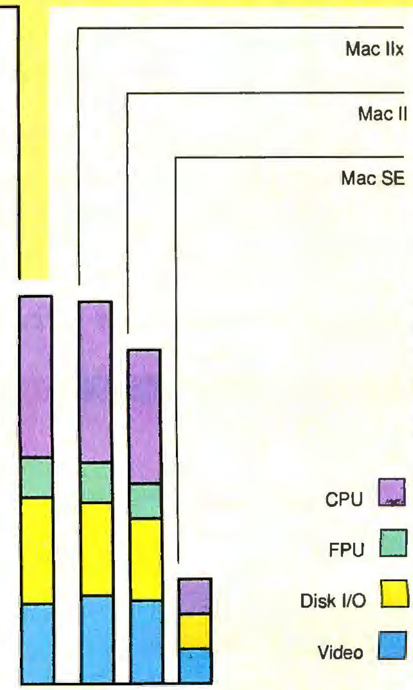
SubFinder Seek	
SCSI	
1 block	14.22
32 blocks	26.68
Floppy	
1 block	63.73
32 blocks	309.38
File I/O (SCSI)[3]	
Seek	0.11
Read	0.01
Write	0.01
1-megabyte (SCSI)	
Write	4.28
Read	4.80
Index:	**3.01**

VIDEO

Text	
Textedit	5.52
Drawstring	2.36
Graphics[4]	
Slow Mac	44.60
QuickDraw	0.31
Index:	**2.33**

CONVENTIONAL BENCHMARKS

LINPACK	232
Double LINPACK	241
Dhrystone (Dhry/sec)[5]	3754



N/A = Not applicable.

1 All times are in seconds. Figures were generated using the 68000 version of Small-C. Figures for the Mac II use 68020-specific instructions for the LINPACK and Double LINPACK tests only.

2 The Floating Point benchmarks use the SANE library.

3 Read and write times for File I/O are in seconds per 64K bytes.

4 The Slow test uses code written in Small-C to perform the circle draw and fill. The QuickDraw version uses QuickDraw commands to draw and fill the circle.

5 For the Dhrystone test only, higher numbers mean faster performance

For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE

The Mac Does DOS

When you work in an office with a medley of different computers, sooner or later you're going to get asked The Question: "Say, I've got these Excel/PageMaker files on a PC disk. Can you take a look at them and print them out for me?" I get this request a lot, since the IBM PC AT that I use is linked to the Mac II by a serial cable, allowing me to transfer files between the two.

However, the Mac SE/30, like the Mac IIx, has a new floppy disk high-density (FDHD) drive that lets you read and write to 3½-inch 800K-byte Apple II ProDOS or 1.44-megabyte PC-formatted floppy disks. This new drive has been dubbed the SuperDrive.

While I was doing this review, someone asked me to print out some PC Excel files that were on 3½-inch floppy disks. I launched the Apple File Exchange application and popped the disk into the internal drive slot. I selected the desired files and had the AFE move them to the hard disk drive while performing the default translation. The Mac version of Excel had no difficulty reading the files, and the results came off the laser printer in a matter of minutes.

The Mac SE/30's ability to read and write foreign disk formats is good. If you're on a limited budget, the Mac SE/30 and Mac IIx offer the ability to read the occasional PC disk that users might have to deal with. Mac SE and Mac II owners can upgrade their 800K-byte drives to FDHD SuperDrives for $599.

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only to the application you're working with, and it gives you access to the drives or file server shown on the Mac Desktop.

After its performance, the Mac SE/30's best feature is its price. The top-of-the-line Mac SE/30 reviewed here with an extended keyboard ($229) costs $6798. A similarly equipped Mac IIx costs $8098—without a monitor or video display board. Adding the cost of an Apple monochrome monitor and standard 16-color video board pushes the Mac IIx's price to $8996, making the price difference between the two systems a whopping $2198. If you need color or a large screen later on, the 030 Direct Slot offers you the option of buying a color board from third-party vendors.

If you own a Mac SE, don't despair—Apple hasn't forgotten you. For $1699, you can swap a motherboard to upgrade your Mac SE to a Mac SE/30. It's not cheap, but it's much better than being stranded, as a lot of Mac Plus owners are.

The Bad and the Good

My one complaint about the Mac SE/30 is that it can't run A/UX, Apple's version of Unix. Apple doesn't support A/UX on the Mac SE/30 at this time because it doesn't have to an 030 Direct Slot board that would provide network connections for both AppleTalk and Ethernet, something a typical Unix user demands. I hope something is done about this, because the Mac SE/30 seems ready-made as a reasonably priced Unix workstation with decent processing power.

The Mac SE/30 is a nice technical achievement. In terms of size and performance, it can best be characterized as a luggable Mac IIx, and the SuperDrive gives it the ability to read and write PC floppy disks (see the text box "The Mac Does DOS" at left). The Mac SE/30 is true to the original concept of the Mac, down to the whisper-quiet cooling fan and small desktop footprint, yet it incorporates the latest advances in technology. It also brings the architecture of the compact Mac family closely into line with that of the Mac II family by providing an FPU, the same amount of RAM, the same ROMs, and the same sound chip. This should simplify Mac software development, since it brings to a halt what was becoming a bewildering array of different internal hardware.

I'm impressed with the Mac SE/30's processing power—and I'm used to working with a Mac II. I do miss the color, though. If you need the power of a Mac IIx without color or a large screen, give the Mac SE/30 a serious look. ■

Tom Thompson is a BYTE senior technical editor at large. He can be reached on BIX as "tom_thompson."

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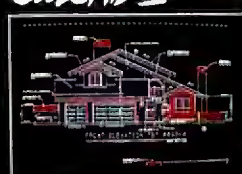

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Dead Heat

Choosing between the Tandon and FiveStar computers means looking beyond performance

John Unger

The Tandon 386/20 (left) and the FiveStar Model 320.

The Tandon 386/20 and the FiveStar Model 320 have joined a growing number of new PCs featuring 20-MHz 80386 CPUs. Computers in this category usually provide high-speed static RAM (SRAM) and I/O caching. They can use from 8 to 16 megabytes of 32-bit RAM and a 20-MHz 80387 coprocessor, and they can handle run-length-limited (RLL), ESDI, or SCSI hard disk drives and controllers.

This combination of speed and CPU is a good trade-off between cost and power. Processors faster than 20 MHz need more expensive components and more sophisticated designs to solve problems like FCC compliance and fast memory access. Besides, a 20-MHz 80386 PC can handle even the most demanding tasks and can run either OS/2 or Unix.

Tandon stands out from the crowd with an integrated system that accommodates an optional 30-megabyte Data Pac removable hard disk drive. The FiveStar Model 320's selling point is a low price tag for a solid system made up of proven, industry-standard hardware that allows a lot of flexibility for customization.

The Tandon 386/20 Model 40 sells for $5999 with 1 megabyte of RAM, a 64K-byte SRAM cache, a 1.2-megabyte 5¼-inch floppy disk drive, and a 40-megabyte 28-millisecond Seagate hard disk drive (but no video adapter or monitor). A similarly equipped FiveStar Model 320 costs $2495.

The Tandon 386/20 that I reviewed was the Model 110DP, which has a 110-megabyte 28-ms RLL Seagate hard disk drive and a Tandon 30-megabyte Data Pac. The reviewed system also had 2 megabytes of RAM and a VGA adapter and analog monitor. The price of this loaded system is $10,479. FiveStar's review machine had an optional 80-megabyte hard disk drive, 2 megabytes of RAM, a 1.44-megabyte 3½-inch floppy disk drive, and a VGA display adapter and multisync monitor. Configured like this, the FiveStar costs $5325.

Subtle Distinctions

The overall size, shape, layout, and hardware components of the Tandon and FiveStar are similar. Each computer has eight expansion slots, six of which are designed for 16-bit, AT-compatible cards. The Tandon's remaining two slots are for 8-bit PC-compatible cards. The two other FiveStar slots include an 8-bit slot and a proprietary 32-bit slot for memory expansion. The Tandon uses separate disk controllers for its floppy and hard disk drives, allowing you to choose either modified frequency modulation (MFM), RLL, or ESDI hard disk controllers. But this means you lose a slot to the hard disk drive. After adding video adapter and serial/parallel port cards in the two 8-bit slots, you have only four 16-bit slots free in the Tandon.

The FiveStar uses a floppy/hard disk drive controller card, which, when combined with a serial/parallel card and a video adapter, also gives you four free 16-bit slots, plus the 32-bit proprietary

continued

Tandon 386/20

Company
Tandon Corp.
405 Science Dr.
Moorpark, CA 93021
(805) 523-0340

Components
Processor: Intel 32-bit 80386 running at 20 MHz with zero wait states, switchable to 8 MHz; socket for optional 20-MHz 80387 math coprocessor
Memory: 1 megabyte of 80-ns DRAM, expandable to up to 8 megabytes on system board using optional 1-megabyte SIMM modules; 64K bytes of static RAM cache; AMI ROM BIOS 1.01
Mass storage: One 1.2-megabyte 5¼-inch floppy disk drive
Display: VGA card and analog color monitor
Keyboard: 101 full-size keys with 12 function keys; separate editing keys and numeric keypad
I/O interfaces: One RS-232C serial port with DB-9 male connectors; parallel printer port with DB-25 female connector; eight (six 16-bit and two 8-bit) expansion slots

Size
6¾ × 21¼ × 16½ inches; 40 pounds

Software
Microsoft MS-DOS 3.30 and custom utilities; Microsoft GWBASIC 3.22; Microsoft Windows/386; LIM/EMS 4.0 memory support software

Documentation
Operation and installation guide; MS-DOS, Windows, and GWBASIC documentation

Price
Model 40, with 1 megabyte of RAM, 64K-byte SRAM cache, 1.2-megabyte 5¼-inch floppy disk drive, and 40-megabyte hard disk drive: $5999
System as reviewed (Model 110DP), with 1.2-megabyte 5¼-inch floppy disk drive, 2 megabytes of RAM, 64K-byte SRAM cache, 110-megabyte hard disk drive, Tandon 30-megabyte Data Pac, and VGA color adapter and display (80387 not included): $10,479

Inquiry 864.

FiveStar Model 320

Company
FiveStar Computers
1621 West Crosby Rd.
Carrollton, TX 75006
(800) 752-5555

Components
Processor: Intel 32-bit 80386 running at 20 MHz with zero wait states, switchable to 8 MHz; socket for optional 20-MHz 80387 math coprocessor
Memory: 1 megabyte of 80-ns DRAM, expandable to up to 8 megabytes on system board using optional 1-megabyte SIMM modules; 64K bytes of 35-ns static RAM cache; AMI ROM BIOS
Mass storage: One 1.2-megabyte 5¼-inch floppy disk drive
Display: VGA card and analog color monitor
Keyboard: 101 full-size keys with 12 function keys; separate editing keys and numeric keypad
I/O interfaces: Two RS-232C serial ports, one with DB-9 male connector and one with DB-25 male connector; parallel printer port with DB-25 female connector; eight expansion slots (six 16-bit, one 8-bit, and one 32-bit proprietary memory-expansion connector)

Size
6½ × 21⅛ × 16½ inches; 39 pounds

Software
None

Documentation
User's manual

Price
System with 1.2-megabyte 5¼-inch floppy disk drive, 1 megabyte of RAM, and 64K-byte SRAM cache: $2495
System as reviewed, with 1.2-megabyte 5¼-inch floppy disk drive, 1.44-megabyte 3½-inch floppy disk drive, 2 megabytes of RAM, 80-megabyte hard disk drive, 80387 math coprocessor, VGA display adapter, and multisync color display: $5325

Inquiry 865.

slot. The serial/parallel card on the FiveStar gives you two serial ports.

You can upgrade the memory on either system to 8 megabytes by adding 1-megabyte single in-line memory modules on the motherboard. You can also use 256K-byte SIMMs on the motherboard to obtain a total of 2 megabytes of RAM. For the Tandon 386/20, the motherboard SIMMs are the only way to add 32-bit memory. For the FiveStar Model 320, you could also use the proprietary 32-bit expansion bus for RAM expansion; this option would only be an issue if you had 256K-byte SIMMs in your system and wanted to have the full 8 megabytes of RAM without replacing them with 1-megabyte SIMMs.

Both of these systems use memory caching, which makes it possible for the processor to run with zero wait states much of the time. The caches use 64K bytes of 35-nanosecond SRAM, but neither computer employs the more sophisticated Intel 82385 cache memory controller in combination with the SRAM, as other 20-MHz 80386-based computers (such as the Dell 310 and Compaq 386/20e) do.

Using a memory cache means that, during normal program execution, approximately 80 percent of the data will be available from the cache at zero wait states. If the processor doesn't find the data it needs in the cache, then it accesses normal RAM at the expense of extra clock cycles. The memory cache increases the system's memory I/O speed by a factor of about two, since main memory access would need two wait states with no cache.

You can switch the CPUs of both computers to run at 8 MHz from the keyboards if you have problems running older, speed-sensitive software. The 8- and 16-bit expansion slots run at a constant clock rate of 8 MHz. The optional 80387 coprocessor runs at 20 MHz.

Both computers use the same ROM BIOS from American Megatrends, Inc. (AMI). The BIOS version used in the Tandon system is dated January 13, 1988, and the version used in the FiveStar is dated September 25, 1988. This chip set provides a full suite of ROM-based system diagnostics and setup routines.

The FiveStar Model 320's motherboard is the popular model MI386-20 made by Mylex. This board has a good reputation. The Tandon motherboard carries the Tandon name. Both motherboards appear well-made and have clean designs with easy access to key components such as the coprocessor and SIMM sockets.

Storage to Go

Both microcomputers have enough space and power supply capacity (190 watts for the Tandon and 200 W for the FiveStar) to accommodate a large number of mass storage devices. Each has two main storage bays; the right bay can hold up to three half-height devices, and the center one can house either two half-height or one full-height hard disk drive. The Tandon 386/20's Data Pac hard disk drive module mounts in the center bay.

The disk drive controller board in my

continued

FiveStar Model 320, Tandon 386/20

APPLICATION-LEVEL PERFORMANCE

WORD PROCESSING	FiveStar	Tandon
XyWrite III+ 3.52	**Med./Large**	**Med./Large**
Load (large)	:13	:14
Word count	:02/:16	:02/:16
Search/replace	:05/:18	:05/:21
End of document	:01/:10	:01/:13
Block move	:09/:09	:09/:09
Spelling check	:07/:50	:07/:50
Microsoft Word 4.0		
Forward delete	:11	:12
Aldus PageMaker 1.0a		
Load document	:10	:13
Change/bold	:24	:24
Align right	:18	:19
Cut 10 pages	:16	:17
Place graphic	:04	:04
Print to file	1:51	1:52
Index:	**3.07**	**2.91**

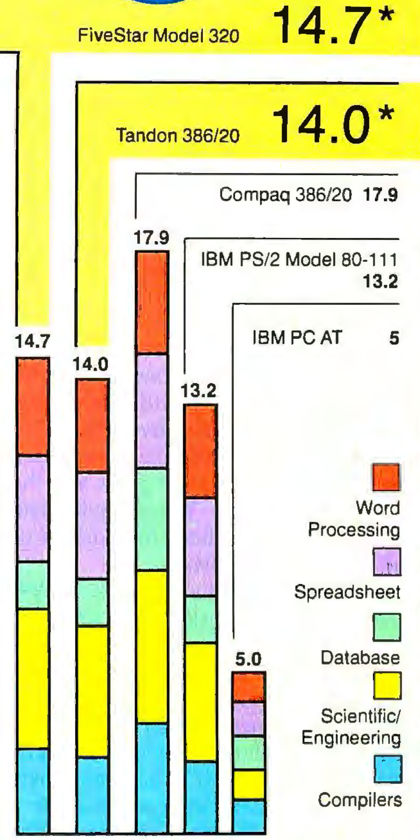
SPREADSHEET	FiveStar	Tandon
Lotus 1-2-3 2.01		
Block copy	:03	:03
Recalc	:01	:01
Load Monte Carlo	:16	:16
Recalc Monte Carlo	:04	:04
Load rlarge3	:04	:04
Recalc rlarge3	:01	:01
Recalc Goal-seek	:03	:03
Microsoft Excel 2.0		
Fill right	:04	:04
Undo fill	1:29	1:29
Recalc	:01	:01
Load rlarge3	:21	:22
Recalc rlarge3	:01	:01
Index:	**3.21**	**3.19**

DATABASE	FiveStar	Tandon
dBASE III+ 1.1		
Copy	1:05	:50
Index	:20	:20
List	1:36	1:54
Append	1:50	1:42
Delete	:02	:02
Pack	1:20	1:20
Count	:17	:17
Sort	1:20	1:18
Index:	**1.49**	**1.52**

SCIENTIFIC/ENGINEERING	FiveStar	Tandon
AutoCAD 2.52		
Load SoftWest	:38	:40
Regen SoftWest	:28	:28
Load StPauls	:09	:10
Regen StPauls	:05	:05
Hide/redraw	9:35	9:38
STATA 1.5		
Graphics	:23	:38
ANOVA	:11	:12
MathCAD 2.0		
IFS 800 pts.	:13	:13
FFT/IFFT 1024 pts.	:13	:13
Index:	**4.31**	**3.97**

COMPILERS	FiveStar	Tandon
Microsoft C 5.0		
XLisp compile	3:34	3:51
Turbo Pascal 4.0		
Pascal S compile	:05	:05
Index:	**2.59**	**2.41**

All times are in minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT=1



*Cumulative application index. Graphs are based on indexes at left and show relative performance.

LOW-LEVEL PERFORMANCE[1]

CPU	FiveStar	Tandon
Matrix	3.48	3.54
String Move		
Byte-wide	31.36	31.36
Word-wide:		
Odd-bnd.	31.27	31.29
Even-bnd.	15.67	15.67
Doubleword-wide:		
Odd-bnd.	23.47	23.45
Even-bnd.	7.86	7.85
Sieve	18.84	18.82
Sort	14.39	14.32
Index:	**3.31**	**3.30**

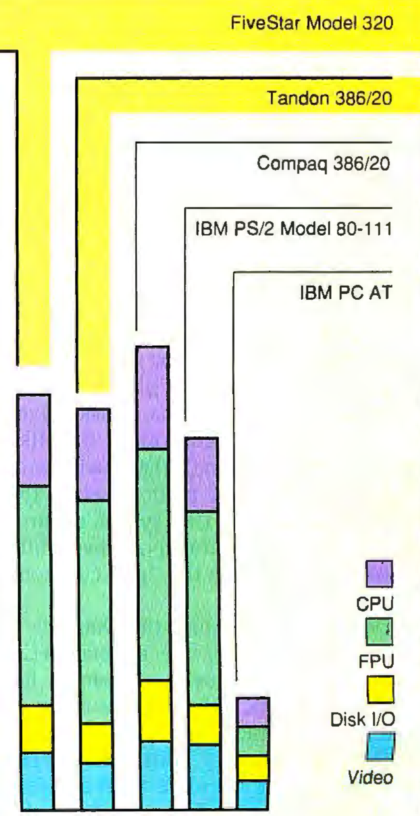
FLOATING POINT	FiveStar	Tandon
Math	6.48	6.49
Error[2]		
Sine(*x*)	2.09	2.09
Error		
e^x	2.32	2.29
Error		
Index:	**7.99**	**8.02**

DISK I/O	FiveStar	Tandon
Hard Seek[3]		
Outer track	3.28	3.30
Inner track	3.29	3.30
Half platter	10.00	10.00
Full platter	14.45	13.32
Average	7.75	7.48
DOS Seek		
1-sector	10.52	12.78
32-sector	28.30	41.90
File I/O[4]		
Seek	0.11	0.07
Read	1.05	1.14
Write	0.86	1.01
1-megabyte		
Write	4.72	5.97
Read	5.38	6.92
Index:	**1.66**	**1.49**

VIDEO	FiveStar	Tandon
Text		
Mode 0	5.49	7.83
Mode 1	5.51	7.83
Mode 2	5.40	7.65
Mode 3	5.42	7.65
Mode 7	N/A	N/A
Graphics		
CGA:		
Mode 4	1.44	1.56
Mode 5	1.44	1.57
Mode 6	1.54	1.63
EGA:		
Mode 13	3.16	3.37
Mode 14	3.41	3.70
Mode 15	N/A	N/A
Mode 16	3.41	3.64
VGA:		
Mode 18	3.51	3.82
Mode 19	1.54	1.63
Hercules	N/A	N/A
Index:	**2.11**	**1.71**

CONVENTIONAL BENCHMARKS

	FiveStar	Tandon
LINPACK	177.19	177.52
Livermore Loops[5] (MFLOPS)	0.16	0.16
Dhrystone (MS C 5.0) (Dhry/sec)	5910	5910



N/A=Not applicable.

1 All times are in seconds. Figures were generated using the 8088/8086 and 80386 versions (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.

For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

FiveStar Model 320 accommodates up to two floppy disk drives and two hard disk drives. Tandon's standard setup includes a floppy disk drive controller for two drives. Adding an optional hard disk drive to the system requires installing its controller in one of the 16-bit expansion slots. This arrangement prevents you from adding an inexpensive MFM hard disk drive to the system without also purchasing a controller.

Tandon offers three hard disk drive controllers as options. One accommodates four MFM fixed hard disk drives; the second allows you to have four RLL fixed hard disk drives; the third has a 128K-byte disk cache and gives you the option of having two 30-megabyte Data Pacs and two RLL hard disk drives or four RLL hard disk drives.

The Tandon Personal Data Pac ($599) is a removable hard disk drive system that comes packaged either as an external unit to add to any 80286 or 80386 MS-DOS microcomputer or as an integrated internal component of certain Tandon computers, including the 386/20. The Data Pac ($399) itself is a 30-megabyte 3½-inch hard disk drive mounted in a 2½- by 4¾- by 7-inch plastic case. The hard disk drive is suspended inside the plastic case by specially designed shock absorbers that isolate it from the case. It can withstand shocks up to 250 g's or, as Tandon puts it, a drop of 18 inches onto a hard floor.

Inserting a Data Pac into its drive is much like putting a video cartridge into a VCR; you push the Pac partway into the receptacle until you feel some resistance. Then an internal auto-insertion mechanism takes over and pulls the Pac in the rest of the way and seats the 36-pin electrical connector.

The Data Pac's hard disk drive is designed for ruggedness and speed. Instead of simply parking the four heads on unused portions of the platters when powered down, as most hard disk drives do, the Data Pac incorporates fork-like fingers to lift and lock the heads completely off the disk platters when the drive is turned off. This system ensures against jolts during transport that might move the heads from the "parked" zone onto data sectors.

Two features enhance the Data Pac's performance. First, the special RLL controller has 128K bytes of memory for caching disk I/O, allowing the drive to read data by track rather than sector. Second, the directory information is put onto the platter's middle tracks rather than on the outside. This cuts down the average distance the heads have to move to find a track after reading the directory's file allocation table.

Face to Face

These two systems are so similar in their specifications that you would not expect to see much difference in their performance—a suspicion borne out by the BYTE benchmark results. Both outperform the IBM PS/2 Model 80-111 by a small margin and fall slightly below the Compaq 386/20. Compared to other 20-MHz 80386 computers that BYTE has recently tested (see the Review Update, "Benchmarks at a Glance," in the December 1988 BYTE), the Tandon and FiveStar machines perform respectably, falling near the middle of the group.

Perhaps more important, these computers feel fast in terms of screen updates, disk I/O, and general computational performance, such as compiling C source code or recalculating spreadsheets. They left no doubt that I was using a couple of hot machines!

Essentials and Extras

Tandon includes a generous collection of software with the 386/20. Not only do you get MS-DOS 3.30 customized for Tandon machines, but you also receive Microsoft Windows/386, GWBASIC 3.22, and a LIM/EMS 4.0 support program, all with full documentation. The operation and installation guide takes the new owner through all the steps necessary to get the Tandon 386/20 up and running. It provides details for adding extra SIMMs and an 80387 coprocessor as well as other system components. Tandon also includes an easy-to-follow pictorial setup guide.

The FiveStar came with a photocopy of a 37-page preliminary user's manual with a table of contents but no index. This manual is adequate for getting the system set up and operating, but it falls short in terms of completeness when compared to the Tandon's documentation. I also received a copy of the Mylex technical reference manual for the motherboard, which was helpful for learning about some of the system's features and technical details. The FiveStar Model 320 does not come with any standard software.

With computers like these two, most software compatibility issues depend on the choice of video adapter and monitor and not on the computer itself. I ran WordPerfect 5.0, Microsoft's Flight Simulator 3.0, Quattro 1.0, Reflex 1.5, and all of Sierra's King Quest series of games on both machines without any problems. Using Borland's Turbo C 2.0 with the Turbo Debugger was a pleasure on such fast hardware.

After-Sale Service

A major difference between the two manufacturers is that Tandon is large and established with a proven track record whereas FiveStar is a relatively small-size newcomer. FiveStar's relative inexperience is shown by a slight mix-up concerning video components for my review computer. The optional XTRON multiscan monitor that FiveStar sent had a 9-pin EGA connector, and the Paradise VGA Professional video card installed in the computer had an incompatible 15-pin VGA connector.

FiveStar provides a one-year limited warranty on parts and labor, which includes toll-free technical support. For $99 you can get one year of on-site service with 48-hour turnaround. Tandon offers a simple one-year warranty. In both cases, you are responsible for shipping the damaged hardware back to the manufacturer for warranty repairs.

Perceived Values

Despite the similarities of these two computers, their price tags are surprisingly different. As reviewed, the Tandon 386/20 at $10,479 costs 30 percent more than a FiveStar Model 320. The Tandon does come with a lot of operating-system and utility software not included with the FiveStar, but not $5154 worth. The Tandon is overpriced compared to the FiveStar and its other competitors in the 20-MHz 80386 market. Its only unique feature, the removable Data Pac hard disk drive, is available from Tandon as an external add-on for use with any 80286 or 80386 computer. Unless you can find this computer heavily discounted, buy a machine like the FiveStar.

The FiveStar is a bargain compared not only to the Tandon 386/20, but also to most other 20-MHz 80386 computers. The absense of operating-system software and thorough documentation are not much of a deterrent to experienced MS-DOS users interested mainly in performance per dollar. Since you can buy the computer as a bare-bones system with one 1.2-megabyte 5¼-inch floppy disk drive, a 64K-byte SRAM cache, and 1 megabyte of RAM for only $2495, you can customize the system with components of your choice. ■

John Unger is a geophysicist for the U.S. government and lives in Hamilton, Virginia. He writes graphics software and uses computers to study the earth's crust. You can reach him on BIX as "junger."

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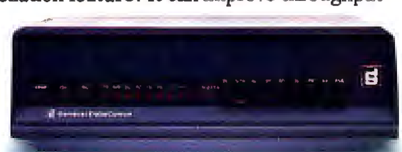

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Handy Scanners

Clockwise from top left: Skyworld Technology's SkyScan, Comar Systek's Niscan, KYE International's GS-2000 Plus, DFI's HS-3000, The Complete PC's Complete Hand Scanner/400, and Logitech's ScanMan.

These six PC-compatible devices perform best on small scanning jobs

Mark L. Van Name
and Bill Catchings

Hand-held scanners offer an inexpensive way to digitize images. While they aren't as easy to use or as powerful as flatbed scanners, they cost much less than their bigger cousins. This makes them attractive for applications that don't require high-quality images. We examined six PC hand-held scanners (their features are summarized in table 1), and we discovered that there's much to understand about these seemingly simple devices.

Scanner Basics

The scanner itself looks like an overgrown mouse with a 6-foot tail. That cord connects to a half-length interface board that plugs into an 8- or 16-bit PC expansion slot. These boards' use of interrupts, direct-memory-access channels, or I/O addresses might conflict with other boards in your system; you can usually change their settings if you get a conflict.

The scanners also include driver software that lets you edit, save, and print the scanned image. To scan an original, first you place it on a flat surface. Then, with the software ready to receive an image, you position the scanner at one end of the original, press the activation button, and slowly drag the scanner across the original.

As you move the scanner, you can monitor your progress. All the units we tested except SkyScan have a small view window through which you can see the original. SkyScan, The Complete Hand Scanner/400, the HS-3000, and the GS-2000 Plus also display the image on your monitor as you scan.

The process sounds easier than it is. These scanners are sensitive: It's easy to actually scan an image, but it's difficult to get a good result. Getting a good image is an art, not a science, and the process varies among scanners. You must scan slowly and carefully—if you move too fast or twitch slightly, you can mess up the result. And holding a true course is hard. For example, all the scanners except The Complete Hand Scanner/400 insist that you hold in a button while you scan, and the force of pushing that button on the side of the unit can cause a crooked scan.

To get a good image, you also must consider the scanner's options. All these scanners except Niscan have controls to set different scanning parameters. (Niscan's controls are in software.)

All the scanners offer two basic controls. One lets you adjust the darkness of the final image, determining how dark a point on the original must be before the scanner will read it as black. The other control lets you tell the scanner to read the original either as a black-and-white image (line art) or as one that has meaningful shades of gray (photographs).

continued

Table 1: *Features available on the six hand scanners.*

Name	Price	Required memory (K bytes)	Graphics modes supported	Max. dpi (physical)	Other resolutions	Max. scan width (inches)	Max. scan length (inches)	Interface	Unit size (h×w×d) (inches)
The Complete Hand Scanner/400	$299	640	CGA, EGA, VGA, Herc.	400	200, 300	2.5	14	DMA, IRQ	1⅛×3½×4¾
HS-3000	$329	640	CGA,EGA, VGA, Herc.	200	100, 300, 400	4.13	20	DMA, IRQ (opt.)	1¼×5¼×3½
GS-2000 Plus	$299	512	CGA, EGA, VGA	200	100, 300, 400	4.1	6	DMA	1¼×5¼×3½
ScanMan	$339	384	CGA, EGA, MCGA, VGA, Herc.	200	100, 300, 400	4.14	41.5	DMA	1¼×5¼×3½
Niscan	$299	640	CGA, EGA, VGA, Herc.	200	100	4	11	I/O ports only	1¼×5×6¼
SkyScan	$349	384	CGA, EGA, VGA, Herc.	200	None	4.16	18	DMA (opt.)	1⅛×5¼×2¾

Notes: .CUT=Dr. HALO
.IMG=GEM
.MSP=Windows Paint
.OCR=OCR Systems ReadRight
.PCX=PC Paintbrush/Publisher's Paintbrush
.PIX=WordStar 2000 Inset format
.SSC=SkyScan format
.SED=GeniScan ScanEdit format
.TIF=Tag Image File Format
.001=The Complete Fax file format

SkyScan offers only these two options. If you want to capture photos, the others let you choose from three different ways of representing the gray tones. All the scanners except SkyScan also have a third control that lets you choose the scanning resolution. While many claim resolutions of 300 and 400 dots per inch, only The Complete Hand Scanner/400 does true 400-dpi scanning.

Finally, the scanning width is necessarily small. With the exception of The Complete Hand Scanner/400, which has a maximum scan width of about 2½ inches, all the units have roughly a 4-inch wide (10½ cm) scan width. The maximum length of the scanned image varies with the resolution you use and the amount of memory in your PC.

If you want to scan an image that's larger than the scanner's maximum scan width, be prepared for a major struggle. You must scan the original in strips and then use either the scanner's software or a compatible paint program to edit those strips into a single larger image. The good news is that the software included with most of the scanners can save images in more than one file format. The software also typically lets you crop images and edit them in other simple ways, as well as save and print them.

Looking Inside

Before the software can do anything, the scanner must send it an image. The scanner reads the original a line at a time. LEDs shine a red or yellow-green light onto the original, and a series of sensors in the scanner eventually picks up the reflection of that light off the original.

There are two approaches to capturing that reflection. The most common involves charge-coupled devices (CCDs). All the scanners except SkyScan are CCD units. In a CCD scanner, the original reflects the light to a mirror, which reflects that light onto a second mirror, which then reflects the light through a lens and onto an array of CCD sensors. This convoluted route is about 40 millimeters long and is necessary because the CCD sensors require some optical reduction of the reflected light.

The ScanMan, GS-2000 Plus, and HS-3000 use a basic scanning engine from Omron Electronics. ScanMan has an Omron red-light scanner, while the other two use a yellow-green one. Scanners can't see colors that match that of their LED light source, so a scanner that uses a yellow-green light will perform better with color images.

SkyScan uses contact image sensors (CISes), a newer and more expensive technology. Here, the light reflects from the original directly to the sensors, without any mirrors, giving a short (5 mm) optical path. This shorter path loses less light intensity than the longer one in CCD scanners and should result in a clearer picture.

Regardless of the basic approach, the number of sensor elements, along with the maximum scan width, determines the maximum physical resolution of the scanner. For example, all the CCD scanners use a 1024-element CCD array. They discard the values of roughly 90 elements on each side of the image, however, because the lens distorts images more on the sides. That leaves over 800 elements (832 for Omron-based scanners, 840 for Niscan) for the image. Therefore, with a scan window of a little over 4 inches, these units have a maximum physical resolution of 200 dpi.

The exception to this is The Complete Hand Scanner/400, which has a true maximum physical resolution of 400 dpi. It uses the same 1024-element CCD array, but with a smaller 2½-inch maximum scan width. It also discards the values of fewer of the sensors on the edges.

In the vertical axis, the maximum physical resolution is determined by how often the scanner's interface board can read the results of the sensor array and be ready for the next line. All these scanners have matching horizontal and vertical resolutions.

Many scanners also offer "effective" resolutions of either 300 or 400 dpi. They simulate the extra horizontal resolution by interpolating between the values of adjacent sensor elements, thereby doubling the number of effective elements. In the vertical axis, they simply double each line.

Image Translation

The sensor elements themselves interpret the reflected light they receive as one of a

LED color	File formats supported	Software
R	.001, .CUT, .IMG, .MSP, .PCX	SmartScan
Y/G	.CUT, .IMG, .MSP, .PCX	Scan, HALO DPE
Y/G	.CUT, .IMG, MSP, .OCR, PCX, .SED	ScanEdit, Dr. HALO III
R	.PCX, .TIF	PaintShow Plus, Scan2TIF, Scan2PCX
R	.CUT, .IMG, .PCX, .TIF	GEM Scan
Y/G	.CUT, .IMG, .MSP, .OCR, .PCX, .PIX, .SSC, .TIF	SkyScan

fixed number of gray scales. The sensors in all six scanners can handle 4 bits of gray-scale data for up to 16 gray scales.

Gray scaling is an output technique that produces grays by using dots consisting of different shades of gray. Strictly speaking, none of today's laser printers can print gray scales, because all laser printer dots are the same darkness. Another much-abused term is *halftoning*. A halftoned picture is one whose dots are of different sizes. Again, laser printers can't do halftones, since all laser printer dots are the same size.

But laser printers can use dithering to simulate grays. Dithering represents a dot's gray shade with not one printed dot, but several. It involves a matrix of dots into which you translate each gray value. For example, to simulate 16 gray shades, you might use a 4×4 dithering array. There's one matrix pattern for each possible gray shade. Dithering algorithms also often vary matrix assignments from one dot to the next, to avoid lines or other repetitive patterns in sections of the image that contain many dots with the same gray shade. By using many dots to represent the characteristics of one, dithering sacrifices resolution for the appearance of additional gray shades.

In hand scanners, sensor element values are one of 16 gray scales. The image they represent, however, will be output on a laser printer that can't directly print gray scales. The scanner could just send the gray-scale data to the PC and let the software use dithering to make the printed image reasonably represent the scanned image; however, sending 4 bits per sensor element would be too much for many PCs. So, all the scanners turn the gray scale of each sensor element into a simple 0 or 1, for white or black.

How each scanner performs this translation varies, but they all use the same basic technique. Scanner vendors call this technique everything from *halftoning* to *hardware dithering*. We prefer the term *image translation* because it's not already fraught with meaning.

Image translation is much like dithering. The scanner reads a sensor element and compares that element's gray value with the next available element in a matrix. Based on that comparison, the scanner sends either a 0 or a 1 for that sensor element.

For example, if the Niscan sensor's gray value is greater than or equal to the value of the comparison matrix element, the scanner sends a 1. Otherwise, the scanner sends a 0. Niscan also varies its lookup matrix between dots so that lines won't appear in the final image. The three different gray-scale translation options mentioned earlier are typically just different matrices that the scanner uses in its image translation.

Now you have black and white dots coming from the scanner, and laser printers can handle those dots. Problems arise, however, when the resolutions of the scanned image and the printer are different. Most of today's laser printers print at 300 dpi. If you use the 300-dpi setting that most of these scanners offer, then the image produced will be the one you see on the printer. When you want to print a 200- or 400-dpi image, however, you must make some hard choices.

If the scanned image's resolution is 400 dpi (or any other resolution greater than 300 dpi), you have two choices. You can print at that resolution, but the printed image will be bigger than the original: Every inch across on the original will take 1⅓ inches on the printed page. If you want to preserve the size of the original, the software must throw away some of the dots it got from the scanner. Neither option is great. After comparing the printed output of The Complete Hand Scanner/400 with the others, we think 400-dpi scanning is not worth much without a 400-dpi printer.

Similar problems occur when the scanned image's resolution is less than the printer's 300 dpi. Again, you can print exactly the same dots if you're willing to have the printed output a different size than the original. In this case, the printed version will be smaller than the original, because the 200 dots that represent an inch of the original will take only two-thirds of an inch on the laser printer. If you want the printed image to stay the same size as the original, the output software must add some extra bits to turn those 200 dpi into 300 dpi.

COMPANY INFORMATION

The Complete PC, Inc.
(Complete Hand Scanner/400)
Cottonwood Dr.
Milpitas, CA 95035
(800) 634-5558
Inquiry 856.

DFI, Inc.
(HS-3000)
2544 Port St.
West Sacramento, CA 95691
(916) 373-1234
Inquiry 857.

KYE International Corp.
(GS-2000 Plus)
12675 Colony St.
Chino, CA 91710
(714) 590-3940
Inquiry 858.

Logitech, Inc.
(ScanMan)
6505 Kaiser Dr.
Fremont, CA 94555
(415) 795-8500
Inquiry 859.

Nisca, Inc.
(Niscan)
1919 Old Denton Rd., Suite 104
Carrollton, TX 75006
(800) 245-7226
Inquiry 862.

Skyworld Technology, Ltd.
(SkyScan)
1772 Lark Lane
Sunnyvale, CA 94087
(408) 446-9392
Inquiry 863.

The Products

We tested the scanners with an 8-MHz AT clone, a Hewlett-Packard LaserJet IID, and BYTE's scanning template. Figure 1 shows the template and a laser-printed output of the best scan from each unit. The template is challenging because it contains both black-and-white line art and a photograph.

The Complete Hand Scanner/400. Al-

continued

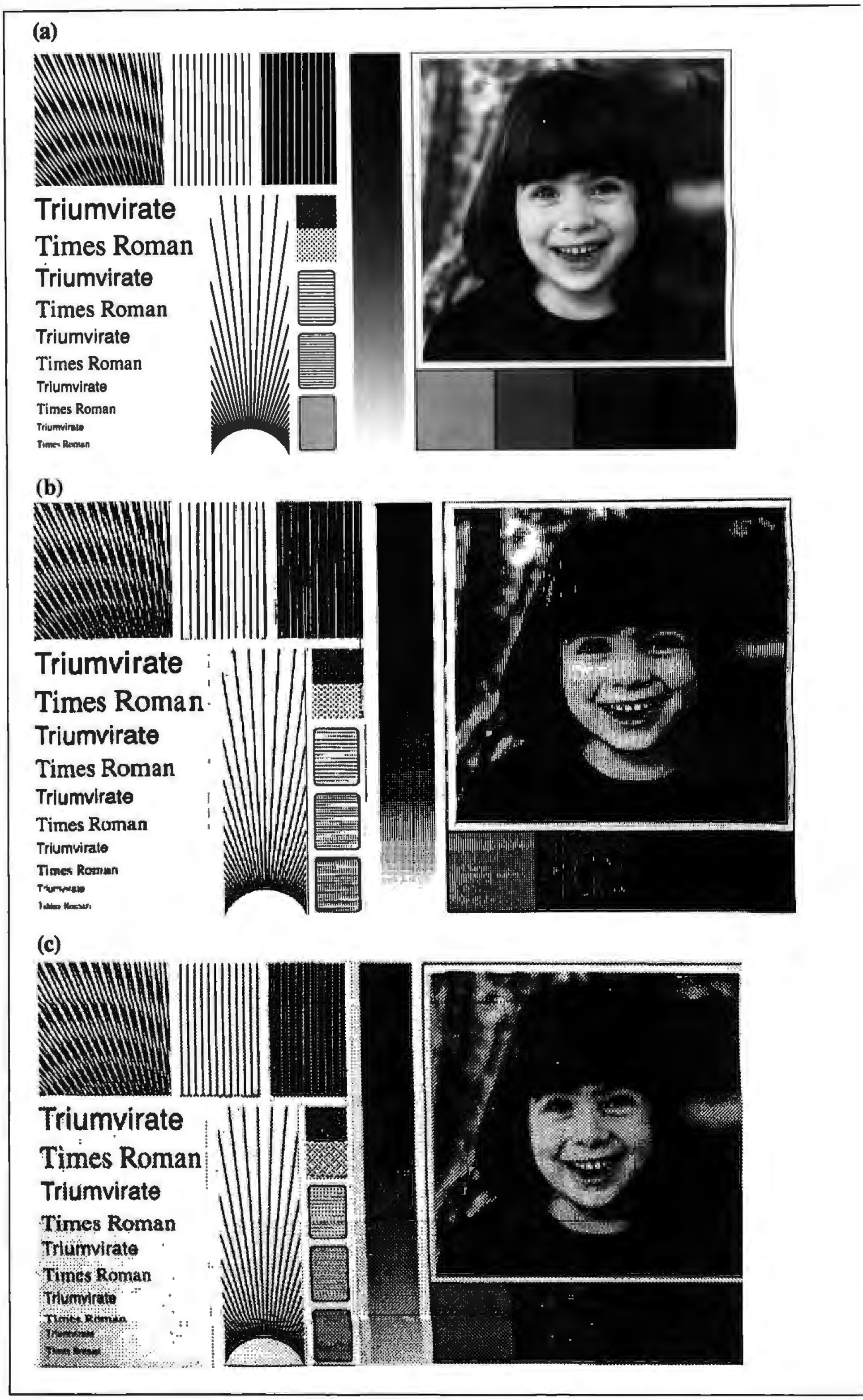

Figure 1: *The BYTE scanner template* **(a)** *and the best results we could obtain for each scanner tested. We performed all scans at medium brightness.* **(b)** *The Complete Hand Scanner/400 at 300 dpi with spiral dithering.* **(c)** *The HS-3000 at 300 dpi with middle-dot translation.* **(d)** *The Niscan at 200 dpi with gray spiral.* **(e)** *The ScanMan at 300 dpi with small-dot translation.* **(f)** *The SkyScan at 200 dpi with halftone setting. Missing is the GS-2000 Plus, which produced only a partial image at its best setting.*

though this unit offered the only true 400-dpi resolution of the bunch, we got the best overall printed images with the 300-dpi setting. The line drawings were a touch clearer at 400 dpi, but not enough to compensate for the better photo scan at 300 dpi. This difference is almost certainly because 300 dpi matches the printer's resolution.

The cost of the extra physical resolution is its very small maximum scan width. While the unit includes a utility that lets you patch scans together, that's a job you should avoid.

Of the reviewed scanners, this package had the nicest manual and one of the best installation programs. The software checked the system for possible hardware conflicts and suggested alternate settings where applicable. In addition, its square shape made it one of the easier scanners to drag.

HS-3000. The HS-3000's software is its biggest problem. You can't print from the Scan program that drives the scanner; instead, you must use the included HALO DPE. You can stay in HALO DPE the whole time, but if you scan from it, you can't see the scanned image until you finish.

HALO DPE has one of the worst user interfaces we've seen. It proves that icons alone don't guarantee ease of use. No one would think to look under the scissors icon to load a stored image, for instance. HALO DPE may handle most basic image-editing needs, but it's painful to use.

While the HS-3000 only simulates resolutions greater than 200 dpi, its 300-dpi scans were very good.

GS-2000 Plus. KYE International's scanner proves that all scanning packages that use Omron scanners aren't created equal. Like the HS-3000, it offers *simulated* resolutions greater than 200 dpi, but its scanning program couldn't handle the entire BYTE template at higher resolutions. It never gave an error, but it always threw away at least half the image—probably because of its unreasonably small 128K-byte scanned image buffer. KYE International plans to fix this limitation in a future release. The image halves that it did produce at the higher resolutions were attractive.

We also had a devil of a time printing with the scanner software. We gave up and printed with another paint program, which illustrates the value of being able to save images in multiple file formats.

ScanMan. Our final Omron-based

scanner produced a very good simulated 300-dpi picture. Unfortunately, printing that picture was a chore. ScanMan required installing a TSR program, called Catch, before we could print. To try different resolutions, we had to change the printer settings in both Catch and ScanMan's PaintShow Plus program.

Unlike HALO DPE, PaintShow Plus is a full-blown paint program that's easy to use. You can scan from the program or from either of two utilities that send the scanned image directly to a file without displaying the image in the process.

Niscan. Niscan doesn't try to simulate a resolution greater than 200 dpi, and that omission is often visible in the printed output. While its 200-dpi images were among the best of the 200-dpi scans we made, the simulated 300-dpi scans from the other packages were better.

Niscan was also the biggest scanner and, as a result, one of the hardest to maneuver. On the other hand, Niscan had the best software environment, in large part because it uses DRI's GEM. It was also nice to be able to control the scanner completely from software and not have to worry about synchronizing hardware and software settings.

SkyScan. Our only CIS scanner was also the only one to offer no resolution options. It did 200 dpi and nothing else. However, its 200-dpi images were nearly on a par with the simulated 300-dpi output of many of the other units.

SkyScan was by far the easiest scanner to drag. Its square shape and large rollers fore and aft of the scanning area (the others have a roller on only one side) made it easy to scan straight. That's fortunate, since it has no viewing window for checking the original as you scan. You can, however, display the image during scanning using the SkyScan program, which also features some of the easiest-to-use printer controls, including options to place the image anywhere on a page and to add descriptive headings.

Which Way to Go?

Price won't help you choose among these scanners, since the units vary by only $50. Image quality is also a toss-up: At the least, The Complete Hand Scanner/400, the HS-3000, and the ScanMan were all too close to call on their ability to reproduce the photo—and the other packages weren't far behind. The Complete Hand Scanner/400 did have a slight lead in line-drawing reproduction.

When we began working with these scanners, we were underwhelmed. If you must have images approaching photographic reproduction, don't look to hand scanners. Nevertheless, their reasonable (albeit imperfect) printed images should be satisfactory for some applications. We're convinced that any of these scanners can produce an image that would adorn any newsletter. ■

Mark L. Van Name and Bill Catchings are independent computer consultants based in Raleigh, North Carolina. You can reach them on BIX c/o "editors" and as "wbc3," respectively.

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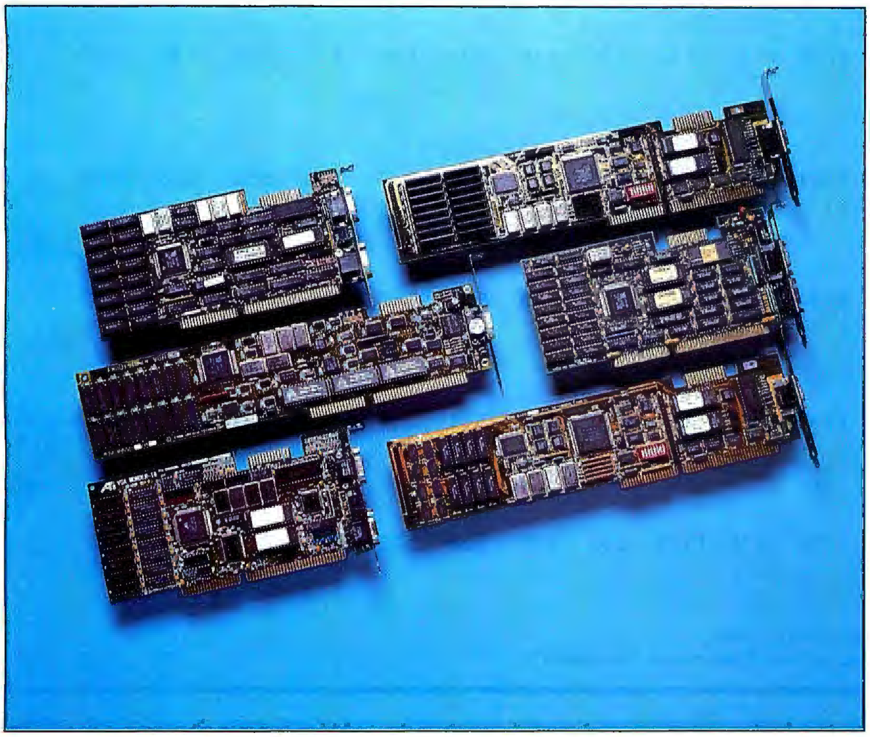
Circle 70 on Reader Service Card

Debunking 16-bit VGA



Design limitations compromise potential speed improvements on 16-bit adapters

Bradley Dyck Kliewer

Clockwise from top left: STB VGA EM-16, Headland Technology VRAM VGA, Genoa SuperVGA 5300/5400, Headland Technology FastWrite VGA, ATI VGAWonder, and Orchid ProDesigner VGA Plus.

VGA's success in establishing a new graphics standard is somewhat surprising. VGA resolution is slightly higher than its predecessor, EGA, and the larger palette adds a bit of flexibility. But while programmers prefer VGA with its readable registers, by and large, the differences between EGA and VGA are subtle.

Whatever the reasons, VGA has gained a huge following. To help their products stand out, engineers have added features like higher resolution modes and 16-bit adapters that make better use of the AT bus. One manufacturer, Headland Technology, has increased memory cycle speeds.

How different are these boards? To find out, I tested six 16-bit VGA cards: ATI's VGAWonder, Genoa's SuperVGA 5300/5400, Orchid's ProDesigner VGA Plus, STB's VGA EM-16, and two from Headland Technology—VRAM VGA and FastWrite VGA.

Misleading Terms

What's a 16-bit board? The terminology can be misleading. VGA adapters have two types of memory: ROM, which contains the BIOS extensions necessary for the additional video modes, and RAM, which is the memory used to store text or graphics data. One or both may use 16-bit addressing.

Vendors tout 16-bit ROM, where the most significant benchmark improvements are evident. But most application programs don't make heavy use of the ROM BIOS—it's frequently used solely for setting the display mode and colors. The BIOS routines have always been slow at writing, so programmers bypass the BIOS and write data directly to RAM. Since the mode and color palette are seldom changed, fast ROM access is not particularly helpful.

Theoretically, 16-bit RAM access can dramatically improve performance. On a standard video adapter, a 16-bit write to RAM is implemented as two 8-bit writes, thus degrading performance. Text output is naturally suited to 16-bit writes; it's always represented by 1 byte for the ASCII code and a second byte for its attributes (e.g., color, background, and underlining). But graphics aren't as well suited for 16-bit writes. Graphics images are often manipulated one pixel, or bit, at a time (or as a collection of bits—such as a circle—that can't be represented as multiple linear bits).

One area where graphics frequently addresses blocks of contiguous pixels is in Windows-based applications. When you scroll or move the contents of a window, the adapter must copy blocks of pixels from one area to another (this is called a bit-block transfer, or bit-blt). To test this function, I wrote the benchmark program BITBLT, which copies a block

continued

Table 1: *Results of the Small-C benchmark tests. Times are in seconds except for the SoftWest load/draw, which is in minutes:seconds.*

	SoftWest		Video modes: Text			CGA		EGA			VGA		
	Load/draw	Regen	1	3	7	5	6	13	14	15	16	18	19
IBM display	1:59.7	36.0	20.76	20.81	20.81	2.30	2.20	5.16	5.77	4.17	5.72	5.93	2.14
VGAWonder													
640 × 480	1:59.8	35.9	13.79	13.23	13.35	2.25	2.14	5.60	5.60	4.11	5.60	5.76	2.14
800 × 600	2:17.9	47.8											
1024 × 768	2:23.3	52.8											
SuperVGA													
640 × 480	1:59.3	35.9	21.20	20.93	21.40	2.15	2.19	5.32	5.65	4.11	5.65	5.83	2.14
800 × 600	2:04.4	43.7											
1024 × 768	2:06.5	44.9											
ProDesigner													
640 × 480	2:00.4	36.0	13.84	13.62	13.62	2.30	2.19	5.17	5.49	4.12	5.55	5.66	2.14
800 × 600	2:02.9	39.9											
1024 × 768	2:03.5	41.1											
VGA EM-16													
640 × 480	2:00.0	35.9	19.94	19.61	19.61	2.15	2.19	5.33	5.65	4.12	5.65	5.82	2.14
800 × 600	2:02.5	40.0											
1024 × 768	2:03.3	40.2											
VRAM VGA													
640 × 480	1:58.7	35.7	13.30	12.97	13.10	2.30	2.30	5.21	5.33	4.10	5.33	5.49	2.30
800 × 600	2:24.7	50.7											
1024 × 768	2:25.1	52.2											
FastWrite													
640 × 480	1:59.1	35.7	13.35	13.10	13.13	2.80	2.30	5.38	5.39	4.10	5.38	5.55	2.30
800 × 600	Failed*	Failed*											
1024 × 768	2:25.2	52.2											

* Drawing did not complete (computer did not hang, but the display failed to update).

For a complete description of the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

Table 2: *BITBLT test of adapter RAM speed. All times are in seconds.*

		Video modes: 5	6	13	14	16	18	19
IBM display	Byte	9.39	9.34	9.39	12.57	20.71	30.48	49.93
	Word	7.75	7.75	7.74	11.81	19.00	28.67	46.74
VGAWonder	Byte	16.64	9.56	8.57	9.44	16.26	22.41	36.69
	Word	8.34	9.50	8.24	9.34	16.21	22.24	18.40
SuperVGA	Byte	11.32	11.37	5.61	11.15	18.84	26.70	44.00
	Word	11.31	11.32	5.65	11.20	18.89	26.74	44.10
ProDesigner	Byte	10.82	10.71	5.38	10.54	17.91	25.10	40.21
	Word	9.56	9.62	4.84	9.45	16.36	22.52	20.15
VGA EM-16	Byte	11.37	11.43	5.66	11.21	18.95	26.92	44.21
	Word	11.42	11.48	5.71	11.26	19.60	26.96	22.14
VRAM VGA	Byte	7.80	5.88	3.95	5.87	10.11	13.84	22.85
	Word	6.48	3.68	3.30	3.68	6.31	8.57	14.12
FastWrite	Byte	9.89	6.86	5.00	6.81	11.64	16.90	26.59
	Word	9.34	5.11	4.67	5.60	8.35	12.80	19.67

Note: On modes 13 to 18, Word moves are ineffective because latch registers are only 8 bits wide. This results in incorrect colors.

of pixels to the entire screen byte by byte, then word by word. Flooding areas with a single color or a simple pattern is another potential application for bit-blts.

Unfortunately, the standard VGA has yet another 8-bit data path that can restrict fills and block moves. To conserve address space and simplify address calculations, EGA and VGA designers use bit-plane architecture. In a sense, several banks of memory are stacked in layers at one address (one plane for each bit of color, or four planes for 16 colors). The processor has to select which planes it must modify, but it has to preserve all planes, so the adapter temporarily stores the data in latch registers. Since VGA was designed as an 8-bit adapter, the latch registers are 8 bits wide. None of the reviewed adapters uses 16-bit latch registers, effectively limiting the bit-plane modes (i.e., all the EGA and VGA modes except 19, the 256-color VGA mode) to 8-bit operations.

Many factors besides data path width influence adapter speed. VGA adapters make heavy use of I/O registers, and since the I/O bus runs at the same speed (8 MHz) on most AT compatibles, there isn't much room for improvement here. Another factor is processor wait states. Both the CPU and the video controller must access video memory: As the CPU changes the memory contents, the video controller must read the memory and make the appropriate changes on the display. Most memory chips can't handle simultaneous access without creating snow on the display. So the video adapter adds wait states, preventing CPU access to display memory during certain intervals. This eliminates snow, but it slows writes to video memory.

Video RAM (VRAM), the approach used in Headland Technology's VRAM VGA, allows simultaneous access without snow. The other Headland Technology adapter, FastWrite VGA, uses a 1-byte memory cache. The cache can accept a write at any time without disturbing the controller. This strategy is most effective in text mode, where the CPU can write directly to the display without first reading the current data.

Finally, when dealing with extended modes, the software drivers supplied by a manufacturer can have a significant impact. The programmers may use an adapter's unique features to particular advantage (and poor programming may be an encumbrance).

Testing

I tested the adapters on an IBM PC AT with a 16-MHz Inboard 386/AT, 5.5 megabytes of memory, and an 80387 FPU. Operating systems used were PC-DOS 3.3 and OS/2 Extended Edition 1.1 (Presentation Manager). I used a Mitsubishi Diamond Scan HL6905 high-bandwidth monitor to test the highest resolution modes (1024 by 768 pixels). A standard multifrequency monitor should work well with other modes.

The test units all came fully configured with 512K bytes of RAM. The additional 256K bytes gives you a larger color palette in high-resolution modes.

I also tested for applications compatibility. I ran AutoCAD version 10, Windows/386 version 2.1, PageMaker 3.0, and Microsoft Flight Simulator 3.0. All adapters supported OS/2 and Flight Simulator without the use of special drivers and without problems.

The test programs include the BYTE Small-C video benchmarks plus the bit-blt function to test RAM speed. I also tested for the time required to maximize the PageMaker sample file PRODSPEC.PT3. (The test results appear in tables 1, 2, and 3, respectively.)

The AutoCAD and PageMaker test results are the best indicators of overall performance, followed by the standard Small-C tests in table 1. Results from the latter are a bit skewed because they don't take advantage of any of the boards' advanced features. The BITBLT test is a better indicator of board design than of overall performance improvement.

When examining the Small-C benchmarks, consider which modes you will use most frequently. Individual adapters tend not to perform as well over the full spectrum of tests. Some are faster at text modes; others are faster for specific sets of graphics modes. I divided the graphics results into CGA-, EGA-, and VGA-compatible modes. You might also want to consider mode 18 (640 by 480 pixels, 16 colors) and mode 19 (320 by 200 pixels, 256 colors) separately. For comparison, I included testing data for the IBM PS/2 display adapter (as run on the above system) in the table.

I had no compatibility problems with any of these cards. This comes as no surprise, since vendors have had nearly two years to refine their chip sets. Also, most of the companies used the same Tseng Labs ASIC (application-specific IC) as the controller for their boards. The two exceptions, Headland Technology and ATI, manufacture their own ASICs.

Using identical ASICs is no indication of an extended mode standard; support circuitry differs from manufacturer to manufacturer and can affect both performance and compatibility.

Table 3: *This test measures the time required to maximize the PageMaker sample file PRODSPEC.PT3. I magnified a portion of the image and the descriptive text at 200 percent. All times are in seconds.*

	Maximize
IBM display	4.8
VGAWonder[1] (VGA driver)	4.6
SuperVGA (VGA driver)	4.7
800 × 600	6.0
1024 × 768	8.3
ProDesigner[2] (VGA)	4.6
VGA EM-16[3] (VGA driver)	4.7
800 × 600	5.5
VRAM VGA (VGA)	4.2
800 × 600	5.3
1024 × 768 (B&W)	5.6
FastWrite (VGA)	4.2
800 × 600	5.4

Note:
Maximize, a Windows function, expands a selected window to fill the entire screen.
[1]VGAWonder has no Windows/386 drivers.
[2]ProDesigner has no Windows/386 drivers.
[3]VGA EM-16 has no 1024 × 800 Windows/386 driver.

The extended modes supported by the different BIOSes also differ. I tried mixing and matching a few drivers for the adapters that use the Tseng ASIC. While the drivers would operate, there were some minor inconsistencies (such as variations in color) when I used them on another manufacturer's adapter. A look at how each board performed follows.

Board Specifics

ATI VGAWonder. This board's distinguishing feature is the built-in Microsoft-compatible mouse. The adapter includes a two-button mouse built by Logitech, but you also can use a Microsoft InPort mouse. The mouse comes disabled; you enable it by selecting an interrupt line and port address via software. The mouse worked fine with the OS/2 version 1.1 Microsoft Mouse drivers.

VGAWonder will drive a standard multifrequency monitor, such as the NEC MultiSync II, at the full 1024 by 768 pixels in interlaced mode. While this monitor is less expensive than an HL6905 or an NEC MultiSync XL, the difference between 1024 by 768 pixels interlaced and 800 by 600 pixels noninterlaced is indistinguishable. A 1024- by 768-pixel display will show improved detail only in noninterlaced mode.

continued

	VGAWonder	SuperVGA 5300/5400	ProDesigner VGA Plus
Company	ATI Technologies 3761 Victoria Park Ave. Scarborough, Ontario, Canada M1W 3S2 (416) 756-0718	Genoa Systems Corp. 75 East Trimble Rd. San Jose, CA 95131 (408) 432-9090	Orchid Technology 45365 Northport Loop W Fremont, CA 94538 (415) 683-0300
Maximum resolution*			
Text (characters by lines)	132 × 44	132 × 60; 100 × 75	132 × 44
Graphics (pixels by pixels by colors)	800 × 600 × 256; 1024 × 768 × 16	800 × 600 × 256; 1024 × 768 × 16	800 × 600 × 256; 1024 × 768 × 16
Drivers	AutoCAD/AutoShade ADI; GEM 2 and 3; Lotus 1-2-3 and Symphony; Ventura Publisher 1.x and 2.0; Windows 1.x, 2.x, and Windows/286 2.x	AutoCAD/AutoShade ADI; GEM 2 and 3; Ventura Publisher 1.1 and 2.0; Framework II 1.1; Lotus 1-2-3 and Symphony; Windows 286 versions 1.03 and 2.x; Windows/386 version 2.03	AutoCAD/AutoShade ADI; GEM Desktop 1.0; Lotus 1-2-3 and Symphony; Ventura Publisher 1.x; Windows 1.x and 2.03; WordPerfect 5.0
Features	Includes Microsoft-compatible bus mouse; additional register-level compatibility with MDA, CGA, EGA, and Hercules adapters; supports digital and analog monitors; automatically detects monitor type	Supports digital or analog monitor; additional register-level compatibility with MDA, CGA, EGA, and Hercules adapters	Font-editing program; additional register-level compatibility with MDA, CGA, EGA, and Hercules adapters
Board size (inches)	8½ × 4⅛	8½ × 4⅛	13¼ × 3⅛
Documentation	User's manual	User's manual	Hardware manual; software manual
Price	256K-byte version: $499 512K-byte version: $699	Model 5300 (256K bytes): $499 Model 5400 (512K bytes): $699	512K-byte version: $599
	Inquiry 851.	**Inquiry 852.**	**Inquiry 853.**

*For all adapters, the maximum graphics resolutions and number of colors require 512K bytes of memory.

To use noninterlaced mode, I had to override the board's automatic monitor detection, which identified the HL6905 as an 8514 (similarly, it identified the MultiSync II as a fixed-frequency PS/2 monitor). Fortunately, the monitor type is stored in nonvolatile memory, so you don't need to specify the monitor type every time you start the system.

The VGAWonder's typeface is noticeably different from that of the other adapters. You might want to view the text for yourself if you are considering the VGAWonder.

Genoa SuperVGA 5300/5400. The 5400 was the slowest board I tested. In fact, the benchmarks reveal that it is operating as an 8-bit adapter even though it has a 16-bit connector. The company is redesigning the card to use 16 bits. The SuperVGA is the only adapter in the group that supports Framework II. If you use Framework extensively, you might want to consider the SuperVGA. Otherwise, wait for the redesigned adapter.

Orchid ProDesigner VGA Plus. ProDesigner performed reasonably well in all areas. The board has only two jumpers: One selects an 8-bit bus, and the other disables the NMI (nonmaskable interrupt, used to switch automatically to emulation modes). ProDesigner uses the same form factor as the IBM adapter, although it's missing the 44-pin Berg connectors near the card's center and end.

ProDesigner has no switches for selecting monitor type, and it doesn't automatically detect the type of monitor in use. It depends on you not to install drivers that run the display at higher resolutions than the monitor can support.

This was the least expensive 512K-byte board I reviewed. In fact, it's competitively priced against several of the 256K-byte adapters and is the only board with WordPerfect 5.0 drivers for that program's VIEW command. (This command puts the adapter in graphics mode and displays a WYSIWYG page layout.) You can just make out the text on a full page view at 1024 by 768 pixels. If you need the features of a 512K-byte board or if you use WordPerfect 5.0 extensively, ProDesigner offers a good balance of price and performance.

STB VGA EM-16. The EM-16 performed well in all modes. It supports older, digital-type displays as well as analog monitors. This is a solidly built adapter, and the 256K-byte version was the best-priced board I tested.

Headland Technology VRAM VGA and FastWrite. VRAM VGA and FastWrite are more similar than different. The board layouts (which follow the IBM form factor) are identical except for the memory and memory-support circuitry on the end of the boards. Both VRAM VGA and FastWrite are very fast in text mode and average on graphics (although fills and moves are exceptionally quick).

Both boards had problems with the

VGA EM-16	VRAM VGA/FastWrite VGA
STB Systems, Inc. 1651 North Glenville, Suite 210 Richardson, TX 75081 (214) 234-8750	Headland Technology 46335 Landing Pkwy. Fremont, CA 94538 (415) 656-7800
132 × 44	VRAM: 100 × 60; 132 × 43 FastWrite: 100 × 60; 132 × 43
800 × 600 × 256; 1024 × 768 × 16	VRAM: 800 × 600 × 256; 1024 × 768 × 16 FastWrite: 640 × 480 × 256; 1024 × 768 × 4
AutoCAD/AutoShade ADI; GEM; Lotus 1-2-3 and Symphony; Ventura Publisher; Windows 1.x and 2.0x; Windows/386 version 2.1	AutoCAD/AutoShade ADI; GEM 3; Lotus 1-2-3 and Symphony; Ventura Publisher; Windows 2.03; Windows/386 version 2.1
Supports digital and analog monitors; additional register-level compatibility with MDA, CGA, EGA, and Hercules adapters	VRAM VGA uses video RAM; FastWrite uses a 1-byte memory cache
8½ × 4¼	13¼ × 3⅕
User's manual	Hardware manual; software manual; optional technical reference ($25)
256K-byte version: $449 512K-byte version: $649	VRAM: $799 (512K-byte upgrade: $299) FastWrite: $599 (512K-byte upgrade: $159)
Inquiry 854.	**Inquiry 855.**

1024- by 768-pixel modes (giving distorted colors and a sparkling effect while writing). Headland Technology attributes this to faulty ASICs in the early production runs. The company has since designed new testing procedures to prevent faulty boards from reaching the market. I received a replacement VRAM VGA that worked perfectly.

The AutoCAD drivers for both boards are surprisingly slow. FastWrite didn't finish drawing the SoftWest circuit board layout. AutoCAD kept running (i.e., the hard disk access continued), and while I was able to exit the program by typing "quit," the display stopped updating until I switched back to the AutoCAD menu. Regen would restart the display cycle, but it quit updating at the same place. This is most likely a problem with the drivers.

Windows/386 performance was excellent; the best option was the 1024- by 768-pixel monochrome mode of VRAM VGA. The VRAM VGA would be my adapter of choice for a desktop publishing system.

Discerning Performance

None of these adapters struck me as particularly outstanding. Certainly all are good alternatives to the standard 8-bit IBM adapter, especially considering the utility of the expanded resolution modes. When choosing an adapter, you should consider what applications you'll use most and focus your attention on the appropriate portion of the benchmarks and the list of supported drivers.

While working with the adapters, the only performance differences I noticed were in Windows/386 at 1024- by 768-pixel modes. The SuperVGA was sluggish, and the monochrome VRAM VGA driver was unusually fast.

For spreadsheets and word processing, good text-mode performance will give you an advantage. In standard text modes, additional speed probably won't give you much more than blurry scrolling, but as the screen width increases to 132 columns (or additional rows), the added speed is definitely desirable. The Headland Technology and Orchid boards performed well in these tests.

Look to the AutoCAD and Small-C tests for good pixel-by-pixel performance. Applications such as CAD and business graphics packages will benefit the most from fast pixel operations. There is less differentiation here, probably because the 8-bit latch registers inhibit performance gains. The Orchid and STB drivers have the edge in high-resolution AutoCAD driver performance.

For desktop publishing, the Windows/386 and BITBLT benchmarks are good indicators. The STB and Headland Technology boards performed particularly well here. Special note should be made of VRAM VGA's monochrome 1024- by 768-pixel mode under Windows/386 (I couldn't discern any difference in speed from standard VGA resolution, although my test results show it was somewhat slower). I would gladly forsake color for the snappy response times.

Don't overlook the driver list. Most software requires special drivers to use the higher resolution modes. Notable exceptions are WordPerfect and WordStar, which use the mode set before entry (although you must patch WordStar or set WordPerfect to recognize the new screen size).

All the adapters show improved text-mode performance, but I'd like to see an adapter that uses 16-bit latch registers to improve graphics performance. Unfortunately, this would be difficult to implement as it would require extending many other VGA registers.

If you need better graphics performance and are willing to spend over $1000, consider graphics coprocessor boards. I evaluated two in the January BYTE (see the review "Pixels on the March"). BYTE will take an in-depth look at more of these boards in an upcoming issue. ■

Editor's note: *The BITBLT test program is available on BIX as BITBLT. It's also available in a variety of other formats. See page 5 for details.*

Bradley Dyck Kliewer is the author of EGA/VGA: A Programmer's Reference Guide *(New York: McGraw-Hill, 1988) and principal of DK Micro Consultants, a microcomputer consulting business in Bloomington, IN. He can be reached on BIX as "bkliewer."*

Smalltalk/V Comes to the Mac

Discover the Mac's object-oriented roots

Ray Valdés

Smalltalk-80, created at the Xerox Palo Alto Research Center (PARC), is a language, a programming system, an application run-time environment, and a systems design philosophy. Digitalk's Smalltalk/V Mac implements much of the original system. Although it is new, Smalltalk/V Mac is a robust and mature product based on software technology that Digitalk has been developing for years.

Digitalk's original product, called Methods, supported a subset of Smalltalk-80 on IBM PC compatibles. Then came Smalltalk/V for AT compatibles. Now Smalltalk/V Mac adds substantial integration with the Macintosh hardware and software environments. For example, it includes Smalltalk classes that provide access to Macintosh system primitives and data structures.

The program files come in compressed form, and it takes 15 to 20 minutes to unpack everything. When installed, the system comprises a 600K-byte image file that contains all the objects in the system, an 80K-byte machine-language kernel, a 500K-byte file containing Smalltalk source code for most of the system, and four folders: Examples, Tutorial, User Primitives (C examples showing how to extend the low-level system primitives), and Tools.

The files in the Examples and Tutorial folders contain commented Smalltalk code that serves as both documents and sample Smalltalk programs. One file contains an eccentric but passable Prolog interpreter written in Smalltalk.

The machine-language kernel that reads the image file comes in two versions: a Mac II version that takes advantage of the 68020 CPU, and a standard Mac version that uses the 68000.

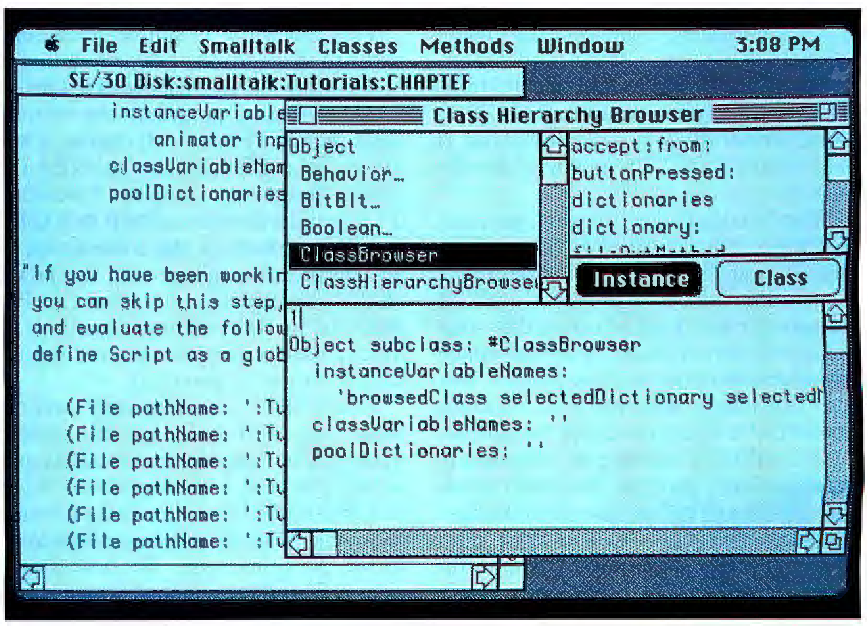
Using the system is like running classic Smalltalk on a Xerox workstation or Smalltalk/V on the IBM PC, except that the user interface follows the Macintosh conventions. In classic Smalltalk, each window (and each window pane within a window) can have its own pop-up menu. In Smalltalk/V Mac, all windows share the single top-level menu bar. When you click on a window to activate it, the program redraws the top-level menu bar and any additional menu items that belong to the recently activated window.

What I call *classic* Smalltalk is the language as found on Xerox and Tektronix workstations and as described in the Addison-Wesley series of books by Adele Goldberg and others. A Xerox spin-off company, ParcPlace Systems, has enhanced this language and ported it to various systems (including the Macintosh) while maintaining a high degree of compatibility. The ParcPlace product is also called Smalltalk-80.

The translation to the Mac user interface is smooth, with only one or two rough spots. For example, when using the Class Browser—a tool that you use to view and modify Smalltalk source code—it's not clear how to save a change. In classic Smalltalk, a pop-up menu would automatically appear, prompting you to accept the change. In Smalltalk/V Mac, you must go to the File menu and use the generic Save, which to me implies saving the image file.

Command-key equivalents for menu choices—another aspect of the Macintosh interface—simplify a number of operations. For example, in classic Smalltalk, you invoke the object inspector by way of a menu. You can do that in Smalltalk/V, too, but command-I is faster and easier. Another nice bit of Macintosh/Digitalk synergy has to do with user-

continued



Smalltalk/V Mac

Type
Object-oriented programming system for the Mac Plus, SE, and II

Company
Digitalk, Inc.
9841 Airport Blvd.
Los Angeles, CA 90045
(213) 645-1082

Format
Two 800K-byte floppy disks

Hardware Needed
Mac Plus, SE, or II

Software Needed
System 5.0 or higher

Price
$199.95

Inquiry 882.

defined primitives. When you want to control a serial port directly or add a graphical primitive, it's helpful to be able to drop into a compiled language. Smalltalk/V Mac can do this in a way that closely resembles HyperCard's XCMD mechanism.

The Pure Object-Oriented Approach

In Smalltalk everything is an object, including what most of us normally regard as procedures and data. For example, to add 3 and 4, you send an Add message to the 3 object, with 4 as a parameter. Both 3 and 4 are objects; more specifically, they're instances of the class SmallInteger. Smalltalk's object orientation is fundamental and all-encompassing. If you're making the transition to this style in the context of C++, Ada, or Modula-2, you will find it worthwhile to pick up a copy of Smalltalk/V.

The Smalltalk environment provides no clear distinction between one application program and another. Everything is an object or collection of objects, and all objects live in a kind of primordial soup called the *virtual image*. A virtual image is a snapshot of the running system. You save this image when you exit Smalltalk and reload it when you restart the system.

In Smalltalk, software development is an exploratory process. You mold existing objects and refine class definitions—themselves objects—to suit your purposes. Because Smalltalk/V is mostly implemented in Smalltalk code that's available for inspection, it offers a great way to learn about constructing complex systems.

Unfortunately, that strength becomes a weakness if you're interested in building stand-alone applications. Smalltalk was designed for prototyping, not for commercial development. Digitalk addresses this limitation with a kind of linking tool called the Cloner. It streamlines a virtual image, eliminating all but the objects and class definitions that an application requires. The result is a Smalltalk program that behaves like a double-clickable Mac application.

Because Smalltalk was designed as an exploratory programming environment, you can dive right into Smalltalk/V. It provides several tools for exploring and modifying objects, most notably the Class Hierarchy Browser, which operates on class definitions. Others include the Inspector, the Debugger, the Class Browser, and the Method Browser.

At start-up, the system presents a transcript window. Here you can enter a snippet of Smalltalk code and then ask the system to execute. The following code lets you create a new window and draw a rectangle in it:

```
(Pen new)
  newWindow:'Foo';
  drawRectangle:((100@100)
    extent:(50@50))
```

You use the mouse to select and execute the text, and up pops a new window containing the rectangle you specified. To close the window, you just click on its close box and then forget about it. Smalltalk/V's garbage collector disposes of it automatically.

This procedure is simple when compared to the equivalent steps required to create, draw in, and dispose of a window in a Macintosh C programming environment such as Think C. Of course, a language like Macintosh QuickBASIC makes things easy, too, but I wouldn't try to build a complex system in BASIC. Smalltalk combines the convenience of an interpreted language with the power of the object-oriented approach. The proof is in the pudding: Smalltalk/V Mac is itself a complex system, and it's largely written in Smalltalk.

Smalltalk/V is a forgiving environment; you can't easily get into serious trouble. The worst thing that can happen is that you send a message to an object that doesn't exist, or you send a message to an object that doesn't know how to respond. In either case, the system activates a WalkBack window, which shows the most recent messages exchanged in the current process. You can either resume execution—with no harm done—or activate the Debugger.

The whole system is surprisingly compact, given what it contains: a compiler, run-time library, virtual memory manager, multitasking process scheduler, graphics library, window manager, menu manager, dialogue manager, event manager, text editor, and source-level debugger. You get all these components as executable programs and also, with the exception of the compiler, as source code.

Making Connections

Most of the concepts in the Smalltalk language are simple and elegant. And its syntax—while more complicated than that of Lisp—is much simpler than that of C or C++. What's complicated is that everything seems connected to everything else. This is another of Smalltalk's strengths that is, from another perspective, also a weakness. Anyone used to procedural-language modularity often won't find items where they are expected. For example, the Process abstraction is implemented with a few methods in a subclass of OrderedCollection, which also happens to be the parent class to Array. Likewise, the equivalent of a FOR...LOOP construct in C is implemented in three lines of Smalltalk code in the class SmallInteger. The text editor is implemented by adding a few methods to subclasses of Dispatcher, Pane, BitBlt, and StringModel.

The whole system is reflexive in a fundamental way. Classes describe objects, and metaclasses describe classes. Both classes and metaclasses happen to be objects themselves. Because the system is interpretive, an object can change its own definition as it is running. In addition, by using the `become:` method, an object can transform itself into another kind of object. Although the system is remarkably responsive and forgiving, it is complex. Digitalk's tutorial provides welcome assistance. It leads you through a series of increasingly sophisticated examples; each example builds on the last. When you finish the tutorial, you've learned a lot about Smalltalk and Digitalk's implementation.

The documentation is excellent. A couple of omissions were addressed in the ReadMe file on the program disk. For example, the Digitalk implementation relies on certain critical global variables such as Processor (an instance of ProcessScheduler), Screen (an instance of GlobalDisplayScreen), and Keyboard-

continued

Semaphore (an instance of Semaphore). The manual mentions these but doesn't explain them well. The index, which is much too short, doesn't even have an entry for Screen.

I also would have appreciated a discussion of the differences between Digitalk's implementation of Smalltalk and the classic Xerox implementation. These differences are considerable—not so much in the language as in the environment—and will make porting a complex program to Smalltalk-80 a difficult endeavor.

Smalltalk/V vs. Smalltalk-80

In terms of syntax and semantics—though the language hasn't been defined in a way that ensures portability—Smalltalk/V is very close to classic Smalltalk. However, at the level of methods and libraries of classes, the two implementations diverge. The ParcPlace product builds on classes described in the Addison-Wesley literature. Digitalk, probably for copyright reasons, has implemented the same classes differently. For example, with classic Smalltalk, you can group methods into categories known as class protocols; the FileStream class contains protocols for file access, positioning, and status. With Digitalk's Smalltalk, you can group methods only by class.

The net result is that a large Smalltalk-80 program is portable to Digitalk's Smalltalk/V, but only with much effort. Any porting efforts will likely be irreversible, although this won't be an issue for most people.

Smalltalk/V Mac differs from its PC counterpart, too. Digitalk has provided classes that allow access to Macintosh ROM services and data structures. For example, you can use the class EventRecord to access the data structures described in *Inside Macintosh*, or the trap primitive to access any Macintosh trap function. Of course, using these Mac-specific functions makes it difficult to port your programs to Digitalk's PC Smalltalk.

In theory, because Smalltalk is interpretive, you can use the system as a tool for exploring the Macintosh ROM Toolbox. In practice, this is harder than you might think. Both Smalltalk and the Macintosh ROM Toolbox were designed as self-contained, complete graphical environments. If you want to focus on the native Macintosh interface, Smalltalk distorts the picture considerably.

Smalltalk/V Mac performs well—no mean feat when you consider the mismatch between the requirements of a pure object-oriented language like Smalltalk and the architecture of conventional CPUs like the 68000 and 80286.

Recent implementors of Smalltalk, including both Digitalk and ParcPlace Systems, have developed proprietary techniques for overcoming this architectural mismatch. Whatever techniques Digitalk used, they represent an impressive achievement.

Digitalk's Smalltalk/V Mac is an excellent, reasonably priced product. It's a great way to learn about object-oriented programming and Smalltalk. It's also a way to construct commercial applications that port from the Mac to the PC. ■

Ray Valdés is president and founder of Sapphire Software, a technology consulting firm in San Francisco, California, that specializes in the design and development of graphics software. He can be reached on BIX c/o "editors."

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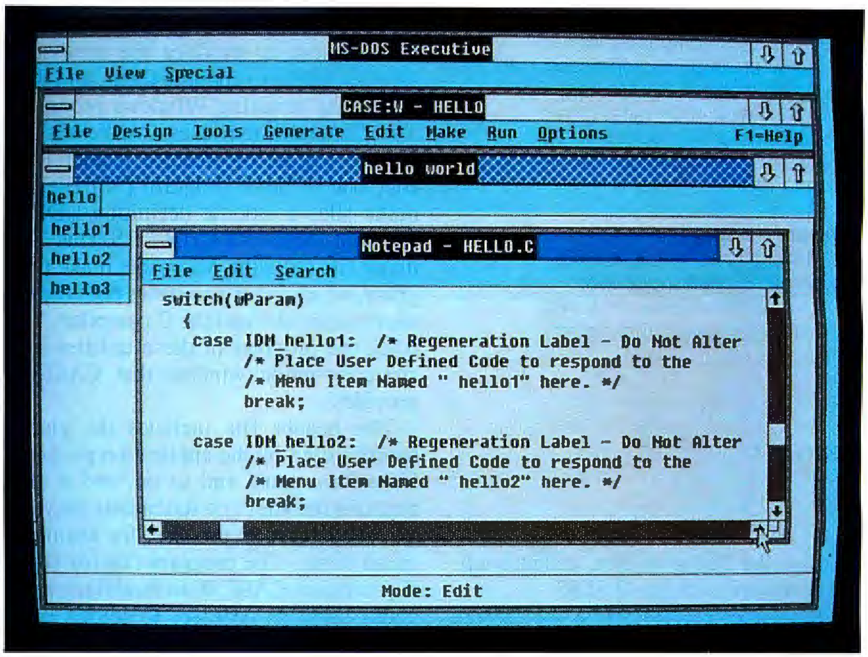
Domesticating Microsoft Windows

CASE:W gets Windows programmers up to speed quickly

Alex Lane



Microsoft Windows, like the Macintosh, makes life easy for users but hard for programmers. Now CASE:W 1.0 (computer-aided software engineering for Windows) lightens the programmer's load, too. It's a tool for constructing skeletal Windows applications, and it's also a Windows application that manages menus, resource script files, icons, and dialog boxes in a WYSIWYG context.

You start with an untitled application window whose menu bar contains no entries. Then you add menu items, specifying whether they lead to pop-up options, dialog boxes, or application-specific code. At any point, you can generate Windows source files, compile them, and run the resulting program. It won't do anything except behave like a normal Windows program. You've still got to add application-specific code, but anyone who's struggled with the often-bewildering Windows programming environment knows that getting even the most minimal Windows program to work is a nontrivial accomplishment. A tool like CASE:W, which does this automatically, will make a lot of friends.

CASE:W is a kind of expert system. It *knows* about the structure of Windows programs and uses that knowledge to generate C source files, resource files, and make files. But CASEWorks downplays the AI aspect of its product and stresses its value as a CASE tool for Windows. I find this approach refreshing.

The software is easy to install. The manual isn't lengthy, but it doesn't need to be. CASE:W is so easy to use that I kept racing ahead of the tutorial and, in short order, built a trivial Windows program. It probably would have taken me several days if I had to work only with Microsoft's tools and its voluminous documentation.

CASE:W requires an IBM AT, PS/2, or compatible with an Intel 80286 or 80386 microprocessor, a minimum of 2 megabytes of RAM, a hard disk drive with at least 400K bytes of free space, EGA or VGA graphics with a monitor, and a Windows-compatible mouse. The memory requirement is a Microsoft recommendation for running Windows; CASE:W itself requires less than 64K bytes of memory. On the software side, you will need DOS 3.0 or higher; Windows 2.03, Windows 286, or Windows/386; the Windows Software Development Kit (WSDK); and Microsoft C Compiler 5.0 or higher.

I examined CASE:W 1.0 on an ARC 386i microcomputer equipped with a mouse, VGA with a multisync monitor, 3 megabytes of 16-bit memory, and a hard disk drive. My system's software configuration included MS-DOS 3.3, Windows/386 version 2.1, version 5.0 of the C Compiler, and the WSDK.

A Tour of CASE:W

CASE:W comes up as a full-screen Windows application. Database (.APP) files contain the information CASE:W uses to generate source files for Windows programs. Once you load an application database, the CASE:W menu bar offers these items: File, Design, Tools, Generate, Edit, Make, Run, and Options. F1 activates a context-sensitive help system.

The File item contains options for loading and saving CASE:W application files. A Setup option specifies tools accessible from within CASE:W. Initially,

continued

CASE:W 1.0

Type
Programming aid
for Microsoft Windows

Company
CASEWorks, Inc.
1 Dunwoody Park
Atlanta, GA 30338
(404) 399-6236

Format
One 360K-byte 5¼-inch floppy disk
and one 720K-byte 3½-inch floppy disk

Hardware Needed
IBM AT, PS/2, or compatible with an Intel 80286 or 80386 microprocessor, at least 2 megabytes of RAM, a hard disk drive with at least 400K bytes of free space, EGA or VGA graphics with a monitor, and a Windows-compatible mouse

Software Needed
DOS 3.0 or higher; Windows 2.03, Windows 286, or Windows/386; Windows Software Development Kit; Microsoft C Compiler 5.0 or higher

Price
$795

Inquiry 881.

these are the dialogue, font, and icon editors that come with the WSDK.

The heart of CASE:W is the Design item. It presents options related to four major areas of Windows design: Program Configuration, Main Window, Menu and Popup System, and Client Area. Once you select one of these, CASE:W puts a prototype window on the screen and places the system in design mode. The prototype window occupies the client area of CASE:W's own window and displays a title bar and a menu bar for the application being built. The title bar has a crosshatched background that distinguishes it from the title bar of a genuine Windows application. This cuts down on confusion, especially when other Windows applications are on the screen with CASE:W.

The Program Configuration option manipulates compiler options, libraries, standard code and data segments, imports, and exports. Main Window controls your application window's title, icon, cursor, font, size, location, and colors. Menu and Popup System enables you to add, delete, or move menu items. Client Area leads to a dialog box that you use to incorporate WSDK-built dialog boxes into your application.

As is typical with Windows programs, there are formal ways to do things in the CASE:W environment, and there are shortcuts. For example, if you want to add a menu item, you can select Menu and Popup System from the Design menu item and then select Add Menu Item from the Options menu. Or you can just use the mouse to click on the menu bar of the application you're developing. That brings up the Add Menu Item dialog box directly. I found these shortcuts helpful and intuitive.

Once you've got your application's interface looking the way you want, you use Generate to produce the necessary sources, Make to compile them, and Run to test the resulting Windows program. The Generate item uses CASE:W's inference engine to create a header (.H) file, one or more program (.C) files, a make file, a module definition (.DEF) file, and a resource script (.RS) file. The make file calls the Microsoft make program, which in turn activates both the resource compiler and the C compiler. You track the progress of these utilities in a character-mode window that CASE:W provides.

The header file includes the global handles used by the application program for colors, pens, and so on, and it also contains the `#define` statements for various labels used to process, for example, menu items. The program file (or files, if you direct CASE:W to modularize the code) contains ordinary C source code for the application. Instead of mashing all parameter information into one line, the function declarations generated by CASE:W follow the pre-ANSI pattern—one function parameter per line:

```
long FAR PASCAL WndProc(hWnd,
  iMessage, wParam, lParam)
HWND hWnd;
unsigned iMessage;
WORD wParam;
LONG lParam;
{...
```

The C file has a commented area at the top for your declarations and another commented area at the end for your code. CASE:W indents code sensibly and inserts comments that are personalized for your application. For example, you'll see comments like

```
/* Menu Item Named " &Open" here */
```

instead of

```
/* Second Menu Item here */
```

You don't need to edit CASE:W's code, but once you get your interface working and are into the guts of your application, you'll want to edit the application-specific code that you insert into CASE:W's program skeleton. The Edit item provides for this. By default, it runs the Windows Notebook editor, but you can specify another Windows editor or a character-based editor for which a .PIF file exists. The bottom line is that you can continously edit, compile, link, and run Windows programs without leaving the Windows environment.

The Big Picture

Everyone's first C program is the four-liner that writes "Hello, world!" on the screen. The program illustrates a number of snack-size concepts—header files, the central function called `main()`, and the `printf()` function. The simplest program you can write in the Windows environment—a program that creates a resizable window on the screen—is an order of magnitude more complex. CASE:W built a 6500-byte C source file to accomplish the task, as well as the obligatory header and resource file.

In ordinary C, the environment calls `main()` with two optional arguments commonly named `argc` and `argv`; these denote the number of arguments on the program's command line and an array of pointers to the string tokens on the command line. Compare this to the central Windows function, `WinMain()`. It requires four arguments: Its own instance handle, a previous instance handle (or NULL, if no other instance of the program is running), a pointer to the parameter line, and an argument that tells the application whether to appear as a window or an icon. Note that you must already know quite a bit about Windows (e.g., what handles and instances are, and what it means to start an application as an icon) before you can start putting together a `WinMain()` function call.

Whereas an ordinary C program may have a lot or a little formal organization, the Windows program must have, within its main body, an initialization section, a message-polling loop, and a closing section. You also have to provide a window procedure that interprets messages sent to your program from the Windows environment, and a paint procedure that will update your application's window when Windows asks it to. This explanation is, of course, over-simplified, and, if you're not a Windows programmer, it undoubtedly sounds like technobabble.

In short, the complexity of Windows programming makes it nearly impossible to become familiar with Windows in a piecemeal manner, as is the case with C. You can't just dip your toe into the pool to get a feel for the water; you have to jump into the deep end and start swimming.

To test the efficacy of CASE:W, I set out to duplicate (to the extent possible) the features of an application my company had developed for a client nearly a year ago. It was the first Windows project for the programmer that worked on the application, and from what I observed, it wasn't a pretty sight. His desk was piled high with manuals and trade books. Marked-up printouts littered the floor. Long hours went into learning enough about Windows to get started—yet the application was simple. Two items on the menu bar led to a limited set of options, and about a half-dozen dialog boxes needed to be integrated into the application. There was also quite a bit of user-specific code.

With CASE:W, I could duplicate the menu bar and pop-up options completely and, with little difficulty, integrate the dialog boxes into the CASE:W code. It took me about two hours with most of my time spent integrating the dialog boxes.

To its credit, I often forgot I was using CASE:W. I got completely absorbed in adding *this* menu item or *that* icon into the application I was creating. At no time did the program tempt me to take out a stopwatch and clock its speed. As far as time is concerned, I substantially duplicated in hours the skeleton of a Windows application that took an experienced programmer a couple of days to build.

I can see several uses for CASE:W in a production environment. First, novices and experts alike can profitably use it alone to generate the skeletons of Windows applications. In addition, using CASE:W would offer novice Windows programmers the opportunity to create working code that they could examine in detail. Third, software specifiers could use it to supplement (or supplant) written specifications and to present developers with a core of Windows source files ready to be fleshed out.

Despite the aid provided by CASE:W, you will need to do more to create a complete, useful application. For example, you must write those portions of the code that make your application more than just a resizable window. In this respect, CASE:W leaves your application-specific code alone. You don't have to laboriously reintegrate your code every time the program regenerates source files. Instead, you can simply flesh out your parts of the application while still modifying the interface.

Unlike some 1.0 products I've seen, CASE:W is not a slapdash attempt at getting a product out the door. It has some minor bugs. For example, I noticed a sporadic corruption of the generated C source files; the company promises to fix this in version 1.1. But in general, the product works as advertised with no hitches. I deeply regret not having had it a year ago. I'm sure its cost would have been repaid several times over by now.

Windows will remain a popular user interface on IBM AT-style machines for some time to come. CASE:W will help those who program in the Windows environment to concentrate on the *what* of their applications rather than on the *how.* ■

Alex Lane is a senior knowledge engineering consultant with Technology Applications, Inc., of Jacksonville, Florida. He can be reached on BIX as "a.lane."

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1024 dots × 768 lines Graphics (Non-interlace)
AutoCAD

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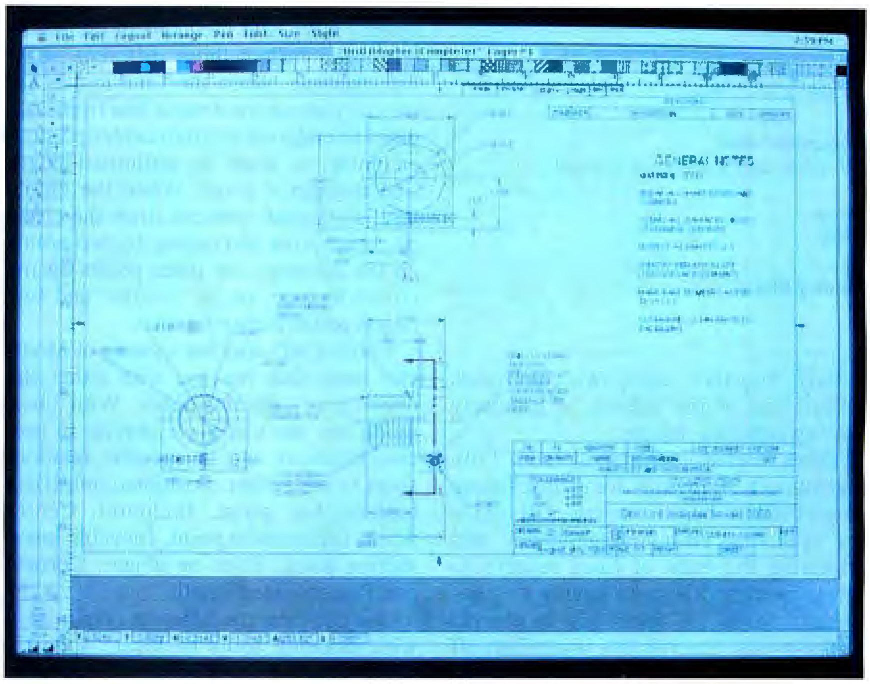
Circle 192 on Reader Service Card (DEALERS: 193)

Claris CAD

Claris's first CAD program is more than just another MacDraw

Paul Tuten



A lot of people have wondered what kind of CAD program Claris, the Apple spin-off company, would come up with. Well, now they know the answer. And if they use MacDraw II, they should feel right at home with Claris CAD, because its design is based on MacDraw II.

In a nutshell, Claris CAD is a two-dimensional drafting program with accuracy to five decimal places. It sells for $799, and MacDraw II owners can upgrade to Claris CAD for $399. But don't think Claris CAD is just a new release of MacDraw II—Claris CAD is powerful enough to compete head-to-head with VersaCAD for the Mac.

The Claris CAD package comes with ample documentation and a videotape that introduces Claris CAD's drawing concepts of tools, methods, and modifiers. In addition to the program and utilities disks, a tutorial disk has a series of exercises that you complete using a workbook. With the videotape and exercises, you can get up to speed right away.

To run Claris CAD, you'll need a hard disk drive and at least 1 megabyte of memory; you'll need more memory if you use a large-screen monitor or MultiFinder. Claris CAD also supports a color monitor on the Mac II. You can produce color documents and black-and-white printouts of four-color separations on the Imagewriter II or a plotter. The utilities disk includes MacPlot Configure and MacPlot Driver, which allow you to use Hewlett-Packard, Houston Instrument, and compatible plotters.

Familiar Look with Different Feel

Claris CAD provides a familiar look: a document window—or in this case, a drawing window—with all the standard Macintosh features. You can have up to seven drawing windows open at once, and you can also open MacDraw, MacDraw II, and PICT files from within Claris CAD. You can open special windows that contain library objects. The package includes a Berol Rapidesign Sampler of library symbols. You can also save drawings in the PICT format for later use in other Macintosh applications.

It's easy to enlarge a drawing or reduce it so that all geometry fits in the current window size, giving you a view of the entire document. To save time scrolling around a drawing, you can save and recall up to nine different views of it.

Claris CAD lets you save a drawing as "stationery" that, when opened, creates a new untitled drawing that has all the settings and drawing elements of the original drawing. One obvious use would be to set up stationery documents with your company title block in different drawing sizes.

Besides the usual Undo, Cut, Copy, Paste, Clear, and Duplicate options, the Edit menu also contains Linear and Polar Duplicate. With Linear Duplicate you can copy objects in one or two directions and enter the total number of copies for each direction. You can also key in the x and y distances and specify them as increments between the copies or distribute the copies equally along that distance. Polar Duplicate works much the same way. You enter the total number of copies for distribution or increment in angular degrees and radius from center, the coordinate (x,y) center of rotation, and whether to rotate each copy normal to

continued

Claris CAD 1.0

Type
CAD program

Company
Claris Corp.
440 Clyde Ave.
Mountain View, CA 94043
(415) 960-1500

Format
Three 3½-inch floppy disks

Hardware Needed
Apple Macintosh Plus, SE, II, or IIx with a hard disk drive

Software Needed
System 6.0 or higher

Documentation
486-page user's reference manual

Price
$799

Inquiry 884.

radials. Together, these two commands relieve you of the tedium of precisely placing replicate objects.

Other useful features include Trim and Smooth. Trim took some time for me to get used to, but it is a powerful option for removing unwanted geometry and trimming the ends of lines relative to other geometry. It saves having to completely redraw an object just to correct minor errors. Smooth lets you polish off the rough edges of splines, polygons, and freehand shapes. Also interesting is how the familiar Show Clipboard takes on an added dimension in Claris CAD. You can flip, change angle, and change the *x,y* scale of objects on the clipboard before pasting them into drawings.

Claris CAD permits you to use multiple scales in a single drawing—for drawing details and so forth—by allowing up to 255 different "rulers" per drawing. You can move the zero point of the rulers anywhere within the drawing space. Also, Claris CAD supports multiple layers, and you can work with objects on more than one layer at a time.

As for other features, you can set the drawing "pens" to inch, millimeter, or point sizes. And you can select standard hatch patterns for iron, bronze, steel, rubber, aluminum, glass, and lead. You can even edit the spacing and angle of the hatch lines and create new hatch patterns. You can also define up to 16,000 different black-and-white patterns and 16,000 different color patterns.

Snap-on Tools

At first glance, Claris CAD's tool icons look ordinary enough. For creating geometry, the tool icons include Line, Rectangle, Square, Fillet, Chamfer, Rounded rectangle, Circle, Concentric circle, Ellipse, Circular arc, Elliptical arc, Freehand shape, Spline curve, Polygon, Double lines, Regular polygon, and Circle center tools. Dimension tools include Linear, Chain, Datum, Angular, Diametral, and Radial.

Beneath the column of tool icons is a pop-up menu of Method icons. Most of the drawing tools can create objects in several ways, and the icons in the Methods menu reflect those different ways. For example, when the Line tool is selected, you can construct a line from endpoint to endpoint or from center point to endpoint, or draw an unlimited-length line through a point. When the Circle tool is selected, you can draw the circle by center point and radius, by two points on the diameter, by three points on the circumference, or by a radius and two points on the circumference.

Claris CAD also has a group of Modifier icons that you use with either the drawing or selection tools. With these modifiers you can place objects in precise locations and in specific relationships to each other. Positional modifiers include Any point, Endpoint, Center point, Intersection point, Invisible intersection point, Point on object, Corner, and Percent along length.

You use these modifiers in conjunction with drawing tools to locate specific points as you draw an object. For example, to connect a line to the endpoint of another line, you use the Line tool and the Endpoint modifier. The Endpoint modifier automatically finds the endpoint of the existing line and connects the line you are drawing to it. You can then finish the line by selecting the Center point modifier and an existing circle, for example. The Center point modifier finds the center of the existing circle and connects the end of the new line to it.

Geometric constraint modifiers include Perpendicular, Tangent, and Offset. For example, to draw a line perpendicular to a line and tangent to a circle, you use the Line tool and the Perpendicular modifier, select the existing line, and then select the Tangent modifier and the existing circle. Offset can create a line parallel to an existing line, concentric arcs, circles, squares, and ellipses.

Selection tool modifiers, supported by a pop-up menu, let you use the selection arrow tool to adjust the size, shape, and position of objects. The selection arrow default is Resize; this is the way selection arrows behave in most Macintosh applications, dragging a handle to resize, dragging the object to move it.

This CAD Can

Claris CAD's approach of tool, method, and modifier combinations provides great latitude in the drawing process. One of its best modifiers is the Location bar. The Location bar is not merely a readout of the cursor coordinates but also an input panel for interactively keying in object creation data, such as center coordinate location and radius for a circle.

Also important is that after you select a tool icon, you can draw an object from the keyboard. If you need a modifier to draw the object, a key equivalent exists. You then only need the mouse to select the modifying geometry. There are key equivalents for most menu commands.

I even discovered that the Chamfer tool can be used as a corner tool by entering a zero chamfer length. I could then easily trim and extend nonparallel lines to their intersection point.

There is one minor annoyance. While you can easily create drawings with details drawn at different scales, the only way you can associate the details with the rulers used when drawing them is to store views of them with Set View. When you recall the views, the rulers displayed will be the ones displayed when you set the view. If you forget to display the proper rulers when setting the view or forget to set the view altogether, determining the scale of a detail can be a tedious process. But that's what drawing notes are for.

In many ways, I found Claris CAD comparable to VersaCAD for the Mac. Both are accurate, and both have positional and geometric modifiers, symbol libraries, hatching, and automatic dimensioning. VersaCAD has more sophisticated spline drawing and group building capabilities, plus the HyperCard utilities and IGES and DXF file translators. The question is, at over twice the price, do you really need those features?

Besides, I prefer Claris CAD's Location bar to VersaCAD's Input window for keyboard entry. Also, Claris CAD ran fast on my stock Macintosh SE; VersaCAD did not. The cost of an accelerator board or Mac II adds considerably to the price of VersaCAD. Even so, Claris CAD is not a hands-down winner over VersaCAD but a viable alternative. ■

Paul Tuten of Wichita, Kansas, is a tool-engineering contractor for the aircraft industry who uses a CAD system daily. He can be reached on BIX c/o "editors."

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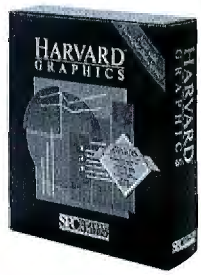

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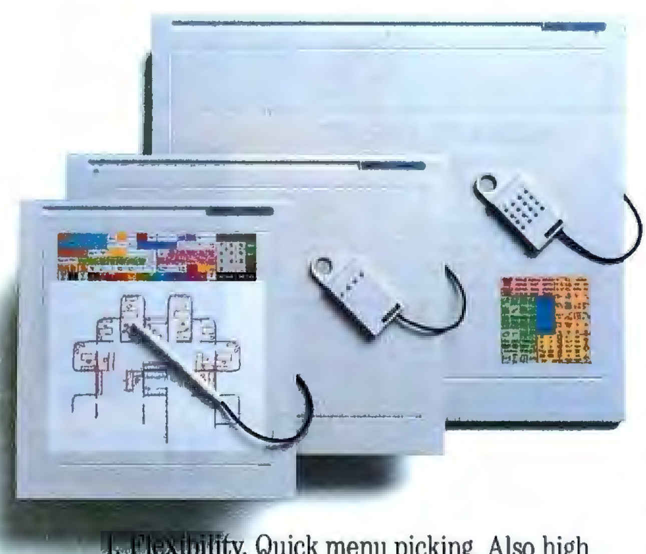

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Corel Draw Shows Great Promise

An advanced drawing and graphics program could be the best yet for the IBM PC AT

Sue Rosenberg

This could be the best yet: a versatile graphics tool set for IBM PC ATs and compatibles that lets you manipulate scanned images or create your own. With the extensive typesetting and drawing controls all in one package, you can produce high-quality graphics for dot-matrix, LaserJet, and PostScript printers and desktop publishing programs. It's called Corel Draw, and it could sway graphic artists away from the Macintosh.

To use Corel Draw 1.1, you'll need Microsoft Windows 2.0 or higher, EGA or higher graphics, a printer, and a mouse or graphics tablet. Included in the $495 package are a program disk, font disk, clip-art disk and handbook, user's manual, quick-reference cards, videotape tutorial, and typesetter's ruler. I tested Corel Draw on an AT compatible with a Paradise VGA board and a Logitech Mouse.

Less Is More

Corel's screen display is similar to that of most drawing programs. It uses a virtual 32-inch by 32-inch sketch pad with a drop-shadowed rectangle to indicate the printable page area.

The surprise is that there are fewer icon tools than in most other drawing programs—only Select, Zoom, Rectangle, Ellipse, Outline, Fill, Pencil, Shape, and Text. However, the tools have great versatility. Corel Draw has no rounded rectangle tool because you create rounded rectangles by pushing on one corner of a rectangle with the shape tool. It has no separate arc or wedge tools because the shape tool creates them from ellipses.

When you work on the sketch pad, you create only an outline of the drawing—a sketch that needs its outline inked in and areas painted with color. The Outline tool controls the angle, shape, and width of the pen nib, the ink color, the type of line it draws, and PostScript halftone screens. The Fill tool specifies the interior color, parameters and colors for fountain fill, and PostScript screens and textures.

Outline and Fill can be spot or process colors, and you can select one type for the outline and another for the interior of the object. Spot colors are defined using the Pantone Matching System. Process colors combine specified percentages of cyan, yellow, magenta, and black (CYMK) for more than a million selections. Corel dithers colors for display in the color selection box and on the preview screen.

The Pencil tool forms all line drawings—straight lines, polygons, and freehand curves. Corel calculates the mathematical equation of the Bézier curves needed to produce the shape you draw and then redraws the image. You control how closely the redraw follows every bump in your drawing, how it decides whether a segment is a straight line or curve type, when a corner should be smooth or cusped, and how close you must get to an end for line segments to be joined automatically.

For line drawings, the Shape tool becomes a "node editor" to add, delete, cut, paste, change the shape, and even change the underlying mathematical equation of each segment of the curve. A menu command, Convert to Curve, transforms rectangle, ellipse, and text

continued

Corel Draw 1.1

Type
Advanced drawing program

Company
Corel Systems Corp.
1600 Carling Ave.
Ottawa, Ontario K1Z 8R7, Canada
(613) 728-8200

Format
Three 1.2-megabyte 5¼-inch floppy disks

Hardware Needed
IBM PC AT or compatible with hard disk drive; EGA, VGA, or Hercules graphics card; printer; mouse or digitizing tablet

Software Needed
Microsoft Windows 2.0 or higher

Documentation
User's manual; videotape tutorial (VHS); clip-art handbook; quick-reference cards

Price
$495

Inquiry 883.

objects into curves so you can then edit the underlying shapes.

The Text tool sets type—up to 250 characters at one time—using one of some 50 fonts in a point size taken from a range of from 1 to 999, including fractional sizes. Selecting individual characters with the Shape tool lets you mix fonts, produce subscripts and superscripts, rotate, change horizontal and vertical alignment, modify point size, and kern text interactively. You can edit text even after it has been rotated, skewed, stretched, mirrored, and fitted to a curve. However, the only changes you can make are insert and delete. There are no commands to cut and paste or to convert between uppercase and lowercase.

Adding to Corel's power are numerous menu commands and keyboard shortcuts. One favorite of mine is Repeat, which repeats the last action you performed on the next object you select. You can also define macros to repeat a series of commands.

Corel's commands are sufficiently intuitive, and if you are familiar with other drawing programs, you'll have almost no need to refer to the manual. I say "almost" because there's no on-line help to tell you about neat shortcuts, like pressing the space bar to activate the previously selected tool. Read the manual in any case. It's excellent, everything a manual should be—clearly written and well organized with extensive step-by-step illustrations, many of which are also supplied as Corel Draw files. A two-hour videotape provides more training in basic techniques.

Warhol à la Corel

To test Corel, I attempted to duplicate a Campbell's Tomato Soup can label as closely as possible. I was inspired by Andy Warhol, of course, but it was a good choice of subject. To reproduce the label's diverse graphical elements requires nearly all of Corel's commands.

I started with the Campbell's logo. None of the script texts came close enough to the swirling "C" of the logo, so I started with an ellipse that I rotated, opened into an arc, and converted to a curve. Using the Shape tool, I added a node to anchor the outline where the line changed directions.

It took half a dozen different fonts to form the other nine characters in the logo, demonstrating the power of the program to manipulate text. The text editor's dialog box shows only one character of a selected font, but you can choose which character to display. That option turned out to be particularly helpful when I was looking for specific letters and characters.

Type for "CONDENSED" is appropriately condensed vertically but diluted horizontally. There are two ways to change the horizontal and vertical proportions independently: the visual, in which a selected object is transformed by selecting a handle and moving the pointing device; and the mechanical, a menu selection, where you perform transformations by entering numbers in a dialog box. Visual transformations, such as shrinking, skewing, and mirroring, take effect relative to the side or corner opposite the handle. Mechanical transformations occur relative to the center line of the object.

Since I had not yet moved the word to its final resting place, I found the visual approach easier for me to judge when the letters were at the proper height. I used the Select tool to condense the height of the letters and then used the Shape tool to grab a handle at the end of a text string to change the intercharacter spacing. "Tomato" was the next word I tried. One of the many fonts supplied with Corel Draw approximates the font used for "Tomato" on the soup can label, but it needed minor modifications. I typed "Tomato," selected the font, and then converted the text to curves. This time, using the Shape tool, I selected all left-side serifs and moved them at once so that they would be converted equally. That worked, so I moved the right-side serifs. Then I squared each "o."

Producing the label's seal was also easy. Text fitted to a curve is the simplest process of all. Corel does all the hard work for you. I just drew the curve and told Corel to fit the text to the curve.

I used the ellipse, rectangle, and line-drawing shapes to form the rest of the seal. Rather than reproduce exactly the intertwined figures on the seal, I scribbled an approximation with the Pencil tool and then used the Shape tool and node editor to remove extra lines and reposition others. I suspect that the reason the Shape tool worked flawlessly here was that it was manipulating objects that were created as curves, not converted to curves.

Portions of the soup can label that I had anticipated having difficulties with turned out to be incredibly easy to assemble. I compiled the fleur-de-lis border from an imported clip-art image. I made a minor adjustment to the image, colored it, set up a grid, and then replicated the image snapped to the grid to ensure an evenly spaced border.

Similarly, "SOUP," with a double outline and a rotated "O," was an easy process. I just typed the word, rotated the "O," duplicated the image on top of itself, and added color. With a judicious selection of pen widths, the outline of the back image peeked out from behind the front.

To speed up the drawing process, Corel Draw shows the picture in color and with proper pen widths only when preview mode is active. Both the drawing board and preview mode can appear side by side on-screen, and adjustments to the drawing can be reproduced immediately in the preview window, displaying the proper pen widths and colors. You can also specify that only the selected portions of the object are to be updated in the preview window when a change is made to the drawing.

Bit-Mapped Imports

I also checked out the way Corel handles bit-mapped images. In particular, I wanted to see how the auto-trace option works. One of my coworkers had a PCX bit-image file handy. It was part of a set of slides for lecturers to use instead of scribbling on a whiteboard. The file

continued

contents were fairly simple: three ellipses with a couple of words in each and arrows drawn between them. However, when Corel had completed its auto-trace, the program had transformed the bit image into something that looked as if it had been hand-drawn on a whiteboard. Even the straightest of straight arrows had a certain artistic flair. Changing auto-trace preferences to track the objects either more or less closely had no noticeable effect on the drawing.

The artistic effect occurs because Corel's auto-trace is set up mainly for freehand or scanned images—not for straight lines and regular curves. The tracing algorithm is supposed to capture accurately about 85 percent of the outline. Results are predictable only in the sense that the identical image in different locations is likely to be traced identically.

There was a certain charm to Corel's version of the bit-mapped drawing, particularly after the proportions were changed and the images colored—so much so, in fact, that I decided the drawing was worth saving. However, when I tried to save the file, up popped "System error. Cannot read from drive C:" Neither of the two button choices, Retry or Cancel, had any effect, nor was I able to exit to either the Windows environment or DOS. Apparently, some action in manipulating the auto-traced file caused a hard disk failure. Fortunately, this was only a transient problem that did not recur after the computer was turned off and turned back on.

Corel Draw can import and export its own CDR format files, PCX and TIFF bit-image files, import Adobe Illustrator ART and Lotus PIC object files, and also export EPSF and Windows Metafile. Surprisingly, for a program that requires the Microsoft Windows environment, it cannot import a Windows file.

WordPerfect 5.0 could read and display the exported files. I would not pay any attention to the manual's suggestion that you select the smallest file size to conserve space. Instead, pick the highest resolution to reproduce the image with any kind of accuracy. And when you want the printed image to fit on one physical page, either select Fit to Page or enlarge the page size. There are invisible margins that the printable page area doesn't tell you about.

Not a Clear Picture

Corel Draw has the potential to become the program of choice for producing professional-quality graphics art for all kinds of people with varying degrees of artistic talent and computer ability. Commands are intuitive, the program is easy to learn, and it is packed with features. But there are a number of problems. Some are mere annoyances, like sometimes locking up the system after a drawing is printed. Some are more significant, like occasionally printing descenders under the wrong letters. And some, like an error indicating a hard disk failure, may portend more substantial problems.

Would I continue to use Corel Draw? Yes, I would. Although the current version is far from perfect, it's more than just pretty good. As a matter of fact, I admit that I've become addicted to Corel Draw. ■

Sue Rosenberg is a consultant at James Martin Associates in Reston, Virginia. Her secret ambition is to become a typeface designer. Sue can be reached on BIX as "suer."

June 1989

BYTE

Bonus All-Mac Issue

Macintosh Special Edition

Mac vs. NeXT
SuperPaint
Swivel 3D
Pushing Standard File to the Limit
The Z88 as a Mac Accessory
Plus More

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BYTE

Macintosh Special Edition

EDITORIAL

A Source of Mac Information

BIX is different from BYTE—and yet the same

BIX (the BYTE Information Exchange) is an on-line service where people come to ask and answer questions about using their computers. All sorts of computers, to be sure, but if you're reading this part of the magazine, I'm here to tell you that there's definitely an electronic watering hole for Macintosh users.

A Change for the Better

If you're one of those who uses BIX regularly for Mac information, you're probably aware that the macintosh conference has been closed for a few months. However, that's because it has been replaced by something better: eight Mac-related conferences that are collectively termed the Macintosh Exchange.

Although the name may have changed, the asking (and answering) of technical questions goes on. It wouldn't be BYTE-ish if it didn't, right? Not to mention the massive diatribes on the Great Mac Questions of Today by people who are intimately involved with those same questions. (Is it better to use System 6.0.2 or 6.0.3? Should I buy an ImageWriter LQ Plus?) Even people from Apple come to BIX to lend expertise and advice.

But unless you telecommunciate via modem, you miss the rich two-way experience that happens here. Worse, you miss the ability to subscribe to an interactive BYTE: up-to-the-minute news information, plus timely reviews of products and services when you need them. For example, you can get tips on how to lay out your first-ever report perfectly on the LaserWriter, the very same day you ask for help. The power of BIX is that you get answers to *your* particular question, when you need it. Also, the Mac listings area has lots of public domain and shareware applications, desk accessories, and INITs to help you use your Mac more efficiently.

Come Join Us

BIX is for rank beginners as well as intermediate folk. Anyone interested in the Mac will find something of interest in the Macintosh Exchange. Because it's on BIX, it has all the resources and people of BYTE available to it. Because it's about the Mac, you can use it. I hope to see you on-line soon.

—Laurence H. Loeb
Editor, the Macintosh Exchange
(BIX name "lloeb")

PSpice

Mixed Mode Simulation Now Available on the Macintosh II

Since its introduction just over five years ago, MicroSim's PSpice has sold more copies than all other SPICE programs combined. In addition to running on the IBM PC family, including the new PS/2 and the Compaq 386, the Sun and Apollo workstations and the VAX/VMS family, PSpice is also available on Apple's Macintosh II.

All these features which have made PSpice so popular are available:

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- GaAs MESFET devices.
- Non-linear transformer devices modeling saturation, hysteresis, and eddy current losses.
- Ideal switches for use with, for example, power supply and switched capacitor circuit designs.

In addition, all these PSpice options are available on the Macintosh:

- Monte Carlo, Sensitivity, and Worst Case analyses calculate the effect of parameter tolerances on circuit performance.
- The Probe "software oscilloscope", provides interactive viewing of simulation results.
- The Parts parameter extraction program, allows you to extract a device's model parameters from data sheet information.
- Digital Simulation, allows you to simulate mixed analog/digital circuits, including feedback loops between analog and digital. A library of over 600 common TTL parts is included.

Each copy of PSpice comes with our extensive product support. Our technical staff has over 100 years of experience in CAD/CAE, and our software is supported by the engineers who wrote it.

For our free information packet, including our PSpice demo program for the Mac, call us at (714) 770-3022 or **toll free** (800) 826-8603. Find out for yourself why PSpice is the standard in circuit simulation.

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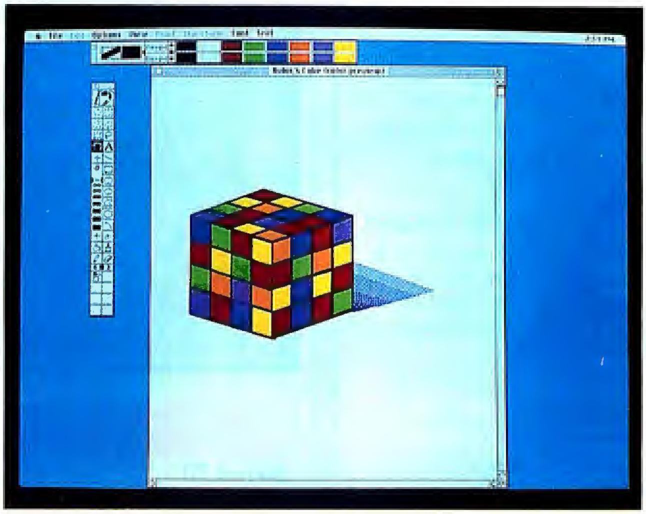
BYTE editors' hands-on views of new products

SuperPaint 2.0

Swivel 3D



THE FACTS

SuperPaint 2.0 $199 *Requirements:* Mac Plus, SE, SE/30, or II with 1 megabyte of RAM and System 6.0.2/Finder 6.1 or higher.	Silicon Beach Software, Inc. 9770 Carroll Center Rd., Suite J San Diego, CA 92126 (619) 695-6956 **Inquiry M200.**

Industrial-Strength Graphics

The original version of Silicon Beach Software's SuperPaint merged the dissimilar strengths of object drawing and bit painting by letting you compose an illustration in two layers. You used a draw layer to manipulate objects (e.g., arcs and circles) that print with PostScript's precision (like MacDraw). A paint layer let you work with bit-mapped images (like MacPaint). The newly introduced **SuperPaint 2.0** follows this two-layer concept while correcting problems the earlier version had with the Macintosh II family's color displays and adding significant new features.

Here are a few of the new features in the draw layer: a freehand Bézier drawing tool, the ability to draw and print hairlines, and a set of gray patterns that correspond to PostScript halftones when these patterns are output on a laser printer. The paint layer has the usual MacPaint-style tools. However, with the airbrush tool, you can modify not only the shape of the spray area and its size, but you can also alter the flow rate, pattern, and dot size of the digital "ink."

SuperPaint 2.0 supports only the eight fixed QuickDraw colors. SuperPaint's function is not to serve as a color painting application, but as a tool to generate industrial-strength business and technical graphics where color is used sparingly, if at all. All editing work is done strictly in black and white, but a color preview selection lets you examine your handiwork in color on a Mac that supports it.

An auto-trace function traces the outlines of bit-mapped images in the paint layer, rendering a duplicate of the image in the draw layer as sets of polygons or Bézier curves. You might use this in a situation where you would scan a technical drawing, auto-trace it in SuperPaint, and edit the drawing for use as a figure in a technical manual.

The most intriguing part of SuperPaint 2.0 is its plug-in tools. These are files, which contain executable code, that appear as tools or as menu selections inside the SuperPaint application. For example, the spiral tool draws spirals, a quill tool closely mimics the actions of an ink quill, a bubble tool sketches bubbles of varying sizes, and another tool draws three-dimensional boxes—with shading, if it's needed—with the stroke of the mouse. The plug-in tools show SuperPaint's real potential, because the application itself can be expanded as Silicon Beach Software or other vendors supply plug-in modules that have more complex features.

I tried SuperPaint 2.0 on a Mac Plus, a Mac II with a SuperMac 19-inch color monitor, and a Mac SE/30. The tools behaved much like those found in MacPaint and MacDraw: the sort of consistent behavior you demand of Mac applications. I scanned some pen-and-ink drawings with a Howtek Scanmaster into MacPaint documents (auto-trace doesn't work on PICT files). SuperPaint's auto-trace function worked reliably, with no bombs. It's a godsend for simple art. For more complicated images, however, you'll probably spend more time than it's worth tweaking curves trying to finish up the image.

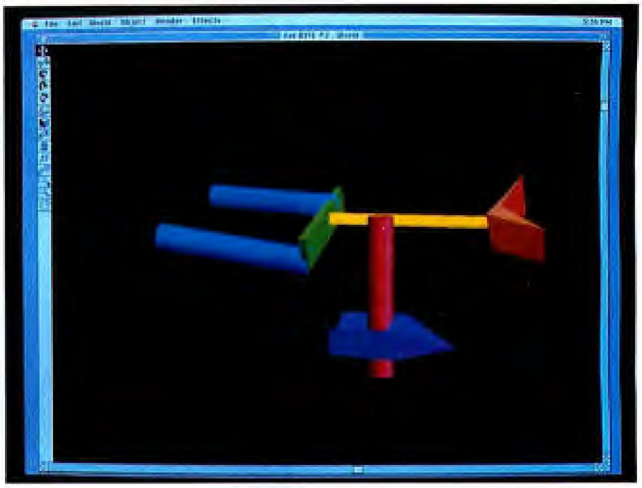
If you want a drawing application that's a lot more capable than MacPaint but don't need full-blown color, SuperPaint looks like the one to buy. If you use MacDraw to crank out images daily for trade journals or newspapers, you should check it out. It has a number of features that make it handy for such work, particularly the auto-trace function. I wish it had a trace function (as Illustrator does) for manually tracing over complex artwork. Perhaps somebody might devise a plug-in tool to do just that.

—Tom Thompson

Mac Modeling in 3-D

Swivel 3D for the Macintosh is an attempt to extend the two-dimensional world of object-oriented drawing programs like MacDraw into three-dimensional modeling, and it's a successful attempt. VPL Research wrote the program in MacForth to satisfy its own modeling needs for the DataGlove it produces (the DataGlove, which is used by NASA when it is doing research in computer-generated simulations, is a pointing/grasping device that you wear on your hand and use to com-

continued



THE FACTS

Swivel 3D
$395

Requirements:
Mac with at least 1 megabyte of RAM, System 1.0, and Finder 6.1.

123 Townsend St.,
Suite 310
San Francisco, CA
94107
(415) 543-3848
Inquiry M201.

municate with the computer).

The key to Swivel 3D is the way it can link the movement of different objects created in the program to each other. These movement links can be linear (like a drawer constrained to only straight-line *x*- and *y*-axis movement), ball and socket (free to rotate but not to translate around one of the endpoints), and free (any movement is OK). This feature is not found in any other program that we're aware of, and it works well for the simulation of three-dimensional movement. Without this sort of linking, the program would simply be another sophisticated drawing program. With these links, movement simulation becomes possible.

It's easy to create objects with the package's tools and the four standard isometric views of the editor. Rendering functions let you develop wire-frame models and also alter contours and shading (with an adjustable light source). The speed of the screen redraws on the Mac Plus, with full rendering switched on, is an order of magnitude faster than any similar program we've tried; such redraws are usually so slow as to be annoying. It looks like the product's programmers did some tight coding here.

Another important feature in Swivel 3D is its "tweening" capability. You specify a start and a stop, and the machine can then generate intermediate views. This works well, but a player program to use these animations (much like the one Silicon Beach Software included with Super 3D) would be a welcome addition. The intermediate views can be saved in MacPaint format.

Two versions of the program come in the box. One works on a Mac with 1 megabyte of RAM or more; the other works on a Mac with 2 megabytes or more. They differ only in the size of memory swaps used internally. We used the higher-memory-size program, and it ran nicely.

This is a unique and well-crafted program that should find its way into the libraries of all serious modelers.

—D. Barker and Laurence H. Loeb ■

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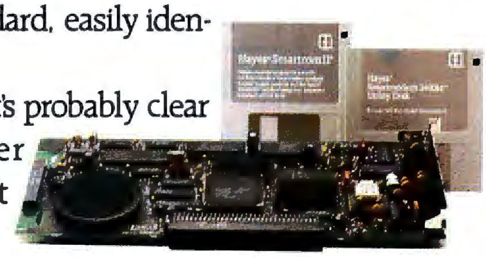

By now it's probably clear that whether they're just used with the Macintosh II or shared by Mac computers on an AppleTalk Network, the Smartmodem 2400M and Smartcom II make a communications system that can't be beaten. At least not by anything on this planet.

Hayes.

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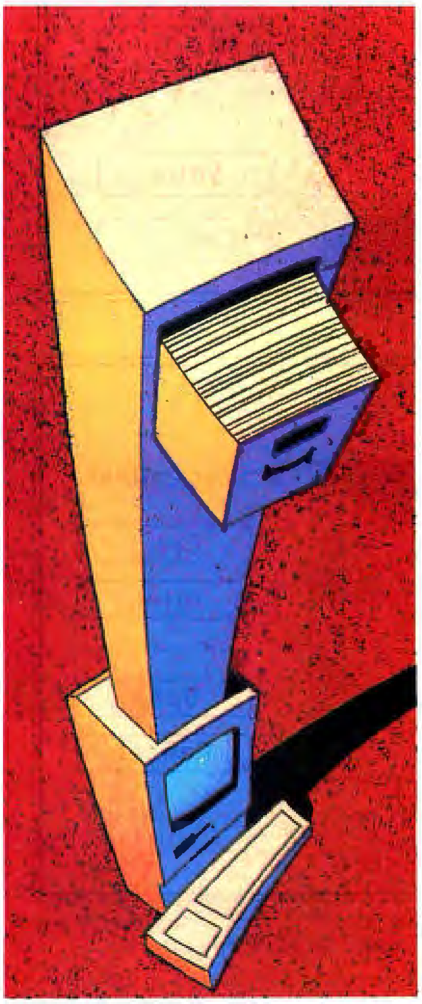
Circle M10 on Reader Service Card

 Circle M1 on Reader Service Card (DEALERS: M2)

Pushing Standard File to the Limit

Jan Eugenides

You can modify Standard File to customize file-selection menus



I began my computing career with an Apple II+. Filenames were short, and DOS 3.3 had no subdirectories. Entering a filename was no big deal. Then came ProDOS. I remember having to type long path names just to open a deeply nested file. One typo, and you had to type it all again. I remember thinking there had to be a better way.

The Standard File Package is the Macintosh's idea of a better way. Standard File is part of the Macintosh System software. It is designed to give the user an easy way to select a file—by displaying a list of filenames from which to choose. Standard File displays the contents of one directory (or folder) at a time in a scrollable filename list. You need to type the filename only once, when creating the file. Thereafter, you simply select it from the list. Point and click. No typos.

There are two regular Standard File dialogues, one for saving files (the SFPutFile dialogue) and one for choosing files (the SFGetFile dialogue). They behave similarly and look very much alike (see figure 1). Each displays a list of folders and files, buttons for switching between drives and ejecting disks, and buttons for opening folders or files and for canceling the dialogue. The SFPutFile dialogue also has a field of editable text for entering a filename.

From the user's point of view, it's an easy system to use. All Macintosh applications use Standard File, so you learn it once, and that's it.

From a programmer's point of view, things are not quite so simple. For some applications, the regular dialogues are sufficient. Then the programming is easy. For other applications, however, Standard File falls short in many areas.

For example, Standard File provides almost no visual cues as to the nature of the files. The user can't see the files' icons and has no clue to their contents other than their names. He or she can tell if they are documents or applications, but that's about it. On a graphics-based system like the Mac, that's almost a crime. And if you, as the programmer, need to let the user select file formats or other file attributes, you can't do it with the standard controls.

The designers of Standard File made it extensible, but the flow of control is somewhat convoluted. Understanding comes slowly, but the system is remarkably powerful once you have fathomed it. With a little work, it'll do just about anything.

In the course of my work, I have spent many hours working with Standard File. In the process, I've developed some useful techniques for modifying its behavior, and I'd like to share some of them with you. *Inside Macintosh* and *Apple Tech Notes* make mention of some of these techniques; however, neither of those sources is always as clear as it could be. I figure there's nothing clearer than a good working example, so I've written a demonstration program to accompany this article. The other techniques discussed here are my own and haven't appeared anywhere else.

Due to space limitations, I'm not going to describe the normal functioning of Standard File in any detail; I'll assume you already understand how to use the regular Standard File calls. If you don't, I suggest you read *Inside Macintosh*, volume 1, chapter 20.

Adding New Controls

The two regular Standard File dialogues are stored as resource templates in the System file. The SFGetFile dialogue is stored as DLOG −4000, and the SFPutFile dialogue as DLOG −3999. Each DLOG has an associated dialogue item list (DITL) with the same ID number.

Two functions display and handle the Standard File dialogues. They are declared as follows (in C):

```
pascal void SFGETFILE
    (where,prompt,fileFilter,
```

continued

```
  numTypes,typeList,dlgHook,
  reply)
 Point        where;
 Str255       *prompt;
 ProcPtr      fileFilter;
 short        numTypes;
 SFTypeList   *typeList;
 ProcPtr      dlgHook;
 SFReply      *reply;

pascal void SFPUTFILE(where,
  prompt,origName,dlgHook,
  reply)
 Point        where;
 Str255       *prompt,
              *origName;
 ProcPtr      dlgHook;
 SFReply      *reply;
```

The point where determines where on the screen the dialogue is displayed. The string prompt is displayed above the editable filename in the SFPutFile dialogue (it is not displayed anywhere in the SFGetFile dialogue). The ProcPtr (procedure pointer) dlgHook points to a procedure, which you provide, that handles the dialogue's controls (you would pass NULL to use the default handler), and the ProcPtr fileFilter points to a procedure that determines which files are displayed in the list. The variables numTypes and typeList provide a simple way of limiting the files displayed to certain types.

The SFReply record is filled in by the Standard File routines and contains all the information you need to access a file. It is declared like this:

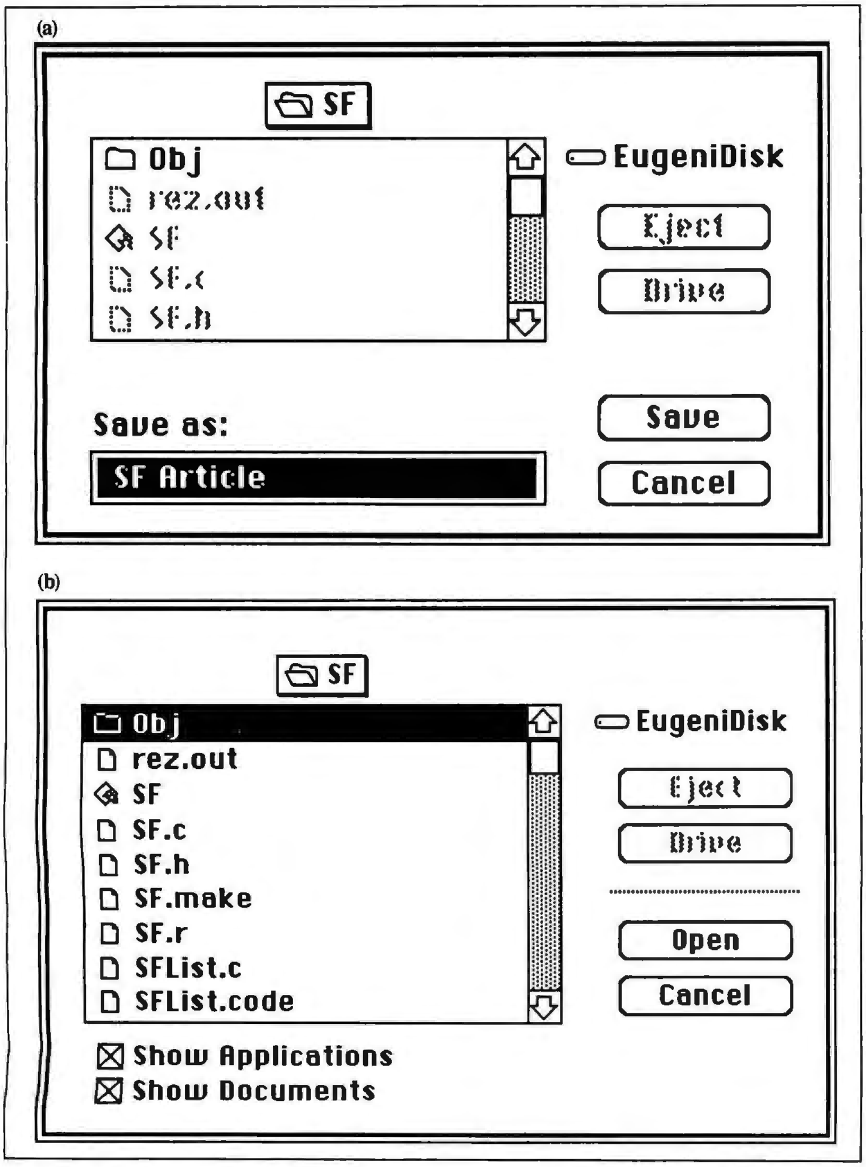


Figure 1: *The two regular Standard File dialogues:* **(a)** *SFPutFile, and* **(b)** *SFGetFile, with file filter checkboxes.*

```
typedef struct SFReply {
  Boolean good;
  /*whether the dialogue was
  canceled or not*/
  Boolean copy;
  /*unused*/
  OSType fType;
  /*the file's type*/
  short vRefNum;
  /*the directory reference
  number*/
  short version;
  /*the version, usually
  ignored*/
  String(63) fName;
  /*the name of the file,
  preceded by a length byte*/
} SFReply;
```

There are two ways to add controls to the Standard File dialogues. One way is to provide alternate DLOGs and DITLs that have the same ID numbers as the regular ones. If these are put into the resource fork of your application, they will be used in place of the regular ones whenever you call the Standard File routines.

The other way to add controls is, again, to provide your own DLOGs and DITLs, but then pass the ID numbers of these templates directly to Standard File, using these two alternate calls:

```
pascal void SFPGETFILE(where,
   prompt,fileFilter,numTypes,
   typeList,dlgHook,reply,
   dlgID,filterProc)
  Point         where;
  Str255        *prompt;
  ProcPtr       fileFilter;
  short         numTypes;
  SFTypeList    *typeList;
  ProcPtr       dlgHook;
  SFReply       *reply;
  short         dlgID;
  ProcPtr       filterProc;

pascal void SFPPUTFILE(where,
   prompt,origName,dlgHook,
   reply,dlgID,filterProc)
  Point         where;
  Str255        *prompt,
                *origName;
  ProcPtr       dlgHook;
  SFReply       *reply;
  short         dlgID;
  ProcPtr       filterProc;
```

Both SFPGetFile and SFPPutFile provide you with an additional hook, the filterProc. It allows you to intercept events, a capability that can be very useful indeed.

The only stipulation when creating your own dialogues is that any new controls must be in addition to the regular controls. You cannot remove or renumber any of the standard controls. You can, however, reposition them or change their titles.

Thus, the minimum you must do to add controls is to create your own dialogue templates and write a `dlgHook` procedure to handle them. The `dlgHook` is declared as follows:

```
pascal short dlgHook(item,dlg)
  short      item;
  /*the item that was clicked
  on*/
  DialogPtr  dlg;
  /*the dialogue pointer*/
```

It must return an item number (not necessarily the one it was passed). This feature can let you change a click on one of your controls to a click on a standard control. But most often, you'll simply pass `item` on unchanged, doing nothing unless one of your extra controls is clicked on.

In the demonstration program that accompanies this article, I've added two checkboxes to the SFGetFile dialogue (see figure 1b).

Four Quick Tricks

Here are four dialogue-hook tricks that can make your life easier. First, before Standard File displays the dialogue, it calls your `dlgHook` with an item of −1. This lets you do any necessary initialization before the dialogue appears on the screen. If you need to change the titles of any of the buttons before they appear, this is the time to do it. If you have radio buttons or checkboxes in your dialogue, this is the time to turn them on or off.

Second, returning 101 for the item number causes Standard File to redisplay the list of files. This can be useful for implementing special controls that specify what types of files to display. When the control is clicked on, you can set up your file filter and then return 101 to redisplay the list with the new filter. The demonstration program does this.

Third, the item #102 is passed to your `dlgHook` whenever the pop-up menu that displays the list of directories is clicked on. Usually you don't need to know this, but for the graphical version shown in the demonstration program, it's essential.

Finally, there is a way to determine which folder on which volume Standard File will display. There are two low-

continued

memory globals that control this: SFSaveDisk and CurDirStore. To display a particular directory, put the negative of the volume reference number in SFSaveDisk and put the directory ID (the unique directory ID number, not the working directory reference number) in CurDirStore before calling Standard File. To change directories in midstream, set the globals and then pass the `item` 101 back from your `dlgHook` to redisplay the list. (This works only in System 6.0 or higher; earlier Systems will not change directories.) If you need to display the root (uppermost) directory, use 2 for CurDirStore. You can also read from these globals to determine which directory is currently being displayed.

Standard File will crash if the standard userItems are not there.

Controlling the Display of Files

File filters let you control which files are displayed in the SFGetFile list. A filter is declared like this:

```
pascal Boolean ourFileFilter
 (ParmBlkPtr pb);
```

The filter is called once for each file in the directory, just before the list of files is displayed. The parameter block is filled in with the file information. All you have to do is examine the information and return TRUE for those files that you do not want in the list, and FALSE for those files you do want in the list. I call this the "No Bananas" routine, because in effect you say "Yes, I don't want this file in the list." Rumor has it that Standard File was originally written in two days. If that's true, it was a heck of a good job, and I can forgive the designers this small idiosyncrasy.

In the demonstration program, I use two added checkboxes to select whether to display applications and documents. The file filter checks the values of these checkboxes and acts accordingly. When both checkboxes are checked, the SFGetFile dialogue acts normally, displaying all files. When the Show Applications checkbox is unchecked, applications disappear from the display. When the Show Documents checkbox is unchecked, documents go away. When they are both unchecked, only folders appear.

Of course, a file filter need not check file type but can examine any file attribute. You can write a filter that displays only files with the word *Fred* in their names or that displays only files created after a certain date. It's up to you.

How to Intercept and Modify Events

For really special needs, the `filterProc` gives you control over the events that the dialogue encounters. All events, including both user events, such as key presses and mouse-clicks, and system events, such as window updates, are passed through the `filterProc` before Standard File handles them. This allows you to intercept them and handle them your own way. You can even modify them before passing them along. A `filterProc` also has access to the item that has been clicked on. This means, for example, that you can change a certain keystroke into a click on a particular control.

A `filterProc` is declared like this:

```
pascal Boolean  ourGetFilter
   (dpeek,ep,itemhit)
DialogPeek       dpeek;
EventRecord      *ep;
short            *itemhit;
```

The event record, pointed to by `ep`, contains information about the current event. The value returned in `itemhit` is interpreted by Standard File as a click on that item.

The demonstration program shows several interesting things that can be done in the `filterProc`. For example, null events are transformed into a click on item #45 if a disk has been inserted or ejected. There is no item #45 in the dialogue, but the dialogue hook is written to treat a click on item #45 as a signal to update the graphical list. This is how the graphical list stays synchronized with the Standard File display.

If the Return or Enter key is pressed, the `filterProc` translates the key press into a click on item #12, which is the "fake" Open button.

Finally, when update events are encountered, the graphical list is redrawn to ensure the proper appearance of the dialogue.

Overriding the Normal Controls

Take a close look at figure 2, the sample graphical file list. It looks like a regular

continued

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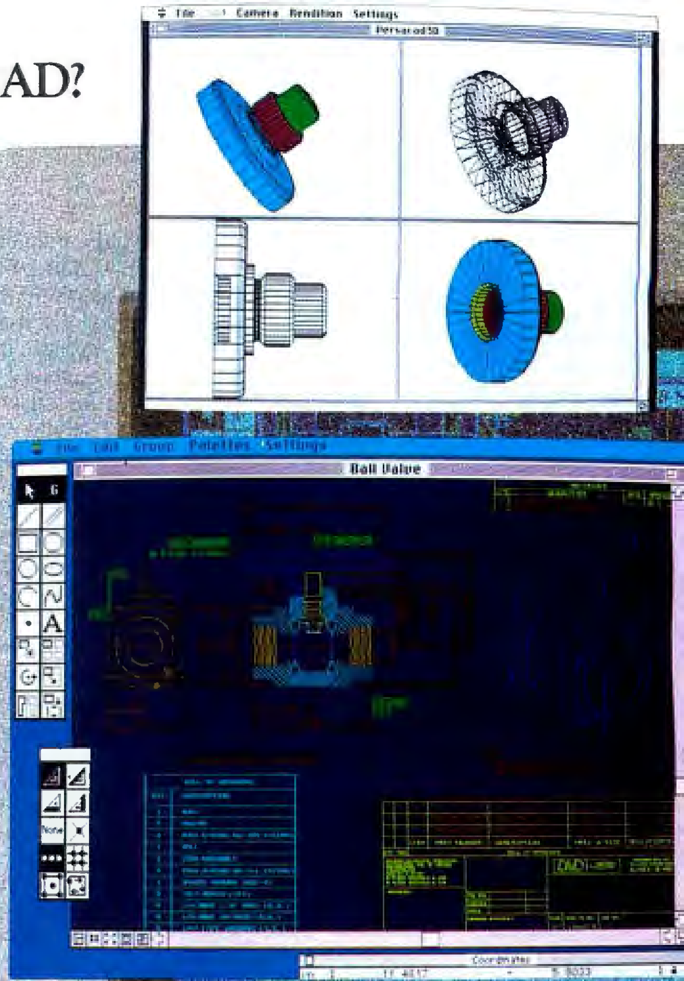

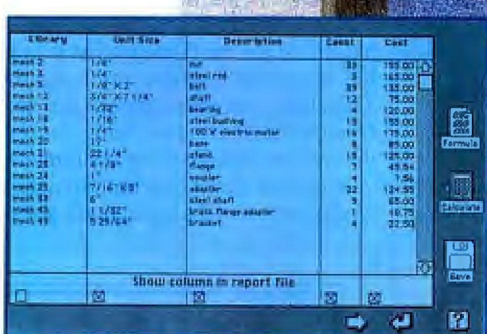

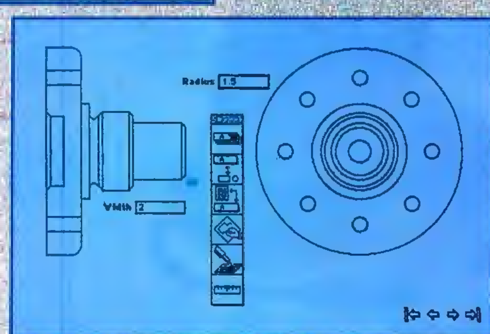

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SFGetFile dialogue except for the list of names, doesn't it? But there's more here than meets the eye. You see, the regular filename list is actually still there. It has to be, because the pop-up menu that displays the folder path always appears just above the filename list. Besides, Standard File will crash if the standard userItems are not there (there are two, one for the list and one for the scroll bar). So the filename list is there, but it's only 1 pixel high, and it's hidden behind the top line of the graphical list. Check out the Rez source code I've provided (SF.r—see below), and you'll see what I mean.

Now look at the Open button. It looks normal enough, but in fact the real Open button (which is always item #1) is way off to the right, beyond the edge of the dialogue, where you can't see it. The one you see is item #12, an added control. This little piece of subterfuge is necessary because of the way Standard File handles a click on the Open button.

When the Open button is clicked, Standard File gets the selected item from the filename list. If it's a file, the information for that file is returned, and the dialogue is closed. If it's a folder, the folder is opened and its contents displayed. Since the filename list is hidden, the user can't select anything there. Therefore, you must prevent the normal Open button from ever being clicked, so that you can handle things your own way.

When the fake Open button (item #12) is clicked, your dialogue hook goes into action. The selected item from your graphical list is retrieved. If it's a file, the information for that file is placed in your global SFReply record, and an item number of 3 is returned. Standard File interprets this as a click on the Cancel button, and the dialogue is closed. This means that the data in the SFReply record that was passed to SFGetFile will be invalid (since Standard File fills it in). That's why you use your global SFReply record, which is filled in by your dialogue hook, instead.

If, when Open is clicked, the selected item is a folder, the routine DownOne() is called. This routine figures out the directory ID of the selected folder and stuffs that into CurDirStore to cause Standard File to display the folder. Then the graphical list is cleared, and the contents of the new folder are displayed. Returning item #101 causes Standard File to redraw its items for the new folder, and everything is in sync again.

The great thing about this method is that Standard File operates completely normally, handling disk insertions and ejections and handling the pop-up folder menu. The only thing your program does is keep track of its own graphical list. Thus, the method is sure to be compatible with future System releases unless Apple changes the rules, and with so many applications depending on Standard File, that's not very likely.

The graphical display used in the demonstration program is very simple, to

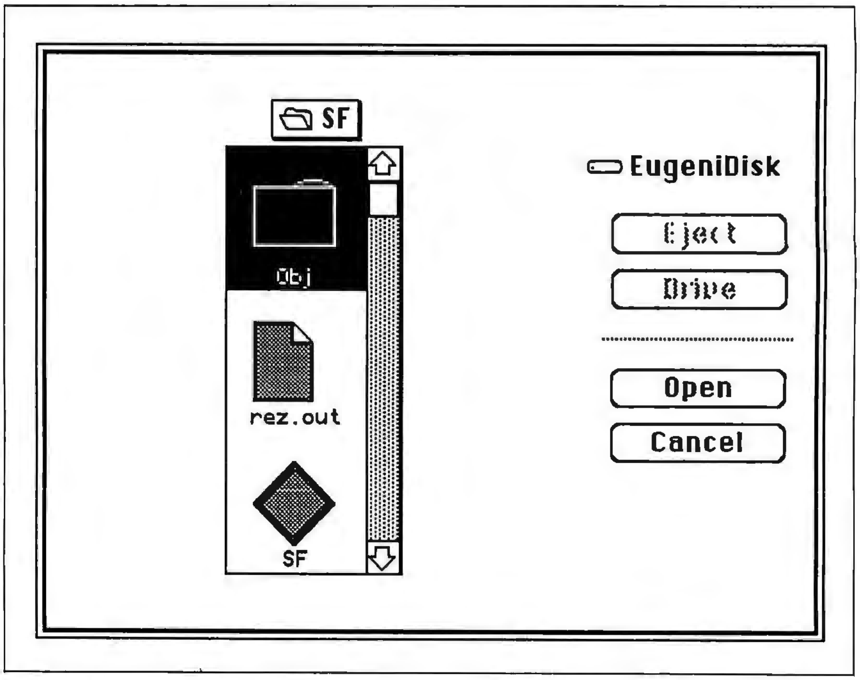

Figure 2: *A graphical file list.*

keep the code short and clear. There are three pictures—one of a folder, one of a dog-eared piece of paper, and one of a diamond shape—that are used for folders, documents, and applications, respectively. You could easily modify this to use the actual icon from the file. Or, as I did in my company's product, The Curator, you could display the contents of the file in some graphical form.

One note of caution: With all these techniques at your disposal, it is possible to overload the Standard File dialogue with all kinds of controls, resulting in a confusing user interface. Before you add controls to Standard File, consider whether there are other, better ways to provide the user with the same functionality.

Feel free to write me if you have questions or comments. And if you use any of these techniques in an imaginative way, I'd love to see your program. I'm on BIX as "j.eugenides," on CompuServe as "74065,16," on Delphi as "ASMCOR," on MCI Mail as "Jan Eugenides," and on AppleLink as "D2015."

Source Code

The source code for the demonstration program referred to in this article is too lengthy to be printed here. It is, however, available in a variety of formats (see page 5 for details). It is written in MPW C.

There are several source files:

`SF.c`	This is the main source module.
`SFList.c`	This is the list definition for the graphical display.
`SF.r`	This Rez source file creates the resources.
`SF.h`	This is the header file.
`SF.make`	This is the make file.
`UserStartup`	This is a customized MPW start-up document.

To use the source code, first create a folder in your MPW folder and name it SF. In the SF folder, create another folder and call it Obj. Put all the source files except for `UserStartup` into the SF folder. Put the `UserStartup` document into the MPW folder. If you have your own `UserStartup` file, append the contents of `UserStartup` to your version.

Run MPW. To build the program, press Command-2. ■

Jan Eugenides is a senior software engineer for Solutions, Inc., in Williston, Vermont. He can be reached on BIX as "j.eugenides."


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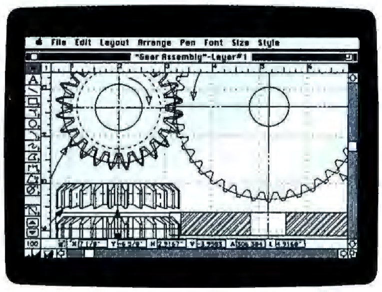

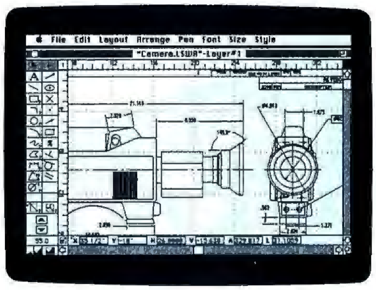

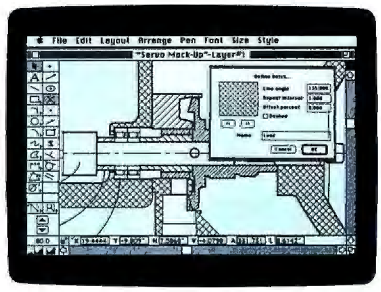

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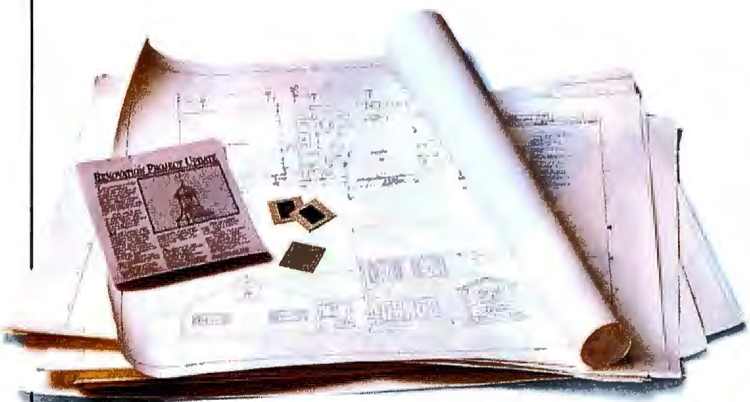

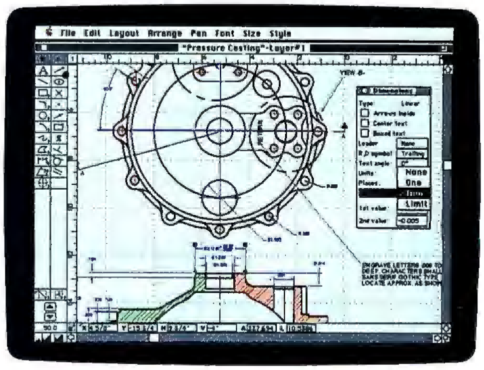

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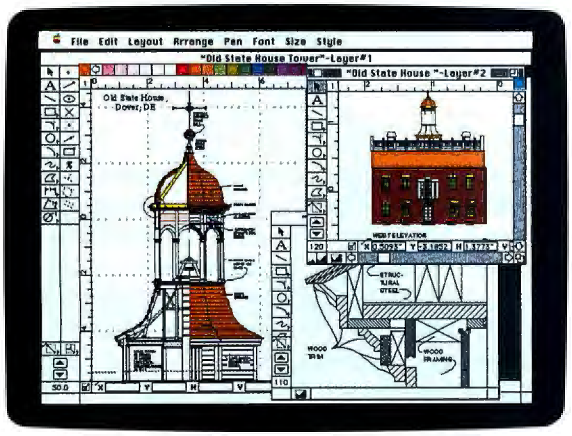

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The Mac Interface: Showing Its Age

Don Crabb

The best microcomputer user interface needs revamping, lest it turn from state-of-the-art to stodgy

A month ago, my NeXT computer showed up, with its 17-inch MegaPixel display, 256-megabyte optical disk drive, 660-megabyte hard disk drive, and 400-dot-per-inch laser printer. During my first two weeks with the NeXT computer, my thoughts haven't focused so much on this machine as on the Macintosh. I find myself thinking about how far the Mac has progressed in the last five years and how it compares to the NeXT computer.

Upon considerable reflection, I have to once again give my kudos to Apple for producing what I still think is the best personal computer on the market. Not the fastest. Not the sexiest. Not the most powerful. Not the most expandable. Certainly not the cheapest. Just the best. So why is the Mac the best microcomputer around? Its user interface.

More people can fire up a Macintosh right out of the box and start getting work done the same day. Regardless of arguments to the contrary from devotees of other user interfaces, and regardless of the inroads made on the interface elements that we all think of as distinctly Macintosh (e.g., graphics, icons, mouse, pull-down menus, special sound cues, and many user-definable options), the Mac's interface remains preeminent among those available today.

Unfortunately, during my first month of fiddling with the NeXT computer and its beta 0.8 software and Mach operating system, it has become clear to me that the once state-of-the-art Macintosh interface is really starting to show its age. Regardless of how Apple modifies the Macintosh operating system over the next couple of years to make it more powerful and better able to extract the full horsepower out of its hardware, the company must also extend and improve its aging user interface.

I've put together a list of possible improvements for future Mac interfaces. It's quite likely that some of these ideas couldn't be easily applied without an extensive overhaul of the System, Finder, and MultiFinder. So be it.

Apple's real competitive advantage in today's microcomputer market is the Macintosh user interface. In fact, that's always been the case. That's why I (unlike other industry watchers) don't really have a problem with Apple's "look and feel" lawsuit against Hewlett-Packard and Microsoft. Apple should protect its intellectual property.

Regardless of whether the company has a legal leg to stand on in its suit, Apple's moral obligations are quite clear: It owes it to its shareholders and customers (many of whom put their professional lives in jeopardy to bring Macs into their companies a few years ago) to protect the interface from being ripped off by competitors. Apple spent considerable time and money on developing the Mac interface; in my opinion, the company is entitled to reap whatever rewards the marketplace deems appropriate for its actions.

My suggestions for improving the Mac interface assume that some important new computing paradigms aren't put on the market by Apple or others over the next two years. If you assume that the microcomputer interface market will continue to make incremental improvements over that period, then my suggestions fit right in.

Improvements need to be made in six different areas: the desktop, file management, the use of sound, the way windows are displayed and used, general operation, and the integration of development and user environments.

The Apple Desktop has aged less gracefully than any other part of the Macintosh interface. A month's worth of NeXT work, plus daily work with other interfaces, like X Windows, has made this clear to me.

Apple needs to make the Desktop more dynamic, more configurable, and more powerful. For example, why can't you tear off any item on the Mac menu and stick it on the screen (open, of course) where you need it? Sure, you can do this with some individual software, and some shareware utilities add this capability to programs, but it needs to be a standard feature, built in and available to developers.

In the same vein, how about resizable menus? Or how about menu items that you can link to function or option keys for one-time use and that revert back to some status quo? How about the ability to place menus at the bottom of the screen, or on the left or right side, or to get rid of them altogether?

The basic point here is that the current pull-down Mac menus are too staid and too static. You should be able to reconfigure them and store Desktop configuration settings. That way, you can create and save a number of customized working environments attached to specific applications.

Naturally, a configurable Desktop needs some real computing power behind it. To accommodate the interface changes I've suggested, the Macintosh operating system will have to become fully multitasking and will have to offer

continued

all the features that a fully multitasking system demands. Such features would have to include virtual memory paging, preemptive event scheduling, and interprocess and interapplication communications.

The use of sound doesn't need to go far to become much more effective.

Once Apple has strengthened the Desktop, the company should improve file management capabilities. The biggest change, which could also be categorized as a Desktop or general operational improvement, would be the introduction of a command-line interface.

I'm not arguing here for a return to MS-DOS's C> prompt or Unix's % prompt, but the Mac needs some kind of shell window (similar to Unix running with X Windows or Mach running with NextStep) that can be popped up as needed for direct file management operations. This shell window could also be used instead of pull-down menus if a power user felt so inclined. But the real purpose of the shell window would be to manipulate odd groupings of files in ways that just aren't possible with a mouse but are child's play when done with commands.

To this end, the command-line interpreter needs a Unix-style grep (global regular-expression parser) facility. The grep commands can flag lines of input filenames that match a pattern and copy them to another file. Of course, to be really useful, the improved Mac file manager would have to include many (if not most) of the techniques used in Unix to keep track of files, filenames, and directories. The file manager would also need things like wild-card character support, so groups of files could be manipulated together.

The future Mac operating system shouldn't become a Unix kernel with Mac window dressing, however. If Apple is going to maintain its competitive edge and protect its intellectual property, it makes more sense for the Mac operating system to incorporate the *kinds* of file management capabilities I've hinted at here, without resorting to simply "Macifying" Unix. What I'm arguing for is a maturation of the Mac file interface by including features that are common to today's Unix and OS/2 interfaces, the most important of which is the command-line shell.

One way to extend current command-line shell interfaces would be with the improved use of sound. While a Sound Finder has been rumored to be under development by Apple for years, I don't think the use of sound needs to go far to become much more effective than it is now. For example, Farallon's MacRecorder has shown just how effective it is to link short sound bites (like quick notes or file descriptions) to files containing other information. Imagine how much more informative it would be if, in the Finder, you could click on a file you'd just created and add a short spoken note to it, a note that could be replayed at any time.

Suppose you have a partially complete C program that a colleague is going to take a look at to help you fix an incorrect algorithm. With the new sound capabilities of the Finder, you could first append an auditory note that plays when the file is opened, telling your colleague where to look for the bad algorithm. In just a few spoken sentences, you could convey more information in that note than you can with a filename or with written comments, because your voice projects inflections and emphasis that written comments lack.

This use of voice annotation is just one way the Finder's management of sound resources could be improved. With the availability of better sound compression and digitization techniques, the increased use of special digital sound-processor chips, and the drop in price of very large hard disk drives and read/write optical disk drives, I have every confidence that the hardware necessary for successful sound management on a Mac will soon be in place.

Did you ever wish you could tile all your Finder windows with a quick Desktop command, or automatically overlap them, or reduce them to icons and sweep them into the corners of your screen? And what about resizing windows in any direction? Why is the Finder limited to a single resizing handle in the bottom right corner of a window?

While the current Macintosh interface does a creditable job of window management, there's significant room for improvement. Overall, the windowing interface should be more flexible, offer more configuration options, and be controllable from the new command-line shell window.

Specifically, with a command-line shell window, you could write special window scripts (since no command-line interface is worthy of the name if it doesn't have its own script language) that could invoke different kinds of windows based on their purpose and environment. Software authors could write programs to invoke a particular style of window, but you could override their choices. Once again, the key improvement is configurability.

A lot of little things have always bugged me about the Mac interface. Why can't I change the fonts (or sizes, or styles) in the menu bar or in the application menu without having to resort to using someone's shareware utility? Why can't I throw away the menu items I don't need from the Desktop or from any application? Why can't I resize icons or get rid of them altogether (without switching to a "Name" view)? Why can't I—well, you get the idea.

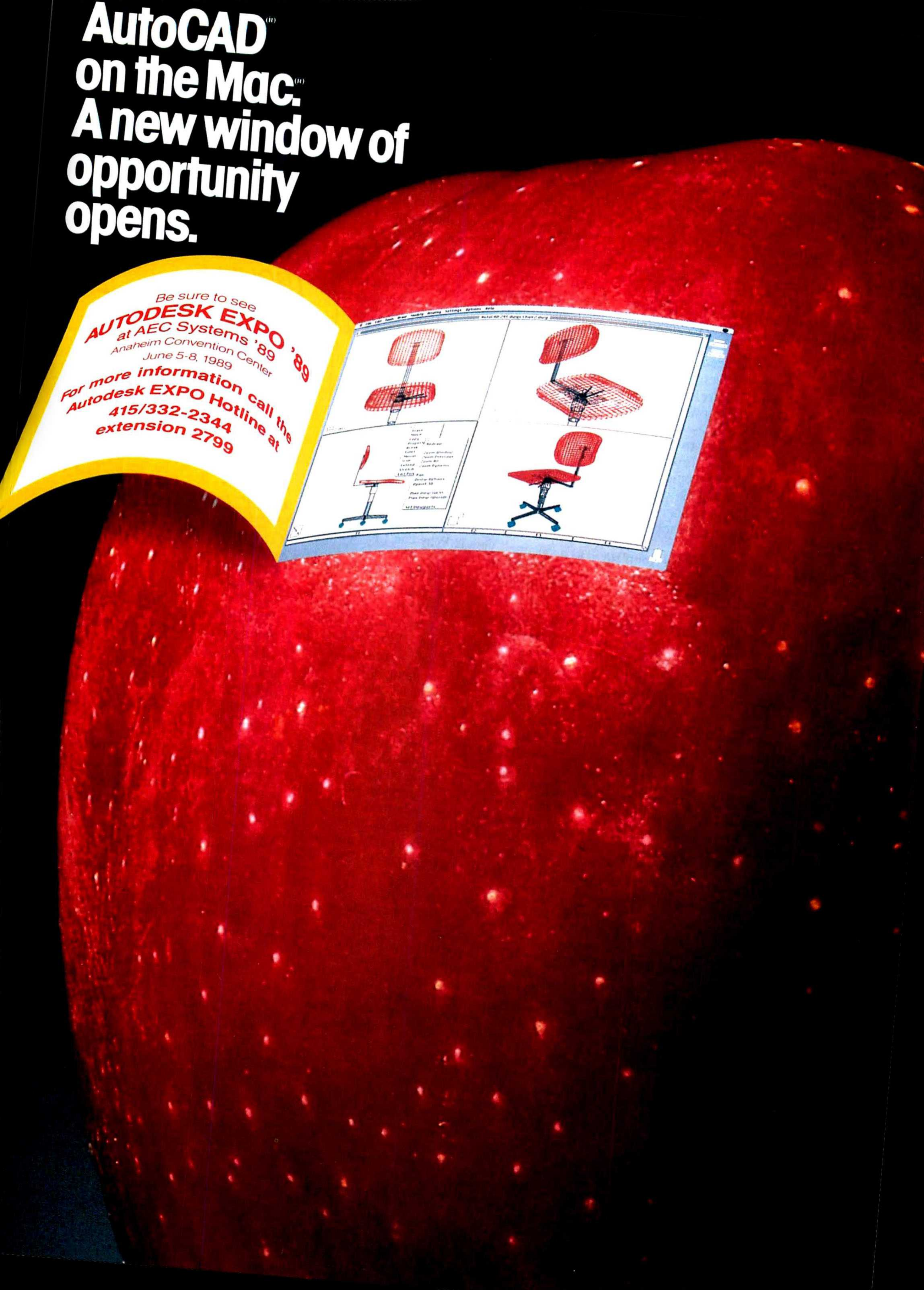
When you've used the Mac for as long as I have, you develop a number of pet peeves. I would categorize these as general operational improvements. I'm sure Apple has a bunch of these kinds of suggestions squirreled away, given all the market research the company does. It's time to pull them out and see which ones would really improve the Macintosh interface.

Finally, we come to development and user integration. All the changes I've suggested in this piece are worthless unless MPW/MacApp provides developer support for them. All modifications made to the Macintosh interface need to permeate through third-party applications, rather than appear just on the Desktop.

I hope Apple is working on the next-generation Macintosh operating system and that it includes some of the improvements I've outlined here. Given Apple's responsive nature in the past and its commitment to the extension of the Macintosh computing metaphor, I'd be surprised if we don't start seeing some of these improvements before too long. ■

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 consulting 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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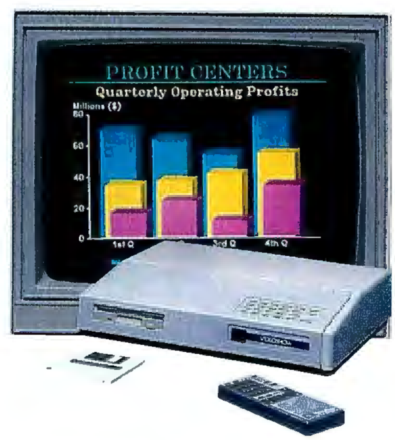

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A Portable Companion for the Macintosh

Laurence H. Loeb

It's not a Mac laptop, but the Z88 plugs the gap nicely

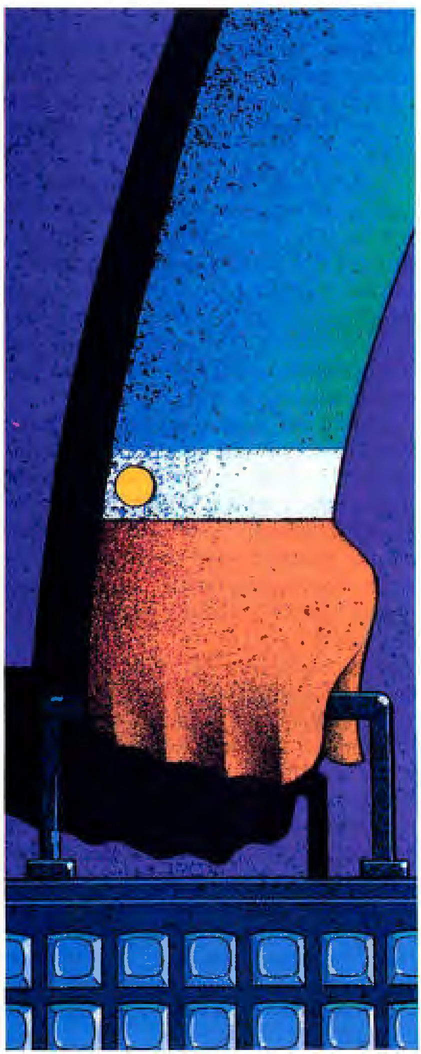
You know the score: All too often you've got to carry work home. This means the Macintosh Plus in the office also has to make the trip. However, the Mac Plus is only luggable; while I can take it home, there's no way I can use it on my trips in the field. For those occasions I need a laptop, of course. As I write this, there's still no Mac laptop from Apple, so any laptop I pick *must* be able to transfer information to and from my office Mac.

A small text-only machine is usually fine for most work, particularly for telecommunications. However, I also use a spreadsheet to tally the figures I take in the field, and it's crucial that these numbers can be fed into the Mac Plus when I return. This is where the text-only capabilities of most laptops let me down.

A Laptop That's Loaded

Imagine my surprise when I found out about Cambridge's Z88, packaged as a system called MacLite. The package starts with the sleek 8½- by 11½- by ⅞-inch Cambridge Z88 laptop that weighs only 2 pounds. For a laptop this size, it's loaded: It has 32K bytes of on-board RAM, 128K bytes of system ROM, and 128K bytes of cartridge RAM. It still sounds rather ordinary, doesn't it? That's where the other parts of the MacLite package come into the picture. First, there's the all-important interface cable that connects the Z88's DB-9 serial port to the mini-DIN-8 serial port on the Mac. Next, there's a 32K-byte EPROM cartridge with a special program that manages the data transfer between the Z88 and the Mac. Finally, there's the 800K-byte floppy disk with Cambridge's Link application on it that handles the Mac's end of a data transfer. Not to mention the manuals to go with all of it.

Simply put, here was a complete solution for my fieldwork, not something where I'd have to kludge a cable or some software to make it work. It was all set up and ready to go. As I used it, I thought that the package was nothing short of miraculous. Once I got through the learning curve, it served *all* my needs for a field laptop. The applications that come bundled with the Z88 include Pipedream, which is a nice word processor–cum–spreadsheet, and an assortment of utilities such as a calendar, a clock, a file manager, and a diary. For telecommunications work, there's the optional Dataport 1200 modem and a COMM-88 program, but they aren't part of the MacLite package.



Cartridge Flexibility

Briefly, this is how the machine works. The front side of the Z88 has a clear plastic pull-down panel where up to three cartridges can be inserted. These cartridges can consist of RAM, ROM, or EEPROM, although an EEPROM cartridge must occupy the third, or rightmost, slot. RAM cartridges come in 128K bytes or 512K bytes. You can fill the Z88 with up to 1.5 megabytes of RAM using three 512K-byte memory cartridges. For my field-to-Mac work, a more practical layout is to have 512K bytes of memory in one slot, the Mac-to-Z88 link program cartridge in another slot, and an EEPROM cartridge or the modem program in the third slot.

The only fully reliable way to save files is to put them on the nonvolatile EEPROM, using a special file command ("copy to EPROM") available from within the file maintenance program. However, you must erase the entire EEPROM at one shot. This makes the chore of saving files a bit convoluted. If you have a 128K-byte RAM cartridge and a 128K-byte EEPROM cartridge, you have to copy the EEPROM files to RAM, wipe the EEPROM, and then copy back just the files you need.

How It Resembles the Mac

The equivalent of the Mac Finder on the Z88 is called the Index. You summon Index by pressing the Index key on the

continued

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Processor: 8-MHz Z80
Memory: 32K bytes of internal RAM; external RAM expandable to 1.5 megabytes; 128K bytes of ROM
Mass storage: 128K-byte EEPROM cartridges; 128K-byte and 512K-byte RAM cartridges
Display: 8-row by 106-column supertwist blue LCD display
Keyboard: 64 keys; QWERTY arrangement
I/O interfaces: DB-9 serial port; three cartridge slots for RAM or ROM with proprietary connector
Power: Four AA alkaline batteries or external 6-volt connector

Size
8½ x 11½ x ⅞ inches; 2 pounds

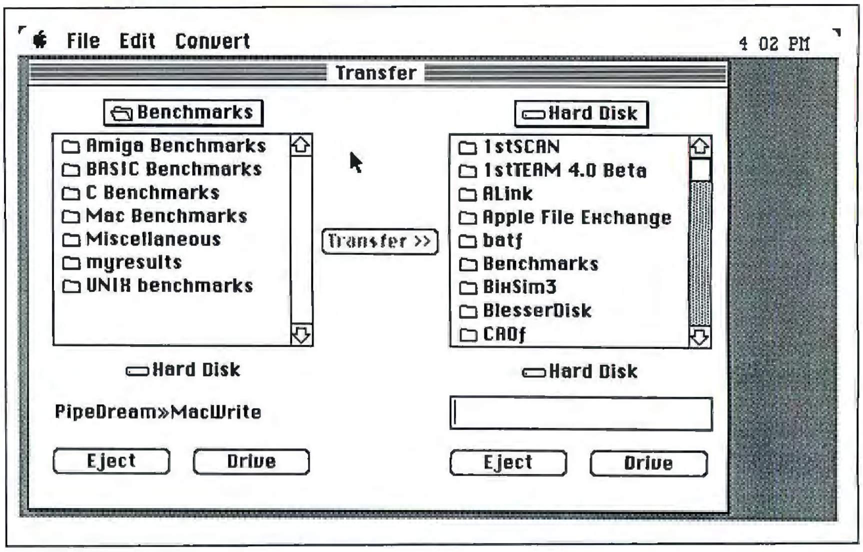
Software
Includes Pipedream (word processor and spreadsheet combined); utilities include clock, calendar, diary, alarm, file management, import-export, VT-52 terminal program, and BBC BASIC in ROM

Options
128K-byte RAM card: $110
512K-byte RAM card: $440
1200-/300-bps portable modem, COMM-88 program on ROM card, and cable: $259

Documentation
User's Guide with index

Price
MacLite combination (Z88, 128K-byte RAM card, Mac-to-Z88 conversion card, Mac disk, and cabling): $899

Inquiry M202.



The Link application in operation on the Mac. It manages the transfer of files between the Z88 and the Mac and provides format translation as required. It's similar in operation to the Apple File Exchange application, which handles the transfer of MS-DOS files to and from an MS-DOS floppy in the Mac's floppy disk high-density drive.

bottom left of the keyboard, and it shows the programs available for execution on the leftmost part of the screen. The list includes any commercial programs in the cartridge slots, such as the Link or modem programs.

There's a Square key (so called because it has a square on it) that accesses these "pop-down" programs at any point. For instance, pressing the Square key and the C key brings up the built-in Calendar program in its own little window. Pressing the Escape key gets you out of the Calendar program and back to your current activity. These pop-downs are rather familiar to Mac users as desk accessories and function much like them.

The OZ (yes, that's its real name) operating system of the Z88 allows very fast switching between applications. You can suspend the current application, go on and do something else, and then return to the previous application at exactly the point you left it. This is very handy and sophisticated stuff for an operating system to be doing for you.

One of the main things an operating system like this does is start you off immediately where you were when you last shut off the machine. If I stop working in the telecommunications program, shut off the machine, and then power it up again, the telecommunications program is still there. I don't have to go to the Index unless I want to.

The major part of the Index screen shows what applications were started and when they were suspended. If you want to jump to a specific application, just select it with the cursor keys and press Enter, and you're there.

The Z88 does not link documents with applications the way that the Mac Finder does (i.e., when you open any document, the Finder automatically loads the word processor that created the document). However, the Index does save the last document that the application was working with and loads it when you restart the application.

The Filer program allows you to manipulate the files in any memory area of the Z88. Whether that memory is internal to the Z88 or on a card doesn't matter. What memory you are operating on will be chosen in the default device setting. This also affects where Pipedream saves a file in the future. However, you can override any defaults in effect by using the full path name for a file. Say you wanted to load a file that resides in the folder that the Filer is set to. In this case, you would simply type in the file's name. But if you wanted a file on another memory device in another directory, you would type `:RAM.x/directory1/directory2/../directoryN/filename`. This redirection technique works for saving a file as well. It gives you a way to short-circuit the Filer when desired, yet retains the ease of use of not having to type all the unnecessary specifiers routinely. Once you get the hang of things, it works rather well.

Z88 applications are organized to provide a listing of applicable keystroke functions. That is, when the Menu key is pressed, a list of the application's commands appears on the screen, organized by function. You select the desired function with the cursor keys, and the key commands for that menu appear. In short, it's an on-line help system for an application's commands. I did not have to carry around the manual to look up how to get things done, and that was a relief. And quite like a Mac.

continued

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Importing and Exporting

The Mac-to-Z88 transfer program resembles the Mac's Apple File Exchange application (see figure) and operates the same way. You select the file on the Mac that you wish to transmit to the Z88, or the folder that's to receive a file from the Z88. On the Z88, you select the memory device and folder in a similar manner. The Link program worked reliably both ways every time I used it.

For plain text files, you don't have to bother with data conversion. Or you can be very specific about the type of conversion, such as to and from the Pipedream program. The beauty of Pipedream's dual identity as a spreadsheet/word processor is that you can take a Pipedream file and make it into a text-only file, a MacWrite document, or an Excel spreadsheet, depending upon the file's contents.

Unfortunately, while the software was up to the task, the hardware wasn't. Specifically, the interface cable that connects the two computers didn't quite make reliable contact to the Mac's mini-DIN-8 serial port pins. A bad interface cable makes file transfers unreliable and defeats the whole purpose of MacLite. Cambridge seems to have recently fixed this problem, but some bad cables did get shipped—one of them to me. My advice is that you check that your interface cable works before buying the package.

Also included with the MacLite software is a HyperCard stack, HC Organiser, which serves as an electronic Day-Timer book of names, addresses, notes, and to-do lists, similar in function to Focal Point II. HC Organiser downloads this data onto the Z88 so you can take your contact and scheduling information with you. For Focal Point II users, HC Organiser will download the information from those stacks instead. I didn't use this stack much, because my reasons for using the Z88 were not to call on people. However, I could see its potential use as a super address/note book.

Not Quite a Mac, but Uses Its Data

All in all, I like the Z88. I don't think it's a machine for use as your only computer, however. The closed way of loading programs through cartridges and the current lack of available mass external storage preclude this. As with any scaled-down laptop, I can put up with its quirks to get what I need done. I have not found another computer in its price range that is as versatile or fulfills my needs for a laptop computer as well.

The major job the MacLite package does for me is the ready exchange of information between the Z88 and my Mac. It does this quickly and effectively without my resorting to rocket science to get it to work.

The Index, pop-down program utilities, and built-in menu scheme are reminiscent of how the Mac operates and eliminate much of the hassle of trying to remember the different command sets for each computer. The ability to move information—either as a written report or as spreadsheet numbers—between the two systems was reliable. Incidentally, the Z88 can also transfer files to PC compatibles via a Link program similar to the Mac's. This one feature alone may be useful to those who work within mixed computing environments. ■

Laurence H. Loeb is an electrical-engineer-turned-dental-surgeon in Wallingford, Connecticut. He is comoderator of the Macintosh Exchange on BIX. He can be reached on BIX as "lloeb."

 Circle M7 on Reader Service Card

Pop Quiz.

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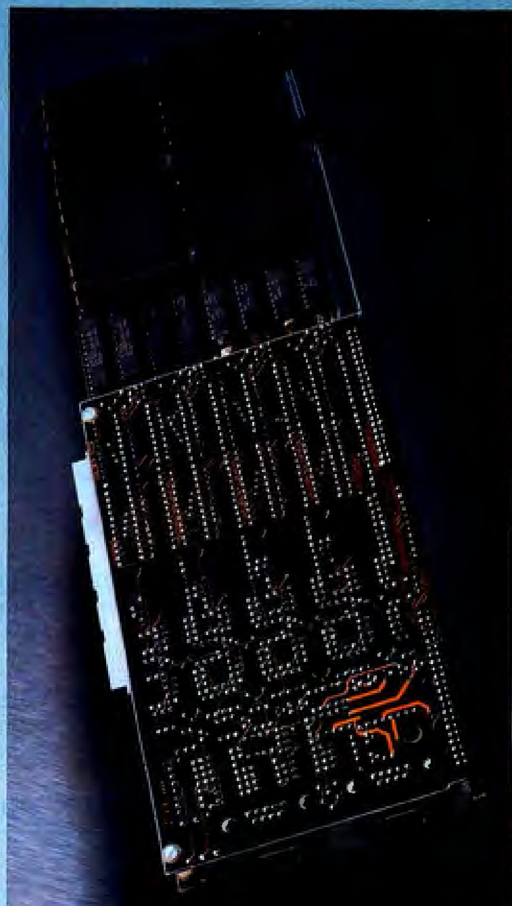
a) NuVista 2M   b) NuVista 4M   c) All of the above

Name the only videographics card which provides true-color, real-time capture *and* broadcast-quality display while occupying only a single slot in a Macintosh II.

a) NuVista 2M   b) NuVista 4M   c) All of the above

Which videographics card offers full QuickDraw™ compatibility at 1,2,4,8,16 or 32-bits per pixel?

a) NuVista 2M   b) NuVista 4M   c) All of the above



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Mixed Blessings

Jerry Pournelle

Despite various drawbacks, the Mac is rapidly becoming indispensable at Chaos Manor

Whatever else you can say about the Macintosh, it isn't dull. I got an undeserved reputation as a Macintosh hater because I wasn't overly impressed with the original 128K-byte Mac; but what I really said was that the hardware wasn't up to the conception and the hype. Still, even that original Mac wasn't *dull*, although it was a bit short on vital features.

In fact, the Mac can be just plain fun. Look at mine: there's a background picture on the screen when it starts up. There's SoundMaster, a neat shareware utility for adding and changing sounds. When I insert a floppy disk, Darth Vader informs me that he's "here to put me back on schedule"; restarting the machine gets Mr. Spock proclaiming that this should prove "interesting"; and when I shut the Mac down, a bell clangs and a gravedigger calls, "Bring out your dead!"

Try that on your PCompatible.

Problems

You should by now have the impression that I'm quite fond of the Mac. All true. The Mac II has become more than "good enough" for anything you'd want a microcomputer for.

The newest Mac IIx is getting there, but it does require a spirit of adventure. I have one with 5 megabytes of memory and the new System software version 6.0.3. If I used only standard software in standard ways, I expect it would be all right; but, alas, I am getting very used to System Error Bombs. I make no doubt that Apple will get software worthy of the Mac IIx hardware, but I do wish they'd get on with it.

For example: I got a bomb every time I tried to open a MacWrite document from anywhere but the MacWrite folder. This was so annoying that I asked BYTE's Mac guru Tom Thompson for advice.

He said to first disconnect the 330-megabyte Priam MacDisk; second, boot with the new System software from the original floppy disk; third, run Disk First Aid (which is more like IBM PC's CHKDSK.COM than it's like Norton Disk Doctor) off the original distribution floppy disk; fourth, run an antivirus program; and finally, check to see that I have a good copy of MacWrite.

It all seemed like good advice, the kind of thing I could do on my Cheetah 386 in about 10 minutes; but it took hours.

It's so easy to *learn* the Mac that you think you don't have to know much to use it. While that's generally true, it also means that many Mac users are completely confused when something goes wrong. I know I certainly am.

Could I be running too many initialization programs? Should I set the Mac System beep back to just "beep" when it wants my attention, instead of doing a "Kaboom!"? Ought I to strangle Darth Vader and Mr. Spock? Do we have a bad memory board or a bad sector on the hard disk? How can I find out?

Alas, Apple's documents don't tell much. Still, persistence pays.

Item: I solved the problem of System Error #02 (Address Error) when opening MacWrite from a document distant from the MacWrite file itself. I used the Find File desk accessory (DA) to search for MacWrite, and lo! It turns out that buried deep in the PowerPoint folder is a folder called Phil's Stuff; inside that is a folder called Phil's Stories; and inside that was another copy of MacWrite. On general principles, I threw it in the Trash, then tried to open a MacWrite document. The machine insisted that I get the old one out of the Trash. I refused to do it. It kept insisting. I emptied the Trash. The system crashed—System Error #02.

I rebooted the system, and the problem was gone. I can start MacWrite from anywhere on that disk without crashing the system. On the other hand, I don't—and apparently can't—have a second copy of MacWrite anywhere on the system, in any folder on the MacDisk. Why?

Also, an attempt to start MacWrite by clicking on a MacWrite document on the internal 80-megabyte Apple hard disk drive produced another crash, and this wasn't even as graceful as the "Sorry, a System Error Occurred" dialog box. The MacWrite logo appeared for a moment, the screen got covered with jumpy lines, and it was time to hit the Reset button. That problem was solved by moving one—and only one—copy of MacWrite onto the Apple boot disk.

I thought I had another solution, booting the Mac while holding down the Command (Splat) and Option (Alt) keys simultaneously. This not-well-documented procedure rebuilds the Desktop file, and Mac experts recommend that you do it every couple of weeks. Alas, while it's probably a good thing to do, it hasn't cured the situation. I suppose that's a small price to pay for the convenience of the Mac.

What to Do Until the Doctor Comes

Whatever the reason, I've had plenty of practice dealing with lockups and system crashes. Here in a nutshell are the procedures I've learned.

First, every time you have a system crash, run Disk First Aid. Do that religiously. Since you'll probably be running it from the hard disk, the program will tell you that it can't fix any problems. That's all right. What you're after

continued

is assurance that there aren't any problems that have to be fixed.

If there's a second crash, again run Disk First Aid. Also, if there's a chance that your system has been invaded—if, for instance, you're getting bizarre results, or you've recently introduced software from an unidentified source—run a virus-detection program.

Incidentally, you should also have Vaccine or some other virus-prevention program as the first thing in your INIT file. Computer viruses are real, and a fair number of them are masquerading as legitimate freeware and shareware.

If you still get bizarre results, don't try to figure them out. When you're sure that something odd is happening, get out your original System Tools floppy disk. Open the write-protect doohickey and leave it open, then boot up the system, and replace your System files. (Your fonts will now be gone and will have to be reinstalled. In the Mac, fonts reside in the System file.) In doing that, don't—as I did late one night—just drag the System Folder on the floppy disk over to the hard disk and drop it on the System Folder there. Use the Installer.

Multiple copies of System files cause problems. It's especially serious if you have several versions of the System software. If you think that you should keep backup copies, keep them on floppy disks, not on your hard disk. Even if you have two hard disk drives, as I do, you're better off seeing that there is one and only one System Folder.

The reason for this is built into the Macintosh philosophy. CP/M machines were originally designed for floppy disks only, and they used to have all the system software loaded onto the floppy disk's track zero. The major problem with that was that it set an upper limit on the size of the operating system. IBM solved that by putting much of the operating system into a file called COMMAND.COM. There's still something much like a "system track"; certain hidden system files that tell the computer how to load COMMAND.COM have to be the very first files in the disk directory. However, COMMAND.COM can be anywhere you like; there's no prohibition on multiple copies.

The Macintosh command system is different. There's not only a System file like the IBM PC's COMMAND.COM, there's also a System Folder, which corresponds to a combination of the CONFIG.SYS and AUTOEXEC.BAT files on a PC. But whereas on the PC you would put something such as DEVICE = VACCINE.SYS into the CONFIG.SYS file to get the machine to load the Vaccine program on start-up, on the Mac you simply drag the proper Vaccine initialization file into the System Folder.

So far, it doesn't sound much different from the PC; but now comes the way you invoke (Macintosh people usually use the word "launch") programs. With the PC, if you want to read a common ASCII file, you tell the computer to TYPE FOO.DOC; if you want to be really fancy, you say TYPE FOO.DOC | MORE, which tells the PC to direct the output of the built-in system command TYPE into another program called MORE.COM.

MORE.COM then presents the text one screen at a time and waits for you to hit a key before moving on. On the other hand, if you want to read a non-ASCII document created in a word processor—say, WordStar or WordPerfect—you have to run the word processing program, then load the document into the editor.

continued

APPLE AND OOPS. A PEACH OF A PAIR.

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Smalltalk/V Mac

You can do that with the Mac, but you don't have to. You can launch MacWrite by double-clicking on a MacWrite document, and in theory that document can be in a file folder (PC users can think of folders as directories and subdirectories) unrelated to the location of MacWrite.

That works because a program appropriately called Finder goes out seeking the programs needed to do whatever job you've just commanded the computer to do; and whereas a PC will search only the directories that a PATH command has told it to look into, Finder looks everywhere, including places that you didn't want it to look; and if it finds several programs with the same name, it can get confused.

It gets even more confused if there are multiple copies of the System file on your disk; it can get absolutely schizophrenic if there's a System file buried in a folder inside the System Folder.

All of which is the long way of saying that if you get odd results with your Mac, use the Find File DA to hunt down and kill every last copy of the System file other than the primary one in your System Folder. The active System Folder is the one with a picture of the Mac on it.

Be of Good Cheer

I have painted a much gloomier picture than the Mac deserves. It's true that I get system crashes, but there are reasons.

First, I'm using a Mac IIx. Over the years, I have accumulated a lot of Mac software, and much of it simply isn't very well behaved: it was written without much regard to the published Apple Macintosh interface standard. A case in point: an absolutely delightful program called Strategic Conquest, a war game that used to consume a lot more time than I (or my sons) should have given it. That program runs fine on the Mac Plus. It sort of works on the Mac II, although the sound doesn't. It crashes randomly on the Mac IIx. That's unlikely to be the Mac's fault.

(Incidentally, it's to Apple's credit that they've gone through six major and countless minor revisions of the operating system, taking the Mac from 128K bytes of memory and a 68000 CPU to as much as 8 megabytes of memory and the 68030 CPU, and much of the software from the old machines still runs on the new. Much, but not all; I'm told that the next revision of the operating system will rigidly enforce the standards, and a lot of popular software will no longer run. We'll see.)

Second, sometimes it's partially my fault. The Mac II and IIx have color. A lot of programs, especially those written for earlier Macs, can't handle color. Some of those have warnings. If you're running color and you try to start a program, it says: "Switch to black and white, Turkey." That's easy enough to do on the Mac II and IIx, provided that you remember; but if you don't do it, some black-and-white programs can totally lock up the system. My son Alex has a large collection of shareware games guaranteed to do that. Some of them will lock up the machine even if you have switched to black and white.

Third, I run a lot of software, much of it developed by people who don't have a Mac IIx. Sometimes their stuff runs fine on the Mac Plus, standard SE, and II, but not the Mac IIx. I haven't the competence to determine whose fault that is.

Fourth, this is a Mac IIx, which is a pretty recent machine. When I buy a car, I am fairly careful not to buy one that's in its first model year.

Finally, this machine is thoroughly loaded. It has 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 that reads and writes IBM PC-format disks. Every bit of that equipment works. I doubt there are many systems comparably equipped. I'm sure there are darned few of any brand that can do all the things this Mac IIx routinely does.

Scanning and Charting

The main work done here on the Mac IIx is preparing briefing materials for the Citizen's Advisory Council; our last briefing was given in the White House. The AppleScan monochrome scanner is invaluable for making presentation materials.

We were able to scan in charts, diagrams, and graphs from a great many sources, so that we built up a library of graphics images we can put into our briefing materials. We've been using Microsoft's PowerPoint to do that; it's only one of several programs that have that capability.

continued

One of our charts is a montage of magazine covers: the ones showing just how serious the U.S. space problems have become. The original covers were in color, of course. For our primary presentation charts, we used photographs; but by playing around with the scan parameters, we were able to get good images of those covers into the Mac. Then we pasted them into our handout materials, since we couldn't really afford color printing; the Citizen's Advisory Council is all volunteers, and we don't take money from the aerospace industry for obvious reasons.

The result was strikingly good, far better than anything we could get out of the best grade of Xerox machine.

Once those files are scanned in, they can also be altered. With suitable paint programs, you can get down to individual dot levels to twiddle with contrasts, erase lines and blemishes, and, depending on your artistic skills, make some improvements.

Of course, there are color scanners for the Mac II and IIx. One of the best is the Howtek series. Howtek also makes color printers. Color is clearly the wave of the future. So far, it isn't cheap, but I expect that to change. After all, back in 1976, I more for my original Z80 with 64K bytes of memory than the Mac IIx costs today.

The bottom line is simple: the Macintosh is "good enough." There is sufficient nuts-and-bolts software (i.e., spreadsheets and word processors) to run any type of business. There is also a large number of just plain interesting programs that you're not likely to find on a PCompatible.

The Macintosh is overpriced, and both hardware and software could use some commonsense improvements. Apple insists on doing odd things, like requiring a useless plastic carrier to be used in the CD-ROM player. Despite all that, the Mac is rapidly becoming indispensable at Chaos Manor. You'll be seeing more about it in my regular column. Meanwhile, it's sure never dull. ■

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 "jerryp."

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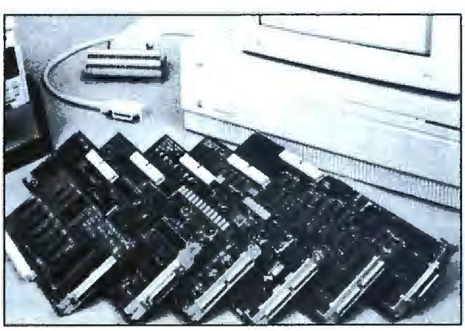

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IN DEPTH

Security

Everybody talks about microcomputer security, but few of us like to use it. We think of it as something difficult and costly. While we probably can't have security without some level of inconvenience, we can understand the issues. While there will be some cost, we can also understand and appreciate that the cost of security is minimal compared to the cost of doing without it.

We are pleased to begin our look at small computer security with "How Safe Is It?" by Martin Kochanski, a leading theorist and designer of encryption and security systems. He gives us a good look at security issues and ways to address them so that they work together with the people who must use them. Another area of major concern is network security, a huge topic which BYTE plans to come back to. But for now, Michael Durr and Mark Gibbs take us through the various levels of LAN security in the accompanying text box "Peeling Back the Layers."

Next, in "Secret Codes," Asael Dror explains how computer cryptography, the Data Encryption Standard (DES), and the RSA standard work. His is one of the clearest explanations of this complex subject that I have seen to date. He shows quite well that the theory of cryptography need not be impenetrable just because the encrypted results are.

Then, Ross M. Greenberg tells us about one of the most discussed security subjects, computer viruses (and related electronic fauna), in his article "Know Thy Viral Enemy." A well-known author of antivirus software, Greenberg shows us just how insidious these destructive programs can be.

Securing your computer may be worth doing, and it surely helps to know how to go about it. Peter Stephenson, in "Personal and Private," describes some of the many products available for securing your system and its data. In the accompanying text box "The Small Data Center," Bob Brown, a data center manager, tells us how to put all of this together into a coherent program. Coherency, after all, is required if your security program is going to work.

Inconvenient and costly? Sometimes. But computer security is one of those safety features that you don't think about until it's too late. It's an insurance policy you hope you'll never need. While it would be nice to work where you don't need security, most of us never will.

—Wayne Rash Jr.
Consulting Editor

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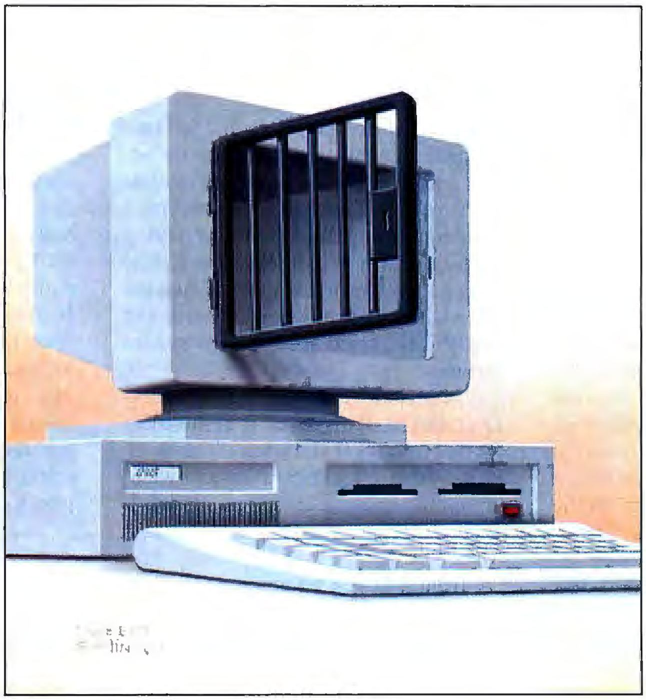
How Safe Is It?

Absolute security is unattainable, and doing nothing is dangerous. So how much security is enough?

Martin Kochanski



No one truly wants personal computer security. Access control, passwords, authorizations, and the procedures needed to enforce them are all part of the old world of mainframes: Microcomputers are about freedom and simplicity, not bureaucracy.

Unfortunately, such an ideal doesn't exist in the real world. As the use of personal computers spreads, more and more sensitive data is stored in them, and more people have the ability to look at and even manipulate that data. However unwanted and inconvenient security measures may be, they are nonetheless necessary.

Since security measures are needed whenever you use a microcomputer for a serious business purpose, the logical place to expect to find security features is in the operating system. It seems scandalous that MS-DOS, for instance, has no data security features at all. Worse still, some alternatives to DOS *appear* to provide security in the form of passwords, but you can alter or remove them with any commercially available disk-utility program. They lead you to *think* you're safe—but you're not. Even OS/2, which is being touted as the operating system of the future, ignores the question of security, and its very architecture makes remedying this deficiency almost impossible.

In another sense, however, ignoring the problem at the operating-system level is correct, because designing effective security measures is harder than it sounds. It's hard enough to design a system that is secure in the conventional sense of being hard to break (and several security systems fail spectacularly in this area), but it's harder still to make a security system so easy to use that people will use it and *continue* to use it without constantly being reminded to do so. For instance, there's no point in having the world's most secure file-encryption program if it takes 5 minutes and 50 keystrokes to encrypt or decrypt a file. The cost in terms of time, inconvenience, and broken trains of thought is too great. Even if they have to use such a program, most people will soon start looking for (and finding) ways to circumvent it.

Access Control

The very mention of data encryption immediately discourages many microcomputer users. "We are not," they rightly argue, "the CIA: Why should we indulge in James Bond methods to protect our sales ledger?" To answer this, I'll look at something less dramatic—a straightforward mainframe-type password system—and examine its effectiveness. I'll assume that the microcomputer being used is a

continued

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Peeling Back the Layers

Michael Durr and Mark Gibbs

The basic security model, for a computer, a bank, or any other subject, resembles an onion. Layers of security surround the subject that needs to be secured. Each layer insulates the subject and makes it more difficult to access in any way other than those planned for. Physical security is the outer layer and, in general, consists of locking things away or bolting them to a desk.

With a distributed processing system, the primary physical-security concern is preventing access to the hardware. To defeat all other security measures, you must have physical access to the hardware. This is common to all computer systems, whether distributed or not.

The inner layers of security are concerned with logical security—the methods that cover control of access to the system resources and services. You need to be as concerned about these inner layers as about the physical layers.

Disk Server vs. File Server

In early LANs, the server systems were disk servers; that is, they provided access to disk storage and other services at a hardware level. Each workstation managed the shared hard disk as if it were a dedicated device, communicating via low-level I/O calls. The server wasn't designed to handle anything but the basic data storage blocks. Coordinating file access among workstations was left to the applications accessing the files or to the users themselves. If an unverified write by an unauthorized process occurred to the file allocation table, it was possible that a significant portion, or even all, of the data on the disk could be lost, for all the users.

The file server is a result of the evolution of LAN technology. The file server provides a much higher level of service to the client workstations than does the disk server. The low-level processes of the server devices are available only through requests to logical devices rather than directly to the physical device. Because of this, the system can be designed for security. In addition, file access can be coordinated and data integrity can be verified.

The file server, as a design concept, is the foundation for all client-server protocol security. Most network operating systems have adopted this approach. The disk server is now obsolete, but it helps illustrate the primary threat to security on distributed systems. Any design that permits someone to get around the security protection in the operating system and directly control the filing system must be considered insecure.

Logical Layers

Logical security has layers that fall into two major groups (see figure A): the access security layers and the service security layers. The ASLs are concerned with controlling availability, verifying identity, and establishing access rights, and are a higher-level function than the SSLs. SSLs are concerned with the availability of and access to the system services.

The highest ASL is the system access layer (SAL). This layer is responsible for determining if and when the network is available on either a system-wide, group, or individual station basis. It may also be responsible for disconnecting a station on which there is an attempted break-in, as well as providing an activity audit trail. The SAL also carries out supervisor-enforced log-out. The SAL could, for example, prevent log-ins during non-office hours and disconnect all sessions after a certain time.

Below the SAL is the account access layer (AAL). This layer verifies that the user who logs in with a given name and password exists and has a valid user profile.

The innermost layer in the ASL is the access rights layer. When you have passed through the SAL and AAL, the ARL determines what connection privileges you have (e.g., the account can only have sessions that total 4 hours per day, or the account can only use workstation 27). Some of the functions you can implement at the ASL are accounting (for connect time, disk usage, and so on) and user-activity audit trails.

Service Layers

The service security layers (SSLs), which sit below the ASLs, control access to system services, such as queues, disk I/O, and server management. The highest SSL is the service control layer (SCL), which is responsible for advertising services and their status reports. It also enables and disables service operations.

Once the SCL has established a service, the service rights layer (SRL) determines exactly how the account can use the service. For example, an account may only have the right to add jobs to printer number 3 but have full

fairly conventional one, with a hard disk on which sensitive data is stored.

The simplest password system is a program that runs when you boot up, demands a password, and won't let the boot proceed until you enter the correct password. One common method uses a line such as DEVICE=PASSWORD.SYS in the CONFIG.SYS file to activate it. A scheme this simple has many obvious defects—notably that the computer remains permanently vulnerable once it has been successfully booted. However elaborate a real-life password system may be, it is subject to attack in essentially the same ways as this simple example.

A frontal attack on any password system—even such a simple one—is unlikely to succeed. Repeatedly switching on and attempting to guess passwords is time-consuming, and, unless the choice of password was blindingly obvious, it is also unrewarding.

However, both IBM and Microsoft sell a program that will break into any DOS-based password or access-control system that doesn't use encryption: IBM calls it PC-DOS; Microsoft calls it MS-DOS. Buy the disk; insert it into drive A; start up the machine; and you have access to all the data in the computer. By booting from a floppy disk that has no CONFIG.SYS and no AUTOEXEC.BAT file, you circumvent any possible password protection and can examine or alter any file on the hard disk. (If the computer uses nonstandard hardware and special device drivers, it may take a little longer to get at all the files, but it's just as simple.)

The problem with password systems exists because passwords are not a security feature—they are an *insecurity* feature, intended to provide controlled access to an otherwise impregnable system. To use a physical metaphor, a vault with 3-foot-thick steel and concrete walls is (almost) impregnable, but useless; add a add and delete rights to jobs on printer number 4. The SRL also administers the specific rights of an account. If the account is a member of one or more groups, then the SRL will ensure that the account inherits the group rights. For example, an account may only have read, open, and search file rights in the program subdirectory and operator. The services may include both software-specific high-level service (HLS) and hardware-specific low-level service (LLS) operations.

The HLSes are operations that are not hardware-bound—for instance, a request to open a file by name. Other such services are queues and mail slots. The HLSes are actually built from LLSes and may require several of the lower-level functions to operate. The LLSes are hardware-dependent. These services are the fundamental building blocks of the system and cover disk sector-level I/O and memory-block allocation and deallocation.

A Trusted Connection

As a connection is established, the ASLs validate and define the account. The actual operations to be carried out are controlled by the SSLs, which prevent requests not specified within the user profile. Access in a thoroughly secure system must be through these layers from top (SAL) to bottom (LLS). But when disk servers and other aspects of the system use only the ASLs to control access to the system and then allow you to make requests directly to the LLSes, the layers of the SSL are easily avoided, and unauthorized operations can be performed without detection. This happens when all the other layers of the SSL are implemented and executed in the disk-server client.

Any system that lets you avoid one or more layers of the model or just leave them unused runs the risk of being insecure.

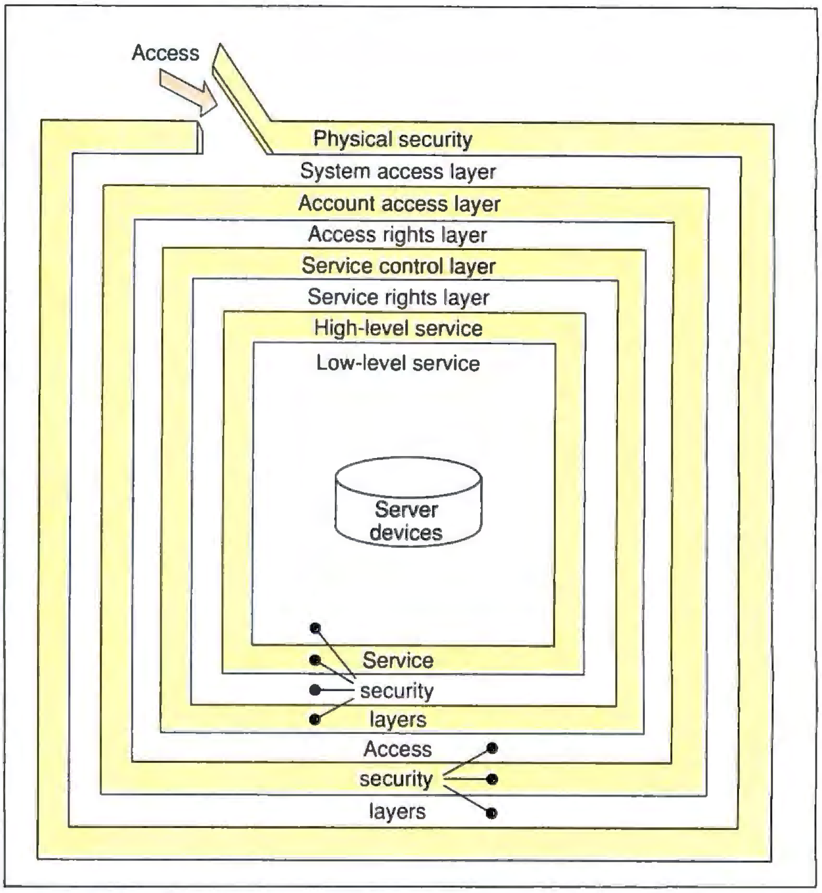

Figure A: *Like an onion, good security is composed of layers wrapped on layers. In the file-server model, access to the actual device must go through three layers of access security and four layers of service security.*

Michael Durr works for Novell (Provo, UT) in corporate marketing. He is based in Los Angeles, California. Mark Gibbs also works for Novell in corporate marketing and is based in London, England. They can be reached on BIX c/o "editors."

door, and access becomes possible; add a lock to the door, and you have *controlled* access. Mainframes are inaccessible, air-conditioned, and often surrounded by white-coated acolytes; passwords provide controlled passage through all this security. Microcomputers are in the office, physically accessible, and sometimes even portable. Adding passwords is like building a strong door with a secure lock on a house made of playing cards.

Access *restriction* is a prerequisite for access *control*. Access restriction can take several forms. It can be *physical*, as when you keep a computer locked away in a separate room; in this case, you don't need any additional hardware or software security measures.

It can be *inherent*, as when a computer is of such an unusual kind, or so hard to operate, that you can't figure out how to do anything harmful even if you do have access. Many companies still rely on this kind of protection. It worked well in the past, when there were few microcomputers around and few people knew how to use them, but it's not as safe now.

The access restriction can be *logical*, imposed by the hardware or software and making access impossible without special programs or knowledge. Encryption provides the simplest way of doing this.

Using encrypted data with a decryption program may sound like using a password system—it even looks similar to the user, who may not appreciate the distinction between a password and a decryption key—but it's not. If you bypass or disable the password system, everything is accessible; but even if you circumvent the decryption program, you still can't read anything.

One more point worth noting when considering encryption: It's not really the computer you need to secure, it's the data. Even if you consider the locked-room approach adequate to protect the

continued

computer—and using keylocks or PS/2-type power-on passwords is essentially a variant of this approach—the data exists not only on the computer but on many backups in different places.

To ensure data security, you must consider not only preventing unauthorized access but also not losing data. Preventing unauthorized access is best achieved by having no backups at all; preventing data loss requires as many backups as possible. Encryption can resolve this fundamental contradiction simply and effectively. If backup disks are securely encrypted, you can make unlimited numbers of them without compromising confidential data. Thus, even if you don't use encryption directly in daily operations, you may want to use it on backups.

Transparent Encryption

The simplest way to implement encryption on a microcomputer is with an encryption and decryption program. On command, this will encrypt or decrypt a specified file with a specified password. Such programs are simple to write but impractical to use. For example, to edit a previously encrypted sensitive document during a typical word processing session, you must

- exit the word processor;
- call up the decryption program, specify the filename and appropriate encryption key, and wait for the whole file to be decrypted;
- reenter the word processor;
- edit the document;
- exit the word processor;
- call up the encryption program, specify the filename and appropriate encryption key, and wait for the whole file to be encrypted; and
- reenter the word processor.

In addition, you must overwrite any temporary or backup files that the word processor may have created. If it created and deleted any temporary files itself, you must overwrite all the free space on the disk in case sensitive data was left there.

One refinement of such encrypt-on-demand programs is to make them permanently resident, activated by a single keystroke. This removes the "exit word processor" and "reenter word processor" steps, but otherwise leaves the procedure as awkward as before. Faced with frequent amendments to a document, normal human impatience will dictate leaving the document file unencrypted just in case another change is needed.

A further weakness of these schemes is their use of keys. You have to enter encryption and decryption keys frequently, so many people will select short—and thus insecure—keys for ease and speed of typing. Also, there is no built-in protection against misspelling. Suppose that the key CONFIDENTIAL (obvious and thus insecure) is misspelled as COMFIDENTIAL. Everything seems all right until you try to access the document, perhaps months later, and find it to be unreadable.

Transparent encryption solves these problems. A transparent encryption system is a TSR program that remains permanently active. It monitors and intercepts all disk accesses for sensitive files. Whenever records are written, the encryption system encrypts them before they reach the disk; whenever records are read, it decrypts them before they reach the application programs.

A transparent encryption system is

continued

invisible to the application program, which is unaware that any encryption is going on: This eliminates any possible compatibility problems. Also, full protection automatically extends to temporary files that the application may create and delete without your direct knowledge.

Transparent encryption is almost invisible to the user, too. Encryption keys are set up once and for all at the start of each session and remain buried (suitably encrypted and concealed) in the TSR program's private memory. Thus, after an initial log-in, the complex sequence of operations necessary to edit a confidential document with simple encryption systems becomes simply "edit the document."

Because you enter the keys only once, there is less user resistance to making them complex and obscure, and you can solve the traditional problem of choosing short, memorable, easily guessed passwords by requiring that keys have a certain minimum length (e.g., eight characters) and a high maximum length (60 characters or so).

With transparent encryption, entering a wrong key has no catastrophic effect on what is already stored. All that happens is that whatever you read from the disk with the wrong key *appears* to be corrupted: Once you enter the correct key, everything is readable once more.

A final major advantage of transparent encryption is its efficiency in database applications. Instead of having to decrypt and then re-encrypt a whole database—possibly several megabytes in size—whenever a record is required, a transparent encryption system decrypts only the data you actually need: probably an index entry or two, a few pointers, and the required record itself. The resultant increase in speed makes all the difference in terms of practicality.

The things to look for in a transparent encryption system are speed, granularity, transferability, and security. Speed is an obvious necessity. If encryption or decryption takes too long, the computer will appear slow and unresponsive.

Granularity refers to the degree of detail you can use in specifying encryption keys. Encrypt-on-demand systems can easily accommodate file-level granularity, with a different key for every file if necessary; transparent encryption systems have more difficulty doing this. Disk-level granularity—with everything on a disk encrypted identically—is easy to achieve, but it's not enough.

On a bootable hard disk, some files, such as CONFIG.SYS and device drivers (and of course the encryption program itself), must be read before you can install any encryption program, so at the very least there should be a distinction between unencrypted files used in the boot process and encrypted files used thereafter. Moreover, different people may use the computer for different projects, and it's a good idea to enforce separation by using different keys. A usable transparent encryption program must offer at least directory-level and preferably file-level granularity.

Transferability is often overlooked. You will always need to be able to exchange files between computers. This means that you must be able to accommodate different keys, unless everyone uses the same keys. At least one commercial package generates a key randomly at each installation, making piracy the only practical way of ensuring freedom of interchange.

Security is the most difficult criterion

continued

of all. Too many vendors of security systems underestimate the subtleties, intricacies, and pitfalls of cryptography and publish products that are dangerously insecure, many of which can be broken in a few hours with no specialized cryptographic knowledge. Unfortunately, the encryption algorithm seems to be the last thing considered in designing most security systems. In evaluating a number of security systems, I have found that some use trivial algorithms, misapply them (e.g., use random-number generators for cryptographic purposes), or use stream ciphers, which are intended for use *once only* in data transmission, to repeatedly encrypt blocks of data.

The most dangerous thing about such mistakes is that they are completely invisible to the user who has no cryptographic expertise. You notice if your word processor prints nonsense or your database retrieves the wrong data. But in a security system, all you can do is check that your files continue to be readable after being encrypted and decrypted. Beyond that, you can only hope that your system is truly secure.

Even the respectability of the vendor doesn't appear to be a good guide to the security of its systems. One international accounting firm promoted a data security product whose disks you could decrypt in the time it took to physically read and rewrite them. When confronted with this fact, the firm claimed that the encryption algorithm was "only a part" of the complete system. Indeed it is, but it's an indispensable part. The foundations may be only a part of a building, but without them, the building will crumble.

Standards and Validation

Traditionally, areas of functionality where you are unable to form judgments for yourself are covered by standards, and it might be reasonable to expect this to happen with encryption algorithms. There does indeed exist a U.S. Data Encryption Standard (DES), along with an array of ancillary standards describing how to use it in a variety of contexts.

Unfortunately, the DES is a hardware standard rather than a software standard. It relies heavily on bit manipulation and thus runs slowly in software: It is hard to exceed 100,000 bps even on the fastest IBM PS/2. Moreover, DES is a stream cipher with a small block size (8 bytes), *intended* for data transmission rather than data storage, so it's not prudent to use it for transparent data security.

DES is over 10 years old, but it's unlikely that any replacement standard will appear, especially one more suited to data storage than to data transmission. Standards consolidate progress, but they also hamper further development.

When DES was originally designed, there was an overwhelming need for standardization in hardware, because of the size of the investment required to design encryption chips and because data communications (the principal application) required that the same encryption algorithm be used at both ends of a link. But with software, especially software designed mostly for local operation on a single microcomputer, the investment is smaller and there is less need for uniformity, so the expense and inconvenience of a single standard cannot be justified.

It has also been suggested that there should be some sort of central body whose duty it is to evaluate encryption algorithms and report on their security. Unfortunately, this is impossible. First, security is not a matter of testable fact (except for the most obviously insecure algorithms, whose insecurity can readily be demonstrated). Experience and opinion must play a part in the evaluation, and it is difficult to find someone who has adequate expertise and is not hampered by a conflict of interest.

Short of employing an expert of your own (and trusting that his or her expertise is as great as he or she claims), if you must evaluate encryption packages, you have to cut through the verbiage and sales literature, ask awkward questions about who actually wrote or evaluated the encryption algorithm, and then decide whom to trust—an unenviable task.

Network Security

LANs appear to be more difficult to protect than microcomputers, because access to data is possible from a wider area. This additional difficulty is, however, mostly illusory. Because data on a LAN is typically held on a server machine, physically securing the server takes care of physical data security, and conventional passwords and access profiles become more effective. (See the text box "Peeling Back the Layers" on page 258.) However, you are effectively tied to a particular LAN vendor's offering in its entirety, and awkward trade-offs can arise between security and performance: trade-offs that may not be apparent at first but become more significant as the network grows and you are less sure about the trustworthiness of its users.

Physical interception of LAN messages can become a problem on larger networks. Network analyzers can be used not for their legitimate purpose of identifying and correcting network problems, but to intercept sensitive data. The need to protect LANs against attacks of this kind (and against straightforward decoding of stray radio emissions) is only gradually being realized.

Wide-area networks, along with simpler forms of data and message transmission, have different problems. In principle, you can use many elaborate security protocols to verify the identity of the participants in a dialogue and to secure data against interception or alteration. In practice, complacency leads to a total lack of precautions, and compatibility considerations mean that straightforward "dumb-terminal" protocols (with little or no scope for data security) are used even when there is considerable CPU power present at both ends of a link. Incidents such as the Internet worm may serve to alert people to the need to take reasonable precautions, but this multivendor situation is one in which we must make a strong effort toward standardization if we expect to make any progress.

Appropriate Security

Absolute security is unattainable. Very high degrees of security are commercially available, but they can be inappropriate. When evaluating various approaches, consider how much security you really need. In many cases, a simple power-on password (in either hardware or software) is sufficient. While it can be fairly easily circumvented by anyone who knows how, that in itself may be an advantage, since you needn't worry too much if the password is forgotten (full-blown security systems have elaborate procedures to allow recovery from lost passwords). You may judge that the kind of attackers you have to protect against wouldn't have the technical competence to circumvent even quite simple protection measures—or wouldn't have the patience to try.

Whatever your situation, it's important to evaluate risk. If the risk is mainly from outsiders, then encryption and physical-access control may be most useful; if it's from insiders, then audit trails can be a powerful tool. It's useful to compare data with backups. Doing nothing is dangerous, but an over-elaborate protection scheme is equally irresponsible, because no one will use it. Complacency and panic are equally harmful: A reasoned assessment is essential. ■

Martin Kochanski is a director of Business Simulations Ltd. in London, a firm specializing in information retrieval and data security. He can be reached on BIX as "mjk."

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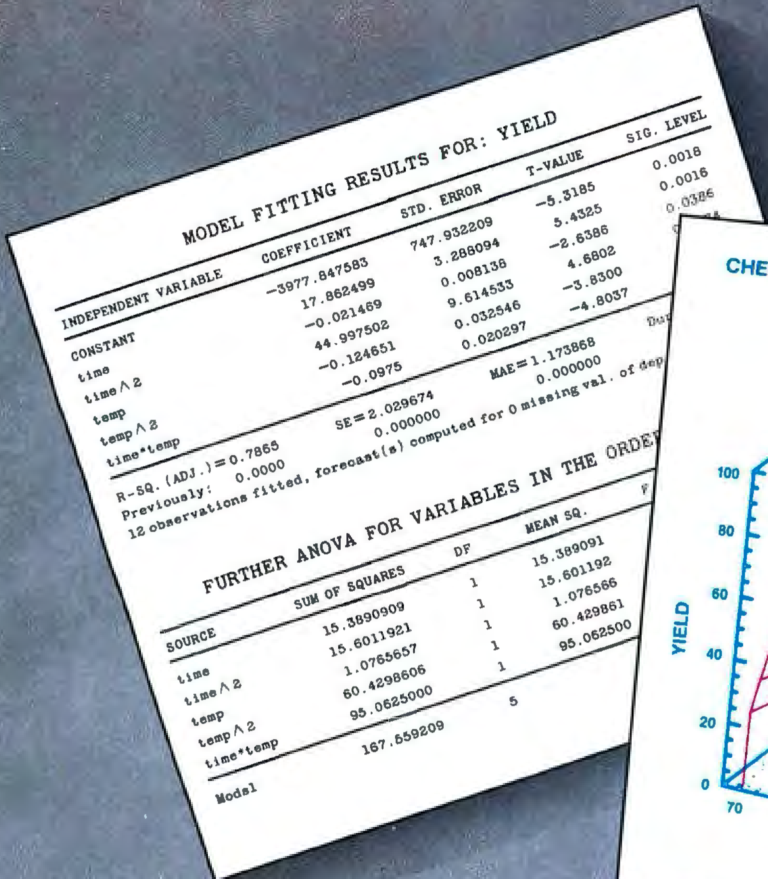

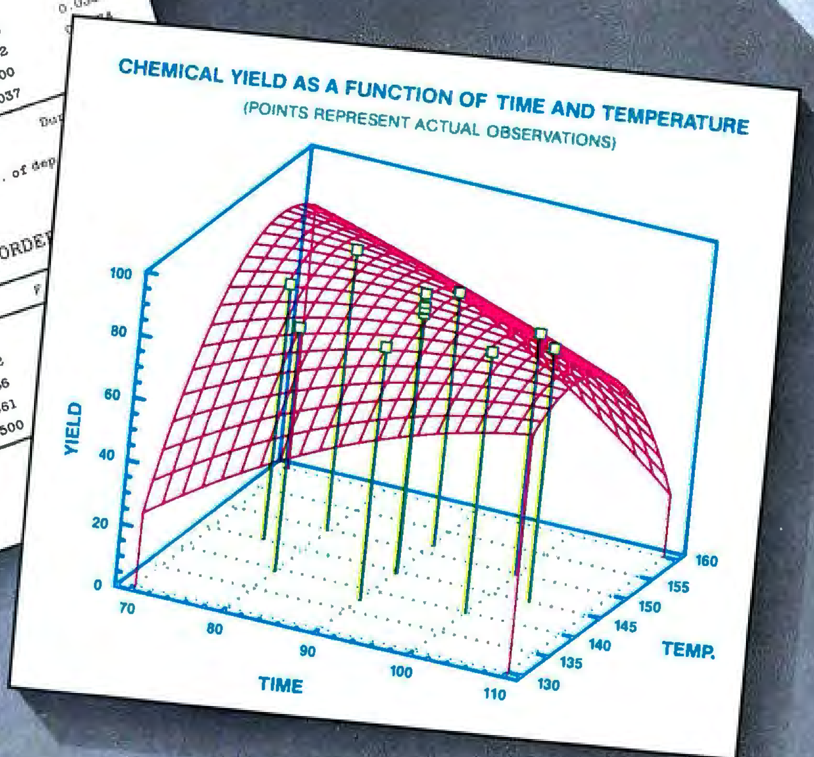

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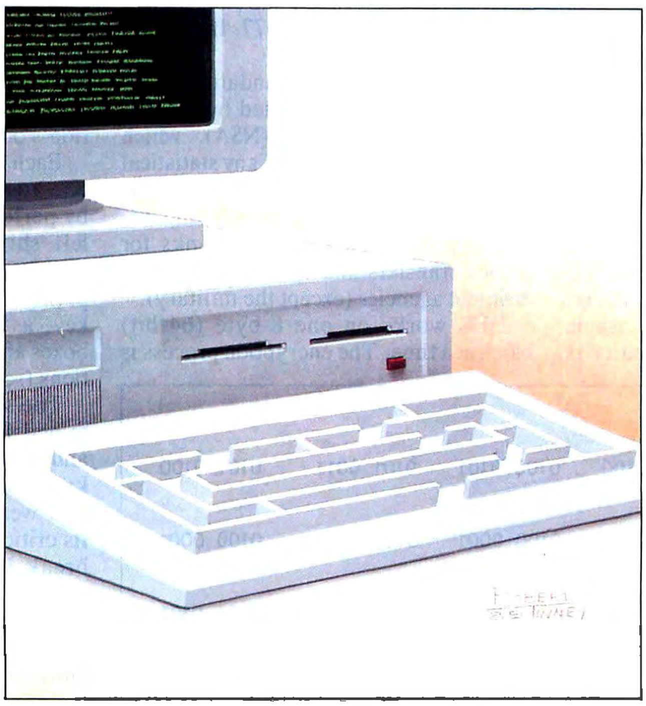
Secret Codes

Any good data security system must rely on encryption

Asael Dror



Cryptography is the ancient art of making the comprehensible incomprehensible to all but a chosen few—of keeping secrets secret. Julius Caesar is credited with protecting the secrecy of messages by replacing every letter in the original text, called the *plaintext*, with a letter three characters later in the alphabet. The result is called a *ciphertext*, in which *A* is represented by *D*, *B* by *E*, and so on.

The war between cryptographers, who devise *cryptosystems*, and code breakers, who try to decipher encrypted messages, has drastically escalated since the invention of the computer. On one hand, computers help to break complicated cryptosystems within seconds. On the other hand, they make it feasible to use extremely complex encryption algorithms that were not practical before. Furthermore, the advent of distributed computer systems, the wide availability of microcomputers, advances in mass storage, and the widespread use of computer communications have all contributed to moving cryptography from military and diplomatic fields to those of more general interest and importance.

Two major cryptosystems are in use today: conventional systems and public-key systems. Two major encryption algorithms relate to these cryptosystems: DES and RSA, respectively.

Conventional Cryptosystems

One important method of encryption is *substitution*: replacing every occurrence of a letter (or word, or byte) with a different letter (or word, or byte). The XOR operator is a convenient way to perform substitution with computers. When you XOR 2 bits together, the result is 1 if one and only one of the input bits is 1. The result is 0 if both input bits are 0, or if both input bits are 1.

The XOR function is convenient because it's fast and you can decrypt the encrypted information simply by XORing the ciphertext with the same data that you used to encrypt the plaintext. For example, you can encrypt the word *TEST* by XORing every byte with the ASCII representation of the letter *A* (0100 0001). In figure 1a, the letter *A* is the *key* used to encrypt the plaintext. To decrypt the message, you XOR it again with the same key, as in figure 1b.

The strength of a good cryptosystem doesn't depend on keeping its algorithm secret; the secrecy of the ciphertext relies solely on the secrecy of the key.

A *statistical cryptoanalysis* attack can easily break a simple cryptosystem. Natural language has specific known patterns, such as the frequency with which each letter is used; common letter combinations, such as *th*, *er*, *ing*, and *ion*; and

continued

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word-usage frequency. Those plaintext patterns will also appear—although their expression will differ—in the ciphertext; once you recognize them, you can use them to break the cipher. Alternately, you can break the cryptosystem with a *brute-force* attack. Since there are only 256 possible keys (binary 0000 0000 to 1111 1111), a computer can quickly try them all.

One way to overcome these problems is to use longer keys. For example, you could use a four-"letter" key such as A5GE (a good "random" key). In this case, you encrypt the first byte with *A*, the second byte with 5, the third with *G*, and the fourth with *E*. After exhausting the key, you reuse it; so you encrypt the fifth byte using *A* again, and so forth. The key length is 4, making it harder, but not impossible, to use letter-pattern methods to break the code.

Unfortunately, if code breakers know (or can guess) part of the plaintext (e.g., if they know that every message begins with "Dear Sir"), then they can use *analytical cryptoanalysis* to derive the key. In figure 1, XORing the plaintext with the ciphertext reveals the key.

Ideally, you should have a key that never repeats. Such a key, composed of random bits and never reused, is called a *one-time tape* (or *one-time pad*). You can prove mathematically that a cryptosystem based on a one-time tape is unbreakable. Unfortunately, such a cryptosystem requires a key as long as the message you want to encrypt; so then you have to figure out how to transmit the key safely. Still, one-time-tape systems are usable when a safe transportation means is available now but won't be in the future, when you need to transmit the secret message.

It may seem that you could create a one-time-tape cryptosystem by extending a short key with a computer's random-number-generating function, using the short key as the seed. Although many commercially available data-encryption packages use such a scheme, it should be considered more of a toy than a cryptosystem. A computer's random-number generator actually generates pseudorandom numbers. A mathematical relationship exists between each generated number and the one that follows it. Consequently, such proprietary cryptosystems, often described as unbreakable, can usually be cracked within minutes (see reference 1).

DES

Since a layman cannot tell the difference between a secure cryptosystem and a complete mockery, the National Bureau of Standards (NBS) established the Data Encryption Standard (DES). It was originally developed by IBM and adopted as a standard by the NBS in 1977. In 1980, it was adopted by ANSI.

Prior to becoming a standard, the security of DES was validated by the National Security Agency (NSA), which found the algorithm free of any statistical or mathematical weaknesses (see reference 2). Since its adoption as a standard, DES has been used by most banks for money transfers and by most U.S. government agencies (except the military).

DES works on one 8-byte (64-bit) block at a time. The encryption process is controlled by a user-supplied 56-bit key; that's 2^{56} (72,057,594,037,927,946) possible keys. Every bit in the output is a complex function of every bit in the input block and every bit in the key. Decryption under DES is the reverse of encryption and is performed by working the algorithm backward. The encryption process (see figure 2) consists of an initial permutation of the input block followed by 16 rounds of encipherment, and finally an inverse of the initial permutation.

After the initial permutation, the block being encrypted is divided into two parts, called L_0 and R_0. In each of the 16 rounds of encipherment (see figure 3), the new L part is the previous round's R part. The new R is the previous round's L part XORed with the result of the *cipherfunction f*. Thus, the output of round *i* is

$$L_i = R_{i-1}$$
$$R_i = L_{i-1} \text{ XOR } f(R_{i-1}, K_i)$$

The cipherfunction f (see figure 4) derives its output based on the old R part (R_{i-1}) and the current round's key (K_i). You use the inputs to perform substitution via eight lookup tables called S boxes and then permute the combined output of the S boxes to give the function's output.

Each round uses a different 48-bit key, K_i. You derive the current round's keys by performing a set of permutations and left shifts on the user-supplied 56-bit key. DES defines the exact left shifts and permutations used to derive each round's key, as well as the definition of the S boxes and all the other required permutations (see reference 3).

The strength of DES has been ascertained by the NSA's thorough analysis and years of widespread use without any known break in the system. DES's biggest weakness is its limited key length. Its critics claim that you might be able to break DES with a brute-force attack (i.e., by trying every possible key).

However, trying all possible keys within a reasonable time frame would require a special machine that would use as many as 1 million processors working concurrently. Each processor would decrypt the ciphertext using a different set of keys and check (e.g., by using a dictionary) to see if it had guessed the correct key. Even though it would cost millions of dollars to construct such a machine (if at all feasible), the fact that DES is in such common use creates an incentive to develop it. However, this theoretical shortcoming is no reason not to use DES. If you are worried about it, you can easily

(a)

Plaintext: (*TEST*)	0101 0100	0100 0101	0101 0011	0101 0100
Key: (the letter *A*)	0100 0001	0100 0001	0100 0001	0100 0001
Ciphertext: (plaintext XOR key)	0001 0101	0000 0100	0001 0010	0001 0101

(b)

Ciphertext:	0001 0101	0000 0100	0001 0010	0001 0101
Key: (the letter *A*)	0100 0001	0100 0001	0100 0001	0100 0001
Plaintext: (ciphertext XOR key)	0101 0100	0100 0101	0101 0011	0101 0100

Figure 1: *A simple example of* (a) *encryption and* (b) *decryption using the XOR operator.*

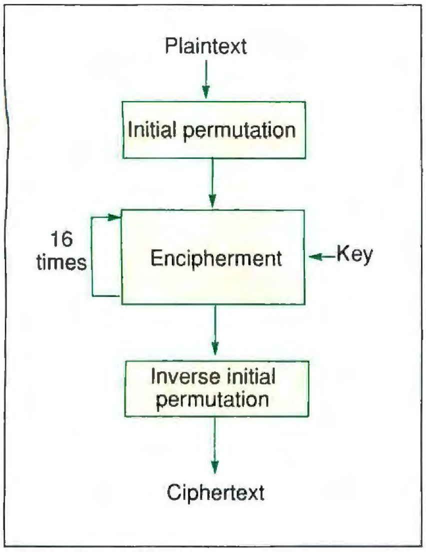

Figure 2: *The DES encryption process. Every bit in the output is a complex function of every bit in the input block and every bit in the key.*

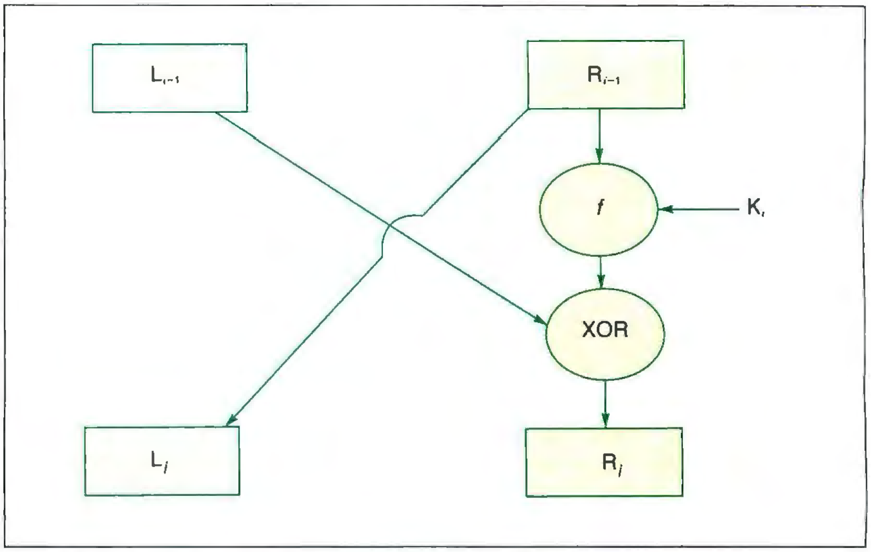

Figure 3: *The details that are involved in each of the 16 rounds of encipherment shown in figure 2. Note that the new L part is the R part from the previous round, and the new R is the L part from the previous round XORed with the result of cipherfunction* f.

overcome it by using an additional pre-DES encryption stage.

Public-Key Cryptosystems

When using a conventional cryptosystem such as DES, both the sender and the receiver must know the key used to encrypt (and decrypt) the data. Therefore, you need a safe means of transmitting the key from one to the other. If you change the keys frequently, transmitting them becomes a major problem. Furthermore, with a conventional cryptosystem, it's impossible to communicate with someone new until you have safely exchanged keys; this can take a long time. Public-key cryptosystems are designed to overcome these shortcomings.

Public-key cryptosystems are based on the use of a *trap-door one-way function*. You can easily compute such a function in one way only—used to encrypt the data. To compute the function in the other direction—used to decrypt the data—you must have certain secret information; hence, the name *trap-door*.

In a public-key cryptosystem, each person has two keys: one for encrypting, E_A, and one for decrypting, D_A. Decrypting with D_A a plaintext *P* that was encrypted using E_A restores the original plaintext—that is, $D_A(E_A(P))=P$. Both E_A and D_A should be easy to compute, but knowing E_A does not reveal D_A.

If you use a public-key cryptosystem, you can publish your encrypting key E (the public key) in a public directory, while you keep D (the private key) secret. If someone wants to send you a message, all that person has to do is look up your public key (E_A) and use it to encrypt the message as $E_A(P)$. Only you

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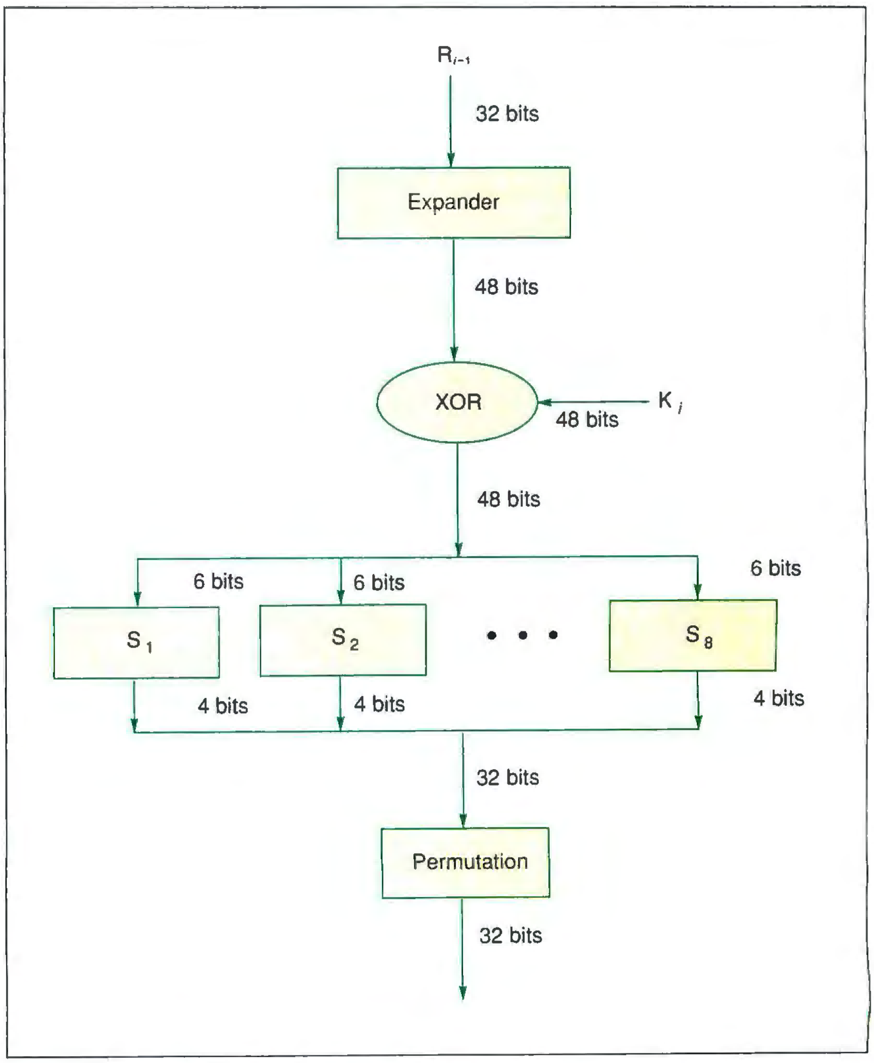

Figure 4: *Cipherfunction* f *from figure 3. Its output comes from the old R part (R_{i-1}) and the current key (K_i). The inputs use eight S boxes to perform substitution and then permute their combined output to give the function's output.*

know the private key D_A, so only you can decrypt the message back to its original plaintext, $D_A(E_A(P))=P$.

RSA

The most important public-key cryptosystem today is RSA (see reference 4), named after its inventors, Rivest, Shamir, and Adleman. To use RSA, you need to choose, at random, two large prime numbers, to be called p and q. Compute n as the product of the two primes: $n=p*q$. Then, randomly choose a large number d, so that d is *relatively prime* to $(p-1)*(q-1)$; in other words, the greatest common divisor of d and $(p-1)*(q-1)$ is 1. Finally, compute e so that $(e*d)$ modulo $((p-1)*(q-1)) = 1$. The notation "x modulo y" signifies the remainder of dividing x by y using integer division. For example, 20 modulo 5 = 0, since 20/5 = 4 with 0 remainder; 13 modulo 3 = 1 since 13/3 = 4 with 1 remainder.

The public key is the pair of numbers (e,n), and the private key is (d,n). Although n and e are public, it is difficult to arrive at d, since there is no efficient algorithm for factoring large numbers. Consequently, to be secure, both p and q must be very large (at least 100-digit numbers), so that n is extremely large (at least 200 digits) and cannot be factored within a reasonable time.

To encrypt with RSA, first you break the plaintext into blocks that can be represented as an integer between 0 and $n-1$. Then, you encrypt each block by raising it to the power e, modulo n. To decrypt the block, raise it to the power d, modulo n; that is, $C=P^e$ modulo n, and $P=C^d$ modulo n.

Let's look at an example of how to use RSA. For the sake of simplicity, you should use very small primes for p and q. To create a secure system, however, you should use very large primes (to find large prime numbers, see reference 5).

- Assume you choose $p=3$ and $q=11$.
- Then, $n=p*q=3*11=33$ and $(p-1)*(q-1)=2*10=20$.
- You can use $d=7$, since 7 is relatively prime to 20.
- Next, you need to find an e, so that $e*7$ modulo $20 = 1$.
- You can use $e=3$ because $3*7=21$, and 21 modulo $20 = 1$.
- Thus, your public key is (3,33) and your private key is (7,33).

If you represent your message by using a 1 for *A*, 2 for *B*, 3 for *C*, and so on, the plaintext DEAD would be written as 4 5 1 4. The following table shows how to encrypt this using the public key (3,33).

P	P^e	P^e modulo n
4	64	31
5	125	26
1	1	1
4	64	31

Thus, the ciphertext is 31 26 1 31 (using large primes would let you create large blocks that would conceal the patterns detectable in this simplified example).

To decrypt this, you would use the following to restore the original plaintext.

C	C^d	C^d modulo n
31	27512614111	4
26	8031810176	5
1	1	1
31	27512614111	4

The RSA algorithm has been known since 1978, and in no known case has it been broken. Its strength is based on the complexity of factoring very large numbers. However, while no algorithm has yet been found to efficiently factor large numbers, such an algorithm may exist. If such an algorithm is found, RSA would be rendered useless. Furthermore, no one has proven that factoring n is essential to deriving the private key.

On a more practical note, RSA's operations on very large numbers make the system extremely slow. In addition, the RSA algorithm is patented, and you can't use it freely.

Digital Signatures

In addition to ensuring privacy, encryption can be used to verify authenticity. Say you send your broker a message telling him to sell all your stocks. How can the broker verify that you sent it? If you dispute ever sending the message, how can the broker prove that you did? If you used paper mail, your signature would be used to verify and prove authenticity, but how about electronic messages?

Simply encrypting the message using a key known only to you and the broker doesn't solve the problem. The broker would be satisfied that you had sent the message, but couldn't prove it since he knows the key and thus could have forged the message. Public-key cryptosystems can provide an elegant and simple solution by creating *digital signatures*.

A trap-door one-way function has the property of $D(E(P))=P$. If the function used by the public-key cryptosystem also has the property of $E(D(P))=P$, it is said to be a *trap-door one-way permutation*. The RSA public-key cryptosystem fulfills this requirement. Using such a public-key cryptosystem, you can encrypt the message using the private key D_A. Anyone who receives the message $D_A(P)$ can decrypt it using your public key E_A, since $E_A(D_A(P))=P$. Since D_A is known only to you, the recipient knows, and can prove, that you are the author.

If you want to send a private message that can be authenticated to someone else, then you encrypt $D_A(P)$ with that person's public key, giving $E_B(D_A(P))$. Using the private key, D_B, that person would derive $D_B(E_B(D_A(P)))=D_A(P)$, which would be saved as proof of authenticity, and then decrypt $D_A(P)$ by using $E_A(D_A(P))=P$. Thus, both privacy and authenticity have been achieved.

Secure Computer Systems

Any good computer data security system must rely on encryption. Whereas both DES and RSA provide a good basis for a computer security system, using proprietary algorithms may be worse than using no encryption at all, because they lead to a false sense of security.

But encryption alone is not sufficient. Proper key selection, key management, physical security, people security, and procedures to ensure that plaintext does not "leak" out of the system via loopholes (see reference 6) are all essential for a secure computer data system. ■

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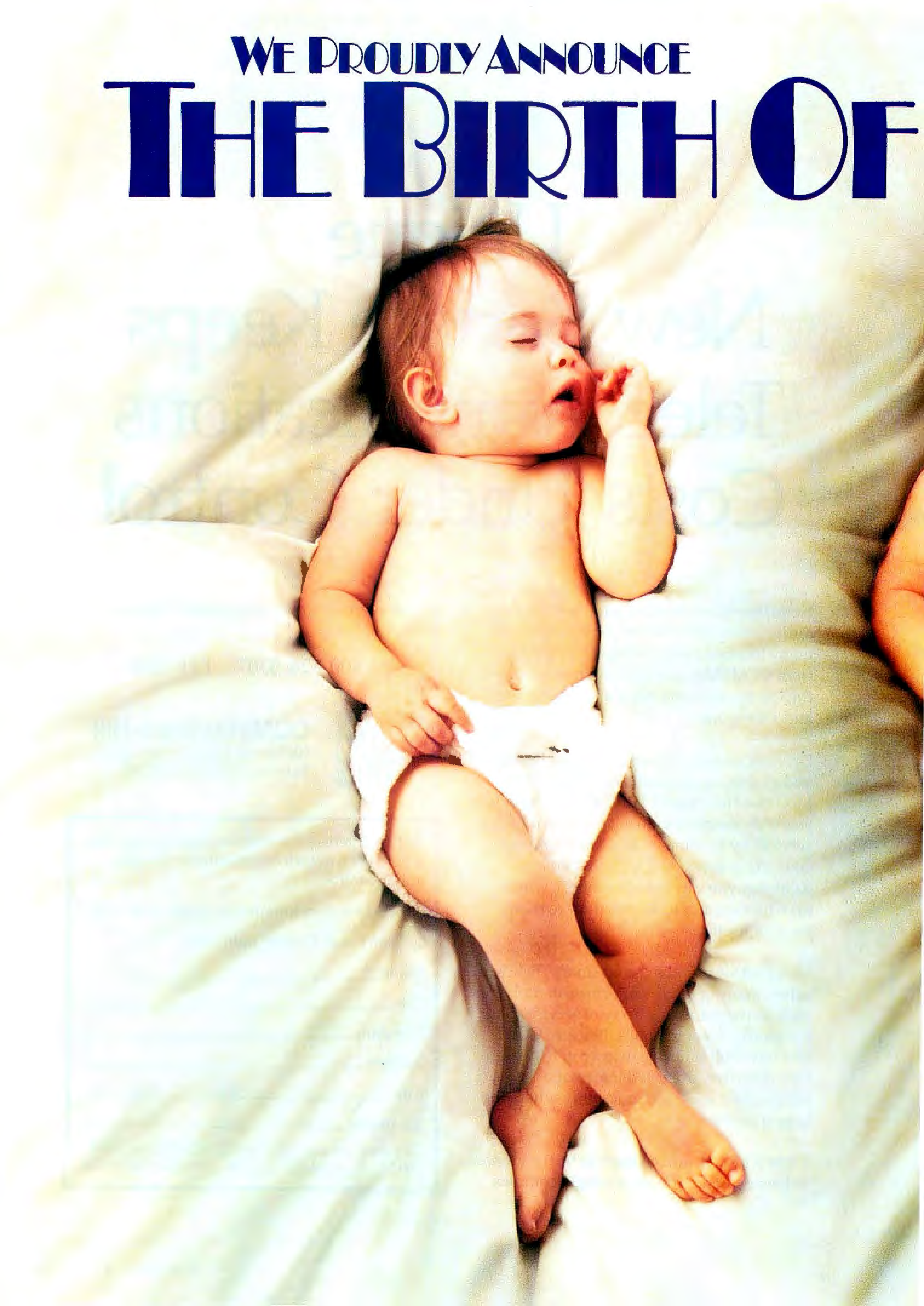
Asael Dror is the founder and president of Wisdom Software, located in San Francisco, California. He is the author of File Encrypt, a DES encryption program for MS-DOS and OS/2. He can be reached on BIX as "asael."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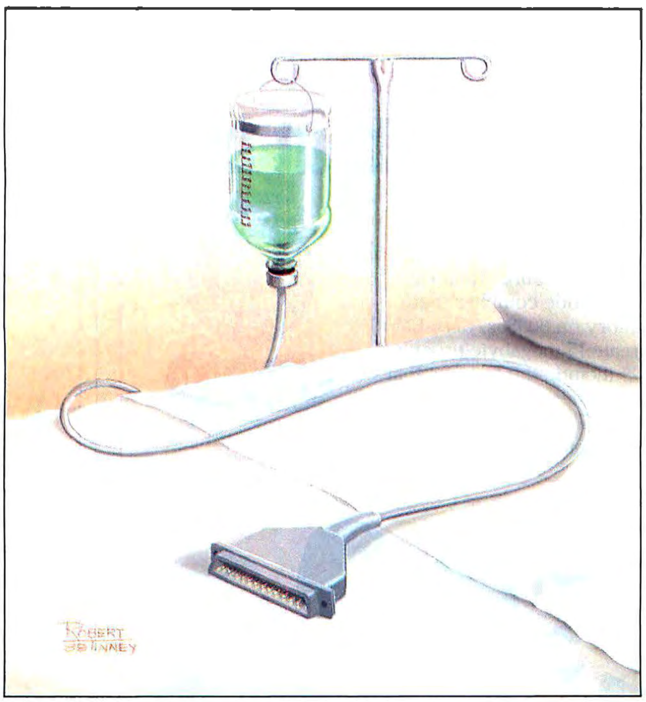


In the late fall of 1987, a message went out from Lehigh University in Pennsylvania indicating that one of the folks in the computer lab was busily fighting a virus program. The virus in question, dubbed the "Lehigh virus," spread itself from computer to computer using an infected disk as its mode of transmission. For a "clean" computer to be infected with this virus, it had to be booted up with an infected disk in drive A. Hundreds of computers were rapidly infected.

After a number of replications, the virus "turned Trojan" and wiped out the data on the infected machines' hard disks. A *Trojan program*, named after the infamous Trojan horse of Greek mythology, is a program that produces a one-time disaster, damaging or destroying data or disks as soon as it is executed.

Currently there is a big drive to develop ways to diagnose and stop viruses before they infiltrate networks and cause irreparable damage to expensive devices, peripherals, and irretrievable data. Many viruses have been identified, but there are several PC viruses considered to be the most prevalent—Israeli, Lehigh, Pakistani Brain, and Alameda. There are also two lesser-known viruses that I have run into in my work. They are discussed in the text box "Two Other Viruses I Have Known" on page 277. And for Mac environments, see the text box "Two Mac Viruses" on page 278.

The main avenue that viruses take to invade PCs is through the use of an infected floppy disk. Virus strains are becoming more virulent and sophisticated; some can hide themselves so well even the best utilities are unable to find them. There are even viruses that can secrete themselves in nonvolatile memory, making system reinfection an increasing problem. Shrink-wrapped software not only is not immune from carrying viruses, it has actually been the cause of many systems becoming infected. CD-ROMs also have been degraded with these nasty diseases at the time they were pressed.

In the DOS environment, viruses use JMPs or other system files to ply their trade. The most common way a system can become infected is through its I/O calls. Actually, viruses use any "chink in the system's armor" to infiltrate the environment. And there's no such thing as a "bulletproof" system.

Although there is widespread controversy over viruses, some basic information may serve to set the scene. Consisting of a number of parts, a *virus* is a code that infects other programs, is self-replicating, and requires a host or executable disk segment. Once it is physically in a system, it can damage or destroy data,

continued

media, the system itself, and any attached peripherals.

Essentially, a virus has four phases: the dormancy phase (optional), the propagation phase, the triggering phase, and the damaging phase. A propagation phase is all that is necessary for the program to be a virus; a virus does not have to cause damage. The creator of a virus might use a dormancy phase to instill a sense of trust in the user since the virus does not propagate or do damage during this phase. The triggering phase is launched by some occurrence, such as a certain date or a particular number of replications. Finally, the damaging phase does whatever harm the author intended the virus to do.

Some viruses even have a *pretrigger.* This is a piece of code that lets the virus benignly sit in a program until something transpires, such as a particular date or timeframe, the presence of another program or file, or the capacity of the disk exceeding some certain limit. Generally speaking, very few viruses have a pretrigger.

If the virus doesn't have a pretrigger, or if it does and its pretrigger goes off, then the virus or virus replication mode activates. At this stage, the virus replicates a virtual copy of itself into other programs or into certain system areas on your disk. When loaded and executed, each infected program or system area is a clone of the virus itself and will produce

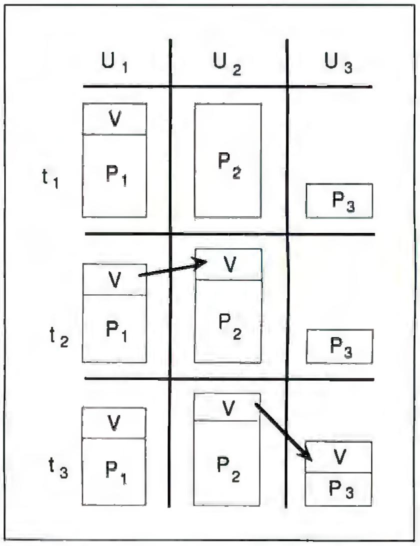


Figure 1: *A picture through time of a virus infecting a system. A virus, V, infects user U_1's program P_1 at time t_1. At t_2, U_1 shares information with U_2 and infects P_2. When U_2 shares data with U_3 at t_3, P_3 becomes contaminated. (Figure courtesy of Fred Cohen)*

Two Other Viruses I Have Known

Not all viruses trash your disk; some trash your data, and these are potentially more dangerous. You can always restore your programs from their distribution disks, but your data is yours alone and you might not even notice a change until it's too late.

The dBASE Virus

The dBASE virus isn't a problem with dBASE itself; it's a virus I ran across at the office of a client who was running dBASE. Thus, I named it the dBASE virus. It's a TSR virus that works in a manner similar to the Israeli virus. The virus intercepts calls to DOS interrupt 0x21 and looks for open calls to files with a .DBF extension. When the virus finds such a call, it stores the returned file handle in a data location within its code space and stores the current size of the .DBF file as well.

Subsequent write operations that would expand the size of the .DBF are made with the first 2 bytes transposed. Future reads also have the first 2 bytes transposed. Therefore, for as long as the virus is installed in your system, everything looks fine. However, after 90 days, it will destroy your file allocation table. And when the virus is exterminated, you will find that the data in your .DBF file is worthless.

The dBASE virus creates a hidden file, called BUG.DAT, the contents of which indicate which records (by byte offset) have a series of bytes transposed and where those bytes are. If you're a dBASE user and the next time you run a CHKDSK you see your hidden file count go up, you should check your disk for this file in the same directory where the .DBF files reside. If it's there, you're infected.

If you create the BUG.DAT file and make it read-only, the dBASE virus won't be able to open the file for read/write access and your data will be safe. This file must exist, however, in each directory you use for storing your .DBF files.

The Screen Virus

More than one virus creates TSR problems and byte transpositions. The one I call the Screen virus is a simple one. After it goes TSR, it waits for the timer tick and wakes up every few minutes. When it wakes up, it examines the screen memory and looks for any four contiguous digits starting at a random place on the screen. When it finds them, it transposes two of them. This process is not as harmless as it sounds.

The Screen virus is a dumb virus—it doesn't check to see if a piece of code is already infected. When first executed (before it goes TSR), it will infect every .COM program in your current directory (including copies of itself if the disk image resides in the current directory). Then, of course, if you use a floppy disk with this virus on it in another system, you will infect the new environment.

This virus does have an identifying characteristic that you can use to determine if you're infected: a file that includes the word `InFeCt`. If you find `InFeCt`, read the 4 bytes immediately preceding it and overwrite the first 4 bytes of the program with their value. Then truncate the program at their stored address. By so doing, you've rid yourself of a nasty virus and restored the program to its pristine state.

Finally, make sure you use a clean copy of your disk editor.

more clones (see figure 1).

Don't confuse viruses with "worms." A *worm* is a piece of software that takes over the resources of a computer (worms its way through the core of the data, for instance) and uses them for its own purposes. Strictly speaking, a worm is not a virus because a virus must actually infect other programs with a copy of itself.

In November 1988, when the Internet (a tightly coupled network of machines throughout the U.S., each communicating with all the others on the network) was infected, it wasn't infected with a virus. It was infected with a worm. The Internet infection used the network's own facilities to spread the bogus code. When it reached the target system, it used the resources of that system to further propagate the infecting program. This process is typically considered a worm, since no preexisting program was infected.

Generally speaking, viruses wreak their havoc in the Macintosh, Amiga, and other environments as well as in the DOS world. Most of the viruses that have been seen to date, however, carry out their damage in an operating-system-specific manner.

The Anatomy of a Virus

It is important to realize that virus programs, in and of themselves, can be innocuous and don't necessarily have to be created with malicious intent. They can be the work of someone who wants to play a practical joke or of people who are experimenting with the technology.

On a DOS system, simple viruses infect the most basic programs of all, the .COM files. These files are almost an exact image of the memory image of the program run after they are loaded. At load time, only upon examination of the segment registers can such a program tell where it has been loaded in memory. The majority of these .COM programs start with a JMP instruction—there is a theory that you should always have the data at the very beginning of your program. This is not strictly true, but programmers usually follow this procedure when they write their programs.

If the JMP instruction at the beginning of the program is modified so that it points to other code, the CPU will automatically run that code. After the virus program has done its dirty deed, it must run the original program as if it were not infected. Since the virus need not be concerned with the meaning of the original data bytes it displaced to infect the errant program, it can treat these bytes just like data, move them back into their original location, and then allow them to execute without any regard to what those bytes are. Therefore, even programs that do not start with the simple JMP instruction can be infected.

A virus can be written in one of two ways: as position-independent code or as position-dependent code. A position-independent virus is usually added to the end of a program. It has no need to manipulate more than the first 3 bytes of the original program—just enough to branch the program's run to itself. Position-independent code is a little harder to write, since at run time, all data accesses must be localized and resolved.

Position-dependent viruses must be set to execute at the start of the program and typically will copy the original instruction(s) at the beginning of the uninfected program to the physical end of the program's data image on disk. Such viruses must also have a block-move routine that must either be position independent (so that it can run from any location) or use a

continued

Two Mac Viruses

Janet J. Barron

In the Macintosh environment, viruses go after operations resources—they use the Mac's architecture as a way to get around in the system. You can eliminate Macintosh viruses by replacing the System Folder and any affected application with clean copies from the original master disks. There are two major viruses that particularly plague Macs—nVIR and Scores.

The first, nVIR, comes in a variety of forms—at least a dozen have been detected, each with its own individual activation characteristics. nVIR's technique for spreading is especially virulent. It invades the System File; once this crucial resource is infected, every application that is subsequently launched is contaminated.

The second, the Scores virus, may account for about a third of all viral attacks, although so far there hasn't been a significant amount of devastating damage. Many government agencies' systems are thought to have been plagued with an infection of Scores. Personnel at NASA's Washington, D.C., headquarters and at the University of California in San Diego have detected the Scores virus in their machines. According to a NASA virus investigator, the agency believes that its Macs contracted Scores by downloading an infected program from a BBS.

It takes only a minuscule amount of time for Scores to spread. And if a Mac's System file is plagued with the disease, any application that runs from that System will also have it. This particular virus infects any Mac application by increasing its size by 7000 bytes.

You can quickly tell if your Mac is infected by opening your System Folder. Check out the small Scrapbook and Note Pad file icons. If they're not the usual crisp representations of Mac icons and they look like generic documents, then you may have a case of the Scores virus. This technique won't work with nVIR because its mode of replication is different.

You can use your ResEdit, the resource editor, to identify viral resources and invisible files, but don't use it to try and kill off the virus. If you attempt to banish the individual resource, the Scores virus changes its resource identifiers, and they come back to haunt you again the next time you boot up. Even after removing the offending virus, some of your applications may not function properly because portions of the virus may still be lying low in your System Folder files.

The Scores virus spreads every time an infected application is launched. The virus lies in wait for two days. Then, when you boot your machine, the INITs installed by Scores load into RAM and begin executing their routines.

At 3½-minute intervals, the virus seeks new hosts. Subsequently, it creates Note Pad and Scrapbook files in the System Folder (hence the change in the icons) as well as invisible Scores and Desktop files. Then Scores begins to look for specific programs to damage or destroy. The whole process takes about a week, during which time you may experience system slowdowns, problems with peripherals and their performance, and even system crashes.

The usual preventatives prevail with both the nVIR and Scores viruses. Be extremely wary of using anyone else's software or downloading programs from unknown or not absolutely trustworthy sources. And always be sure to keep clean backups of your system and application software in case your system becomes infected through the use of a diseased disk.

Janet J. Barron is a BYTE technical editor. She can be reached on BIX as "neural."

known and quantified area of memory outside the program's memory image (e.g., unused areas in the low-memory interrupt vector or video table). These criteria are necessary so that the original code, misplaced by the virus, can be restored to its proper position and can run correctly.

The Israeli Virus

An interesting virus that doesn't really fall into either of these two categories (position dependent or independent) is the TSR virus, typified by the so-called Israeli (or Jerusalem) virus. It infects .COM and .EXE programs and can affect floppy and hard disks. It is spread via infected programs on floppy disks or by the use of floppy disks in infected computers.

When run, the TSR virus moves its position-dependent code into the beginning of its allocated memory, hooks into interrupt 21 hexadecimal (which is one of the main DOS interrupts), and then loads and executes the disk image of itself. The disk image notices that the interrupt 21h hook is already in place and executes normally. When it finishes execution and exits, the loaded image resizes the memory allocation to include only the virus code itself, then executes a TSR command, returning you to the C> prompt but leaving behind a live virus to execute upon other load and execute instructions that come through future calls to interrupt 21h.

This virus also makes an attempt to cover its trail; before it tries to infect a program, it preserves the program disk image's attributes and date/time access. It then modifies the attributes to allow read/write access (marking a file as read-only doesn't help against this virus), infects the program's disk image, and then restores the original attribute and date/time stamp. You'll discover this virus when the size of the disk image increases by just over 1800 bytes.

Part of the code in this virus will check the date. If it happens to be Friday the 13th (the trigger), it will turn Trojan and either trash your disk or delete programs as you execute them, depending on the *version*. Yes, that's right. There are actually different versions of some viruses.

The Lehigh Virus

The Lehigh virus, via which you can lose all your system and hard disk data, is really an infected COMMAND.COM. Whatever you type at the C> prompt is first processed by COMMAND.COM. When you boot your machine from an infected copy, the original vector for interrupt 21h is stuffed safely away at interrupt 44h (normally not used by any program), and then the DOS interrupt is revectored to point to a portion of memory it has reserved for itself via a TSR call. (Version 2, discovered on February 2, used interrupt 63h.)

With this virus, when any disk access is made, the copy of COMMAND.COM that exists on that disk is checked to see if it's already infected. If it is, then normal processing continues. Otherwise, the virus infects the clean COMMAND.COM and increments a counter. The version 1 strain of the Lehigh virus stores this counter on a computer's hard disk in the infected copy of COMMAND.COM. With floppy disks and with the version 2 strain, the counter is kept in memory.

Date and time stamps are not preserved, so by looking at the date on a disk's copy of COMMAND.COM, you can tell if it's been tampered with—a recent access date indicates that it has been. With the Lehigh virus, attributes on the disk image of COMMAND.COM are not modified, so a clean copy can remain that way if you mark it as read-only. Another alternative is to change the name of your clean copy of COMMAND.COM and then modify your CONFIG.SYS and AUTOEXEC.BAT files to point their SHELL and COMSPEC variables to the newly hidden copy.

After version 1 of the Lehigh virus has copied itself four times, it trashes your hard disk. This virus is transferred by sharing infected floppy disks as well as by using a clean disk in an infected system. Version 2 copied itself 10 times.

The Pakistani Brain Virus

The Brain virus infects the boot sector of a floppy disk. When you boot off the disk, the virus rereads itself into memory (in essence, becoming a TSR virus), moves the current boot record to an unused portion of the disk, then marks that portion as bad sectors.

A bad sector will no longer be accessed by DOS. The original boot record is now called, and when you boot, except for a great deal more disk operation than you're used to, you'd never notice the Brain virus's presence. Doing a directory on an infected disk will show the volume label as © Brain—and a CHKDSK will show a few bad sectors. Interestingly enough, when you use an infected system and do a directory on an uninfected disk, the clean disk will become infected.

The Brain virus takes over the floppy disk controller interface (interrupt 13h) and looks for certain operations on the disk. If it sees a read operation, it pushes the original read operation aside and attempts to read the boot track. If it sees anything other than a word equal to 1234 at byte offset location 4, it assumes that the disk is uninfected and then infects it.

This virus has no trigger but immediately starts to mark areas on your disk as bad even though they are good. Eventually, your disk will contain nothing but bad sectors—bringing everything to a halt.

The Brain virus marks areas on your disk as bad even though they're good.

This is a strange virus. As mentioned, it announces its presence with the volume label, and the virus itself contains text that reads: "Welcome to the Dungeon." Then it gives the names of two brothers in Pakistan who are supposed to have authored this virus, an address, telephone number, and a few other admonishments and warnings.

If you modify the boot record on your system to include the value as specified, you've effectively inoculated your system from the Brain virus.

The Alameda Virus

Working in a manner similar to the Brain, but not exactly like it, this virus also does its thing by infecting a system's boot sector. The Alameda, discovered at Alameda College in California, is a very small virus inhabiting only one sector.

It's not one that deliberately goes out and destroys files at random. The Alameda virus does damage data but, besides the boot sector, only in one very specific location on the floppy disk—the last track.

When a machine reads in the boot sector, it reads in the virus, which stores the real boot sector elsewhere. Once it's read in, the virus takes over and reads in the real boot sector, which controls what the machine does from then on. If you insert a nonwrite-protected disk in the A drive, when you do a warm boot, the virus replicates by moving the real boot sector down to the last track of the disk. The virus takes over the last track without regard to what is in it. If a file is there, it becomes corrupted. All floppy disks inserted during reboot can catch the Alameda virus.

continued

The Alameda virus hooks into one of the keyboard interrupts. That's how it knows you're doing a Ctrl-Alt-Del. It stores itself in high memory, decreases the available memory by claiming the last 1024 bytes for itself, and tells the machine that the 1024 bytes don't exist. No other application can load on top of it—it will generate an "out of memory" error. In addition, the network shell won't always reboot when you try to load and run it—it will simply hang up during a warm boot.

The Alameda virus infects only true IBM machines. It does not, however, infect any 80286 machines, including IBM's, because it uses machine instructions the 80286 generally doesn't permit. On some IBM machines, there are programs you can't run because of the memory problem and other programs that won't operate because the virus prevents the proper CONFIG.SYS files from running.

Alameda's staff members suspect the virus came from another school in the Peralta community college district of which Alameda is a member. They believe the source is probably a programming student who wanted to do something unique and interesting. They have just about disinfected their environment by tracing at what stage the virus infects the disk and chasing down where it lives. They wrote a program that looks on the boot sector to see where the virus is and kicks it off. In addition, Alameda users have started booting from the network so the problem can't replicate in that way.

How to Ward Off Infection

A variety of good antiviral programs are available, ranging from freeware to shareware to commercial programs costing many hundreds of dollars. These programs come in many flavors, and there are many kinds for different machines.

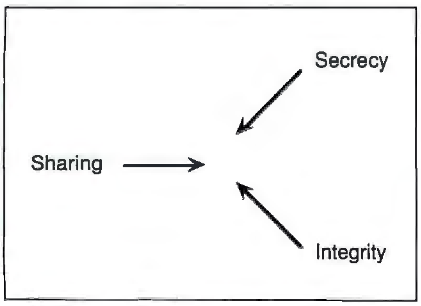


Figure 2: *An impossible dilemma. You need and want data secrecy, sharing, and integrity. However, while you can achieve success in any two of the three, because of viruses, you can't have all three at once. (Figure courtesy of Fred Cohen)*

You can diminish your chances of being hit with a virus if you refrain from putting any new software on your system.

- *Integrity checkers.* This type of program allows you to generate a unique signature or checksum for each program on your system. At boot-up time, these values are checked against the stored (and protected) copies. If there's a difference, you may have an infected program on your disk.

Obviously, programs such as SideKick that store their configuration options within the .COM file itself will have this value changed. Just be aware of such a potential triggering of the checker and you'll be in good shape. Realize that programs such as these will not stop an infection, but they will advise you of infected or modified programs.

- *Monitoring programs.* These programs are typically TSR programs for PCs and INITs for Macs. They sit on the interrupts and examine each one that comes by for suspicious activity. If they notice something the antiviral program's author thought was suspicious, they'll interrupt the operation, trigger an alert of some sort, and ask the operator what to do. Different programs have different options—you'll have to choose the one that serves your needs best.

A subclass of these two classes is a program that monitors for a load-and-execute instruction and does a checksum or signature check on the disk image of the program about to be loaded. If it has somehow changed from the stored value, the antiviral program triggers an alert.

- *Virus removers.* These programs examine the hard disk for signs of viruses that the antiviral program's author knows about. If they find a program with the footprint of such a virus, at the very least, they'll alert you to its presence. The better ones will also remove it.

Be aware that these programs can only catch and cure viruses that were known to the author. Before you buy one of them, ask the manufacturer of the product how many updates have been released in the last year. If there hasn't been an update for quite a while, you might want to shop around to find a company more active in its antiviral efforts.

- *Backups.* This is one defense against a virus, but it is not fail-safe. Some of your data might become corrupted by a virus, and the backup sets of that data might also be infected (see figure 2). You should run a virus checker after you've had to restore from a backup.

How Serious Are They?

Viruses are a serious problem, and they have the potential of becoming even more troublesome. Yet, if you take the proper precautions, you'll probably never be infected.

You diminish your chances of being hit with a virus if you don't put any new software on your system (including shrink-wrapped software and software downloaded from less-than-particular BBSes) and if you never use a network or boot a program from someone else's floppy disk. But in today's environment, these restrictions are less than realistic.

If you do install new software on your system, make sure you make a backup before you start working with it. A virus writer might have just as much access to a shrink-wrap system as the software manufacturers do. Many computer stores allow shrink-wrapped software to be returned to them, and there's no guarantee that when you buy it, you're not getting something extra you didn't plan on.

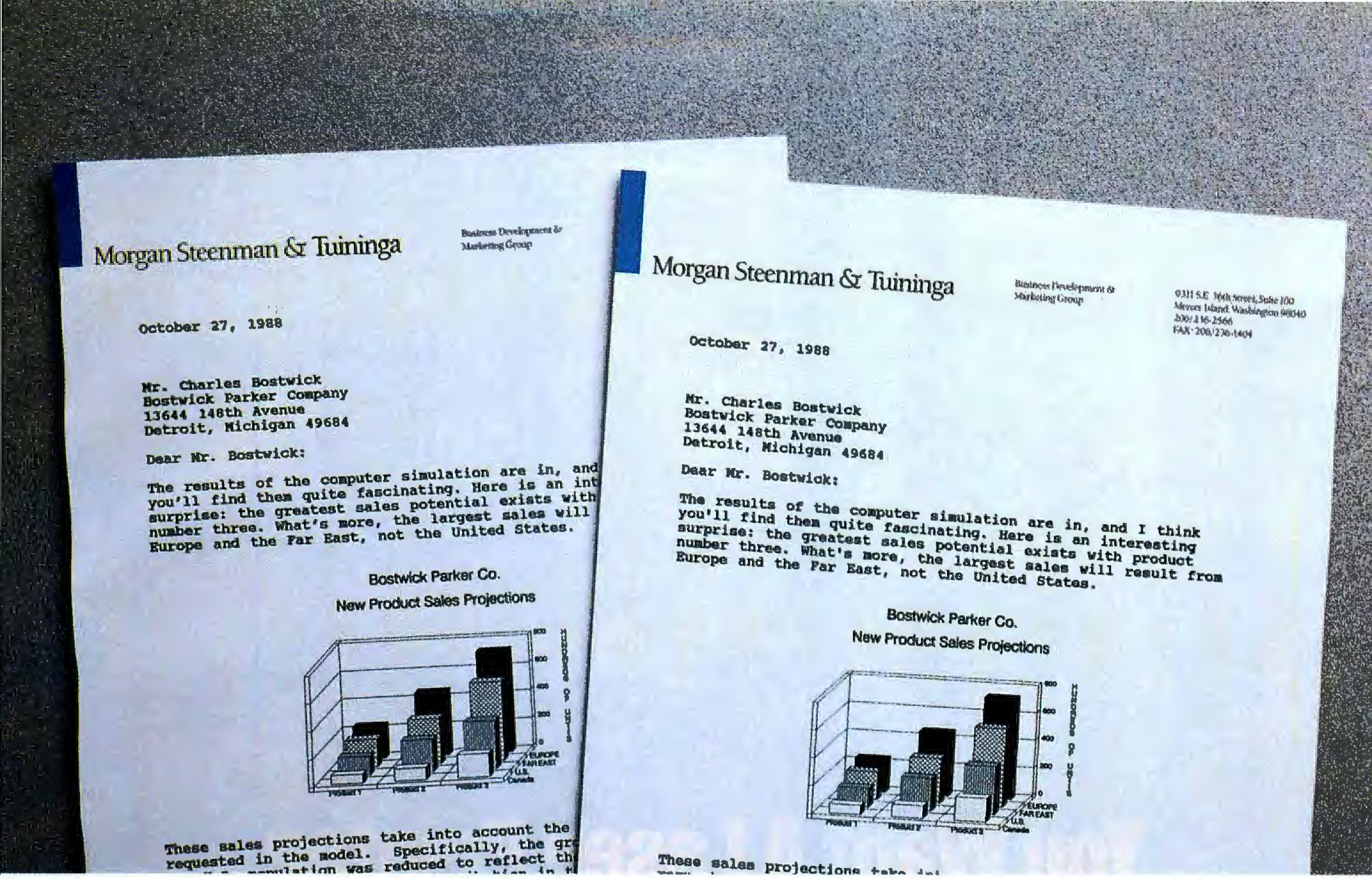
As more and more people network their machines, the threat of viruses becomes more and more serious. As it is, they have already caused millions of dollars' worth of damage and data loss and thousands of hours of downtime.

To protect your microcomputers, use common sense and as many preventive measures as you can. Don't be fooled into thinking you can beat the threat. ■

ACKNOWLEDGMENT

Thanks to Lehigh University's Ken Van-Wyk for his contributions to this material. He is the founder and moderator of an electronic virus discussion group called VIRUS-L.

Ross M. Greenberg, owner and chief executive officer of Software Concepts Design in New York, is a computer consultant and software designer. He can be reached on BIX as "greenber."



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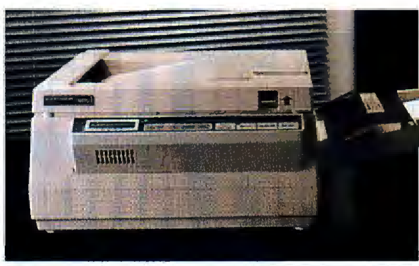

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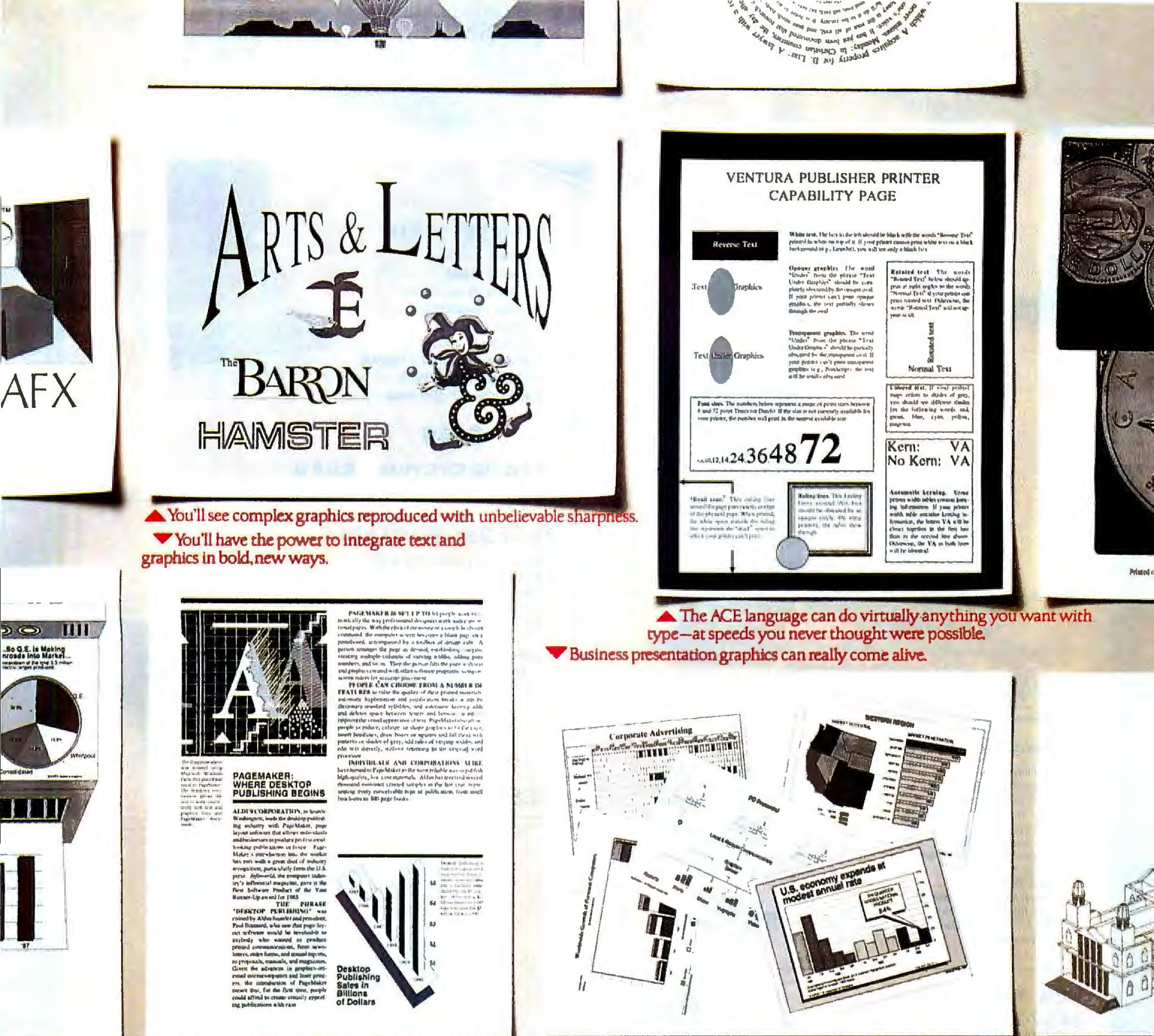

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Personal and Private

How much security is enough on a microcomputer?

Peter Stephenson

Not all personal computers are on networks. But virtually all computers, networked or not, contain sensitive information that poses an open invitation to compromise. Think how easy it is for someone reasonably familiar with personal computers—and today, that's almost everyone—to walk up to an unattended machine and copy a client list, personnel files, or any other information that's usually considered private.

Are security measures on individual personal computers as important as anti-intrusion procedures on a network? Should the contents of a hard disk be kept as secure as paper files in a locked file cabinet? Many people think that security on a personal computer is too troublesome, too confusing, and too expensive.

None of these excuses is valid anymore. Security on a stand-alone personal computer is easy to install, use, and maintain. Often, adding a security program can actually simplify the computer's use by adding a comprehensive menu system. But is this necessary? If you have data that you would lock in a file cabinet were it on paper, you should protect it with a good security program or an add-in board.

Although many software and hardware products are available to lock your microcomputer's electronic file cabinet, they all fall into a few functional categories. You can encrypt the data on your hard disk, prevent access to the data in the first place, and watch active files for viral contamination that could damage or compromise data. Which of these approaches (or combinations thereof) you select will depend on how secure your data needs to be and how open your computer is to outside intrusion. (For a discussion of issues affecting a data center, see the text box "The Small Data Center" by Bob Brown on page 286.)

Keeping It Simple

Encrypting data files, such as word processing documents, databases, and spreadsheets, is the simplest line of defense. The casual snooper can't easily read encrypted data, but a determined data thief can often decrypt your files. The degree of encryption simply serves to slow down the malefactor in many cases. (For more details on encryption, see "Secret Codes" by Asael Dror on page 267.)

One of the fastest and least expensive examples of simple file encryption is File Encrypt from Wisdom Software. At $69.95, it uses the Data Encryption Standard (DES) to encrypt files simply and quickly. File Encrypt is a single-key conventional cryptosystem written in assembly language and running in both DOS and OS/2 protected mode.

continued

The Small Data Center

Bob Brown

Security used to be pretty simple in the small data center with a minicomputer or small mainframe. The data center manager kept the computer room locked and used passwords to control access to data. Often the security policy was little more than an ad hoc collection of procedures. Widespread adoption of microcomputers in corporate and departmental computing has added new complexities to security management. Wise data center managers will review their procedures and develop a written security policy.

The principal reason for developing a security policy is to use it as a tool for communication. A formal policy will communicate your expectations to your staff, to the users of the computing facility, and to corporate management.

The development of a security policy necessitates a risk analysis; you can't determine how to deal with risks until you know what they are. Particularly in small organizations, if a risk analysis has been undertaken at all, it is likely to be out of date.

Finally, development of a security policy will allow threats to be dealt with proactively rather than reactively. For each identified threat, the policy should describe not only the protections to be put in place but also the actions that will be taken if the threat is realized. A security policy will serve as a damage-control guide if the worst happens.

The introduction of microcomputers into corporate and departmental data processing has made a difference. The central computer is generally in a secure location—often in its own locked room. Programs and data are backed up on a regular basis. Transaction-logging software also can provide both an audit trail and another level of backup. Data access usually is controlled by passwords; often the password system is centrally administered, so, in effect, the data center manager controls all access. But even if these controls are actively in use, microcomputers have rendered them less effective.

The Trouble with Microcomputers

The two characteristics microcomputers have that make them so useful are local data storage and local data processing. These same two characteristics are also responsible for most microcomputer-caused security headaches.

Local data storage creates a requirement for backups in the various locations where the information is stored. And, if a microcomputer user has a floppy disk or a modem, data can be exported from or introduced into a system of microcomputers without any possibility of centralized control. It's highly likely that the manager responsible for central computing won't even know what data is stored on the microcomputers in the organization.

The problem with local data processing is one of quality control. Professional programmers are usually subject to a set of management practices and testing guidelines that attempt to verify their work. Despite the formal quality control implemented by centralized data processing, users tend to view new and changed programs with a healthy dose of skepticism. This outlook provides an informal second level of verification. Yet these same users will set up a database or spreadsheet, or even write complete programs, and then rely on the results even though there has been no formal testing or quality assurance.

Analyzing the Risks

In analyzing the risks inherent in using microcomputers, you must consider not only the cost of the damage if a risk is realized, but the likelihood of the risk. Greatest attention should be paid to those risks that are both likely and costly if realized.

Don't forget that the most likely and potentially costly risks are those of human error. There's no limit to the kinds of errors people can make, and you can't guard against all of them. But if you implement a well-thought-out security policy, it will allow recovery from all but the very worst of these.

Probably the largest risk area inherent in the use of microcomputers is the ease with which machine-readable data can be manipulated. Data can be removed from the system, given to unauthorized people, and even destroyed. Some companies have tried to attack the data removal problem with LANs and diskless workstations. Getting rid of

Using File Encrypt is simplicity itself. After starting the program by typing FE and responding to the prompts, you only have to type ENCRYPT, DECRYPT, or SCRATCH. It will prompt you for input and output filenames and path names. Once a file is encrypted, you can only read it if you have the correct key. If you wish to have the original plaintext file destroyed, File Encrypt will do so at the end of the encryption process.

To return the encrypted file to its original plaintext state (i.e., remove the encryption permanently), you issue the DECRYPT command. To erase the file completely, you use the SCRATCH command. Unlike the DOS DELETE command, SCRATCH first deletes the file and then overwrites it with zeros. Thus, once you have SCRATCHed it, you can never recover it. Virtually all competent security products use this method of erasing files.

A variation on the file-encryption theme is provided by Lattice's SecretDisk II. This program not only encrypts the data you select, it creates invisible "drives" where it stores the encrypted files. You can encrypt files using either the DES or Lattice's proprietary FAST data encryption. The advantage of FAST is, as you might think, its speed.

SecretDisk II's invisible logical drives contain only encrypted data in hidden system files. Using it requires installing device drivers in the CONFIG.SYS file. These device drivers create the virtual drives with all the sector-size characteristics of a normal DOS partition. SecretDisk II's entire process is menu-driven using Lotus 1-2-3-like menus.

A single password locks and unlocks the secret drives. Once a drive is unlocked, you can access its contents. Even if an intruder managed to discover the existence and location of the secret drives with a disk-maintenance utility, the files would still be encrypted and, thus, presumably safe. SecretDisk II is a single-key system.

A companion product, the SecretDisk II Security Administrator, is a set of utilities that lets you master-key a secret disk. If someone left your organization or forgot a password, you could unlock the files and assign a new key. The Security Administrator also lets you customize floppy disk drives reduces exposure to data theft. However, "LAN leaks" can be an even bigger problem. An authorized user can download data from the central computer and then store it on the LAN server in such a way that it's available to others who would otherwise not have access to it. This type of security failure is more likely to be the result of an innocent mistake than of malice.

The widespread use of dial-up data communications creates another area of concern. Any small computer with an accessory slot or serial port can be equipped with a modem. At 2400 bps or more, relatively large amounts of data can be exported (or imported) in a short time. The same modem that's used to transmit payroll information to a service bureau can transmit to someone's home computer or to a competitor. Unlike the LAN leak, unauthorized transfer of data via modem is not likely to be accidental.

Programs are as vulnerable to theft as data, perhaps even more so. If someone you work with is in the habit of trading stolen software with others, it's possible that a program for which you paid hundreds or even thousands of dollars could wind up in someone else's hands. Even if that doesn't happen, there is another risk: Software licenses seek to impose an obligation on the buyer to protect the software from theft. A software publisher that finds an identifiable copy of its program in unauthorized hands may try to collect financial damages from the original buyer.

Unauthorized introduction of programs or data is as risky as unauthorized removal. The presence of stolen copies of programs on a company's computer leaves the company vulnerable to lawsuits and perhaps to prosecution. Unauthorized introduction of programs also provides a point of entry for malicious programs—viruses, worms, and Trojan horses—which can result in damage to data or even equipment. The presence of stolen data like bids or customer lists will almost certainly lead to legal action if it is discovered.

Physical security deserves consideration, too. The biggest problem is backup, and it is here that a LAN can help. If all critical or frequently changed files reside on a LAN server, the same person who runs the backups for the minicomputer or mainframe can back up the server. In fact, some server programs can run on certain minicomputers, using the disks for microcomputer data storage.

Microcomputers, like any expensive piece of office equipment, should be protected from theft or damage. Keeping them out of public areas is one of the best forms of protection. Simple equipment locks will prevent surreptitious removal and "grab-and-run" thefts.

Developing the Policy

Once you've analyzed the risks inherent in the use of microcomputers, you're ready to commit to a security policy. Spend the most effort on those risks that are both likely and costly. Consider how these risks can be minimized, and also the appropriate response when a risk is realized. Be reasonable in the requirements your policy imposes; unreasonable demands will be ignored or circumvented, and they can be worse than no policy at all. Keep in mind that what's reasonable for a defense contractor, a bank, or a hospital might be unreasonable for other kinds of businesses.

Formalize the policy in writing in a single document. The collection of procedures that may have been enough for a centralized data center is not sufficient for distributed computing with microcomputers. The written policy should be given to everyone who could be affected by it.

Distributing the policy isn't the end of the job. It must also be kept up-to-date. The introduction of new technology such as LANs, removable hard disks, or optical storage may create new risks or obviate old ones. Changes in business practices may change the assessment of risks or the responses to risks realized. Regular review will ensure that the policy keeps up with the changing environment.

Bob Brown is associate executive director for information systems at the Georgia Medical Care Foundation in Atlanta, Georgia. He can be reached as "bbrown" on BIX, where he moderates the data center conference.

SecretDisk II control panels; thus, you can limit the choices the program presents. Probably the most important use of this feature is its ability to disallow the DELETE command. When you remove DELETE from the control panels, it's impossible for someone to accidentally delete files on a hidden drive.

Several products also exist that facilitate secure transmission of data between two modems, including both software and integrated secure modems. One of the best of these is MailSafe from RSA Data Security.

Secure transmission of point-to-point traffic has three requirements. First, you must guarantee that what is received is what was sent. This ensures that data has not been intercepted and altered en route. Second, you need to determine the identity of the message's author. And third, you must ensure that the traffic is secure and private while in transit. MailSafe provides these three safeguards in software that resides at both ends of the communications link.

Because more than one user must have access to the secure data, MailSafe uses a system of public and private keys. The users who will send secure data use a public key to verify the recipient's digital signature and encrypt traffic for transmission. The recipient uses a private key to sign files and decrypt the received secure messages.

MailSafe uses a system of menus to select and secure files for transmission. The process is kept as simple as possible with allusions to everyday office functions. The sender creates public and private keys using the KeyGen utility. This process also installs user passwords. Passwords can be up to 80 characters long. MailSafe does not use the password to generate a key. Instead, the KeyGen utility automatically creates new keys. You can create new keys at any time. MailSafe also supports digital signatures.

MailSafe also allows you to share public keys. If two users want to encrypt files for mutual use, they can accomplish this by "certifying" their public keys to each other. Consequently, although neither one knows the other's password or key, secure messages can pass back and forth

continued

between them. MailSafe can be used on machines shared by several users without compromising any individual user's secure data.

Denying Access

Virtually all security experts agree that the best way to protect sensitive data residing on a computer is to deny access to the computer. While data encryption provides a certain measure of security, encryption works best as part of an overall security program that includes barriers to intruders. There are two ways to erect these barriers: in hardware and in software.

Software systems designed to thwart data thieves are the easiest to install and use but may allow determined intruders entry through so-called "back doors." One software security system that closes most loopholes is Watchdog from Fischer International Systems. Watchdog is one of the best-known software security programs.

The easiest way to defeat a software program is to bypass the boot disk and boot from a separate, independent disk. Watchdog prevents that by forcing you to boot from a predetermined drive, usually the hard disk drive. From the time that you log on, you are placed in a menu system that displays your authorized directory areas. Areas may be private or shared, allowing multiple users to use the same computer without danger of compromising personal data.

Watchdog assigns permission levels, much as in a LAN, to govern reading, writing, creating, and deleting files, as well as using DOS commands. Permission levels can be set for the system, for each area, and for each user. Files within secure areas are automatically encrypted using Watchdog's proprietary encryption algorithm. Finally, Watchdog provides an audit trail of all system activities by user.

Other features in Watchdog provide convenience as well as security. For example, a mailbox system allows secure messaging among those who share a machine. You can lock out the DOS FORMAT command for certain privilege levels, minimizing the risk of accidental or malicious reformatting of the hard disk. And a system library utility lets several users access shared data efficiently.

However, software intrusion barriers may fall to skilled and persistent intruders. Watchdog, for example, uses a proprietary encryption algorithm that may or may not be susceptible to tampering. The best possible protection against all forms of security breaches is a combination of hardware and software security. Watchdog Armor adds that additional level of protection.

Armor is a half-card that works with Watchdog software to add several new security features and speed up many existing ones. The most obvious addition is the ability to absolutely designate the computer's boot drive. If any attempt is made to bypass the designated drive, Watchdog software kicks in immediately and cannot be bypassed. Armor also provides the option of DES encryption that resides on the board in firmware. This arrangement materially speeds up DES's encrypt/decrypt process. Armor also makes the audit trail's system clock completely tamperproof.

Installing Watchdog and Watchdog Armor is quite simple, and multiple I/O address choices for the board are available. A complete administrator's guide is part of the Watchdog package, and there are a number of administrative utilities.

Perhaps the most intensive hardware security device comes from American Computer Security Industries. ACSI has provided security products for government agencies for several years and has recently begun to provide its "industrial-strength" COMPSEC-II security product to commercial customers. COMPSEC-II is a half-card device that provides a smorgasbord of security and security-management features.

In addition to the features provided by Watchdog Armor, COMPSEC-II offers protection of mainframe-access channels, automatic encryption of data being archived to tape backup systems, copy protection of local files, site-license control, secure notepads, electronic signatures, time-zone control, and message authentication using the DES-based message authentication code (MAC) as specified by the National Bureau of Standards.

Time-zone control, along with the secure clock, allows you to limit the times and durations of individual user access. You can force users to change passwords periodically. COMPSEC-II also interfaces with many biometric devices, such as fingerprint readers.

In fact, the computer stays protected even if the COMPSEC-II board is removed. Should an intruder choose to disable the hardware by taking the card out of the computer, drive C ceases to exist as a valid path. Even booting from drive A won't enable DOS to recognize that the computer is configured for a hard disk drive. The system is menu-driven and reasonably transparent to individual use.

A second concern, beyond compromising sensitive data, is the introduction of a virus or other destructive program into a personal computer. COMPSEC-II has some features that greatly limit the potential for such damage. You can examine files using cyclic redundancy checks. Files in a directory are subjected to an initial CRC when you know they are "clean." Future periodic CRCs compare current to clean readings and warn you of suspected alterations.

You can make drive A or B unusable to all but those with required privilege levels. Since COMPSEC-II's secure kernel mediates all system transactions, you can take steps to ensure that only a limited number of users can introduce new programs (which may be Trojan horses containing a virus or worm) into the secure system.

Putting It All Together

The Immune System, also from ACSI, is a turnkey 80286-class computer completely outfitted, according to its developer, to protect you "against viruses and all other internal and external threats to your system and data."

The Immune System, at $2995, contains all the features associated with COMPSEC-II, as well as other security features aimed at controlling access through COM ports and mainframe gateways. The computer sports a 12.5-MHz 80286 microprocessor, 1 megabyte of RAM, one parallel and two RS-232C serial ports, a high-density floppy disk drive, and a 40-megabyte hard disk drive. It comes completely configured for secure operation and pretested for virus contamination. Although it doesn't include a display, it does incorporate a Hercules Graphics Controller–compatible monographic card, and the computer is EGA-, CGA-, and VGA-compatible. The Immune System, like other ACSI products, uses the DES for data encryption.

What is the best response to the potential for security breaches? The intensity with which you choose to protect your data may depend on what you perceive its value to be. Today, when access to computer data is simple and virtually universal, proprietary information may be as easy to steal as copying a disk. Security systems are becoming not just easy to use and maintain, but also real enhancements to productivity without the expected inconvenience. ■

Peter Stephenson is a freelance author and consultant. He can be reached on BIX as "pstephenson."

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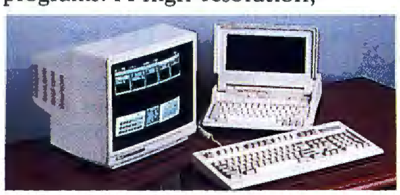

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BY69

PC-DOS: PULLING OUT THE STOPS

The latest versions of PC-DOS have features that speed up file access for applications

Fetchi Chen

Even though PC-DOS has been in existence for only seven years, it is the most widely used operating system. As a result of the variety of IBM PC hardware and application environments, DOS has evolved to provide options for improved performance. In versions 3.3 and 4.0, the design team implemented four new performance-enhancing mechanisms.

The first mechanism is the support of large buffers by using expanded memory, which provides an increase in performance for programs with large, random I/O files. You can now specify a maximum of 10,000 system buffers.

The second mechanism is the support of look-ahead buffers for sequential file processing. You can specify up to eight look-ahead buffers. This mechanism reduces the number of disk accesses for frequent sequential disk requests, improving sequential disk I/O without degrading random disk I/O.

The third mechanism is Fast Open, which caches file directory entries and provides a fast access to opening the files. The cache entries are managed using an LRU (least recently used) scheme. This mechanism is beneficial for files that are frequently opened and closed.

The fourth mechanism is Fast Seek, which caches file cluster information and also provides fast access to the file read and write requests. Compared to the file cluster information on the disk, the cache entries have a denser representation and can dynamically grow when more information is inserted. This greatly improves the performance of random I/O for large contiguous files. Both Fast Open and Fast Seek provide better granularity for the LRU management, as well as better utilization of memory.

Expanded Memory and Buffers

DOS 4.0 supports full functionality of LIM/EMS 4.0. DOS can now address memory beyond the 640K-byte limit. DOS accesses the expanded memory through a combination of an EMS device driver and an EMS-capable hardware adapter. The EMS driver maps a 16K-byte page frame onto the 16K-byte logical page in expanded memory. The 16K-byte page frame is the unused address space between the 640K-byte memory and 1-megabyte memory. DOS uses page frame 255 as a window to extend its addressability.

As in earlier versions of DOS, the first parameter of the BUFFERS command in the CONFIG.SYS file specifies the number of system buffers needed for the file I/O. When you specify the /X option for the BUFFERS command in the newer versions of DOS, you can have as many as 10,000 buffers, equivalent to 5 megabytes of expanded memory.

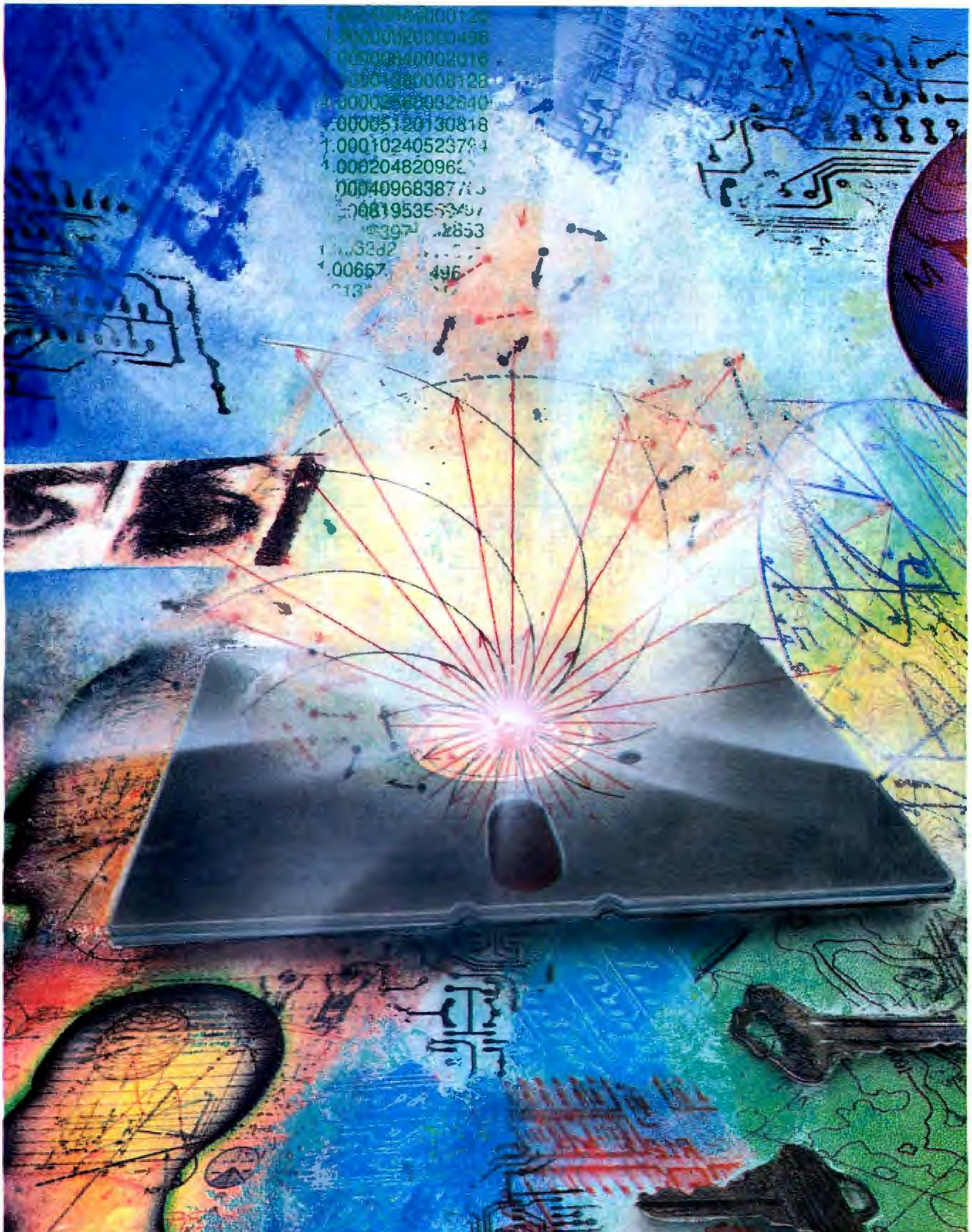
The design team based the design of large buffers on two criteria. First, only 16K-byte system buffers can be addressed at the same time because of the restriction imposed by the 16K-byte page frame. Second, no matter how many buffers you specify, the buffer searching time must be bounded and fast. Because of these criteria, the team adopted a hash algorithm (see figure 1).

The hash table resides in conventional memory. The number of hash entries depends on what option is specified. If you use the /X option, all system buffers are created in expanded memory with each hash entry containing exactly 15 buffers. Since each buffer, including the header information, is 532 bytes, a 16K-byte logical page can map 30 system buffers of two adjacent hash entries. For example, the CONFIG command BUFFERS=50 /X creates four hash entries and 60 system buffers (two 16K-byte logical pages) in expanded memory. If you don't use the /X option, you can specify only up to 99 buffers, which DOS will create just within the conventional memory.

Hashing for Fast Buffers

In order to achieve a consistent performance improvement over all hash entries, the design team used an algorithm for making each hash entry contain almost the same number of buffers. In the algorithm on the next page, M is the number of buffers that the user specifies, H is the number of hash entries created, and N(H) is the number of buffers that hash entry H contains.

continued



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H = 1
If M < 30, then N(1) = M and return
R = remainder(M/15) and H = quotient(M/15)
If R is 0, then set N(1)...N(H) to 15 and return
E = remainder(R/H) and F = quotient(R/H)
Set N(1)...N(H) to (15 + F)
If E is not 0, add 1 to N(1)...N(E)
Return

The hash entry is composed of three fields: EMS Page, Buffer Head, and Dirty Count. EMS Page is the logical page number of the EMS handle, which must be mapped to page frame 255 before buffers of the referenced hash entry are accessed. Buffer Head is a doubleword segment offset pointer to the first buffer of the list. Dirty Count indicates the number of changed buffers per hash entry. To cope with the 16K-byte page-frame window and the EMS mapping overhead, DOS uses the LRU scheme to manage each circular list. That is, when a buffer is needed and no free buffer is available, DOS removes the buffer not referenced for the longest time from the list. The algorithm for reading a disk sector is as follows:

N = remainder(sector number / number of hash entries)
Map the EMS page of hash entry N to page frame
    255 if /X is specified
Search the circular list for the sector
If the sector is found, make the buffer most
    recently used and return
If the sector is not found, find the LRU buffer,
    write it to the disk if changed, and free the buffer
Read the disk sector into the free buffer and
    make it the most recently used
Return

Figure 2 shows the performance test results from a PS/2 Model 60. The test created a 256K-byte file on the hard disk and did 12,800 random-sector reads and writes on the file. The best performance starts from BUFFERS=500. This saturation

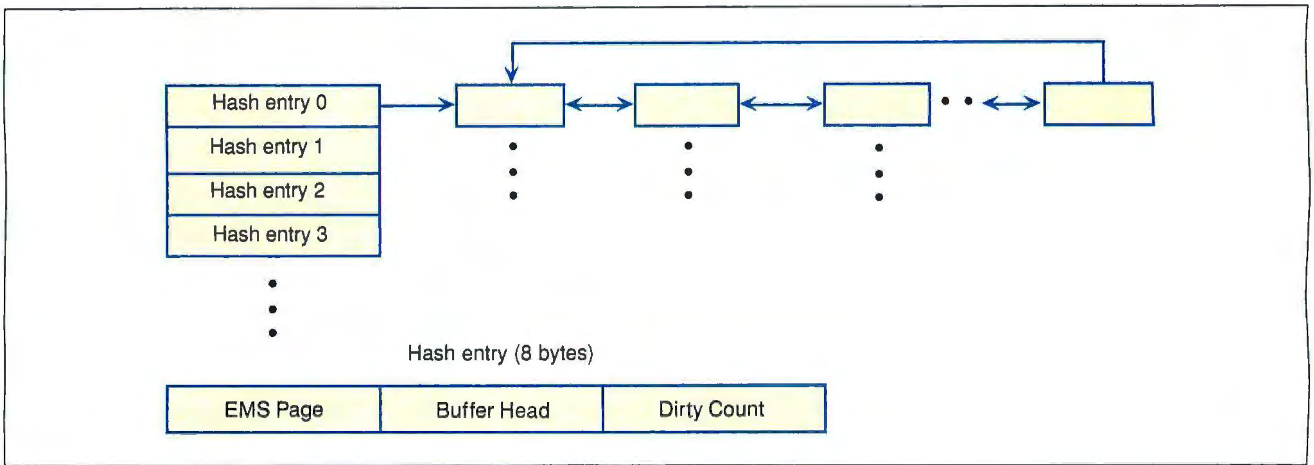

Figure 1: *The structure of the information for large buffers consists of a hash table (in conventional memory). Each 8-byte entry in the table contains an extended-memory page number and a doubleword segment offset (address) of the first buffer in the list of 15 buffers that reside in the expanded memory. In addition, each table entry contains a Dirty Count of the number of changed buffers.*

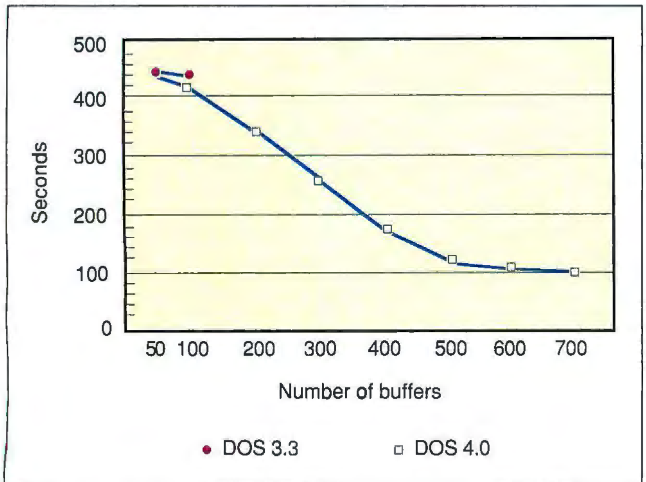

Figure 2: *The performance improvements from using large buffers with 12,800 random-sector reads and writes on a 256K-byte file. The test was done on a PS/2 Model 60.*

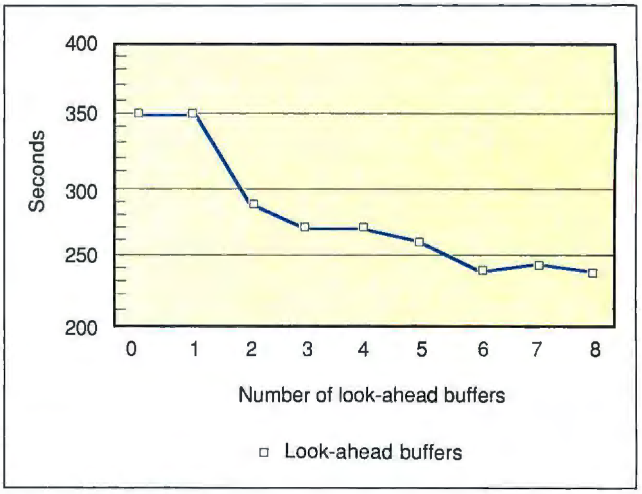

Figure 3: *The performance improvements from using look-ahead buffers with 12,800 sequential-sector reads and writes on a 256K-byte file.*

The intent of Fast Open is to provide a fast access to directory entries by caching them in memory.

point indicates that most sectors of the file are in system buffers and DOS can access data without reading the disk.

Look-Ahead Buffers

The purpose of look-ahead buffers is to read sectors ahead of the current disk sector of a sequential file access, thereby reducing the number of disk reads. The second parameter of the CONFIG.SYS BUFFERS command specifies the number of look-ahead buffers. You can specify up to eight look-ahead buffers. If you specify the value 3, DOS will create three look-ahead buffers in conventional memory.

When DOS reads disk sector 100 with three look-ahead buffers, it actually reads sectors 100, 101, and 102 with a single disk read. If DOS is requested to read sector 101 on the next access, it can retrieve the data from the look-ahead buffer without any physical disk access. To prevent random file-read degradation that would result from unnecessary look-ahead reads, DOS 3.3 and 4.0 use the following simple heuristic method. DOS always compares the current requested sector number, say C, with the previous requested sector number, say P. If $C-P$ is less than or equal to 1, DOS reads ahead; otherwise, DOS reads only sector C.

Figure 3 shows the performance test results from a PS/2 Model 60. The test created a 256K-byte file on the hard disk and did 12,800 sequential-sector reads and writes on the file. This test reads and writes from the beginning to the end of the file for 100 iterations. The random-files test for large buffers was also run to evaluate the effect of the heuristic method. The results indicate that look-ahead buffers greatly improve sequential I/O while not affecting the performance of random I/O.

Fast Open

As the name implies, the purpose of Fast Open is to rapidly open files. Each file on a disk is associated with a 32-byte directory entry that contains information about the file—for instance, Attribute, Date, Time, Size, and Starting location. A directory file is a special file that contains directory entries instead of data. On a call to `open`, DOS reads the file's directory entry from the disk sector into the system buffer so that subsequent reads and writes can use that information. But an application program frequently issuing `open`, `read`, `write`, and `close` to the same file can result in inefficient operations. First, in order to get a 32-byte directory entry, DOS needs to read one disk sector (usually 512 bytes). A four-level-deep file path name (e.g., A\B\C\D) can waste $4 \times (512-32)$ bytes in the system buffers, resulting in less accuracy of the LRU scheme used by the system buffers. Second, because of the limited number of buffers, the reads and writes performed after the file is opened may flush the buffer containing the directory entry and introduce the requirement of an additional disk read for the next reopen.

The intent of Fast Open is to provide a fast access to directory

continued

The idea of Fast Seek is like that of Fast Open, but with the cluster numbers of files cached instead of directory entries.

entries by caching them in memory. The first parameter of the FASTOPEN command specifies the number of cache entries. The cached directory entries are maintained in a tree structure and are managed using an LRU scheme. The interfaces between the DOS kernel and Fast Open are listed below.

- *Lookup*. The DOS kernel always issues a lookup to Fast Open before reading the file-directory entry from disk. FASTOPEN results in one of three conditions: *found*, *partially found*, or *unfound*. For example, for the path of A\B\C\D, the found condition returns the directory entry of D; the partially found condition returns the directory entry of the subdirectory in the path—for example, A, B, or C; and the unfound condition implies that DOS needs to read disk sectors into system buffers and search for directory entries A, B, C, and then D.
- *Insert*. Inserts a file-directory entry in Fast Open—for example, when a file is opened.
- *Delete*. Deletes a file-directory entry from Fast Open and makes it free—for example, when a file is deleted or renamed.
- *Update*. Updates a file-directory entry in Fast Open—for example, when a file's attribute is changed.
- *Purge*. Purges all directory entries in Fast Open—for example, when the disk is formatted or the absolute sector write (INT 26H) function is issued.

The interactions between the DOS kernel and Fast Open are shown in figure 4. Figure 5 shows the test results performed on a PS/2 Model 60 by copying files from an N-level-deep subdirectory to another N-level-deep subdirectory for 10 iterations, where N is 5 or 10 and each subdirectory contains five 32K-byte files. A consistent performance gain is achieved with 20 Fast Open cache entries installed.

Fast Seek

The idea of Fast Seek is like that of Fast Open. Instead of caching the directory entries, the cluster numbers of the files are cached. In DOS, the file is composed of one or more clusters. A cluster is the basic disk-allocation unit, which contains one or more sectors (depending on the media format). From the user's point of view, a file is a string of bytes and all clusters are logically contiguous. That means a file starts from logical cluster 0, continues in 1, and so on. But a file may not be physically contiguous (e.g., logical cluster 0 might map to physical cluster 100, and logical cluster 1 might map to physical cluster 200).

DOS keeps the information about free disk space and file clusters in a block of disk sectors called the file allocation table (FAT). When a file is created, the physical cluster numbers of the file are chained and recorded by the FAT sectors. Before each read or write to the file, DOS calculates the current file

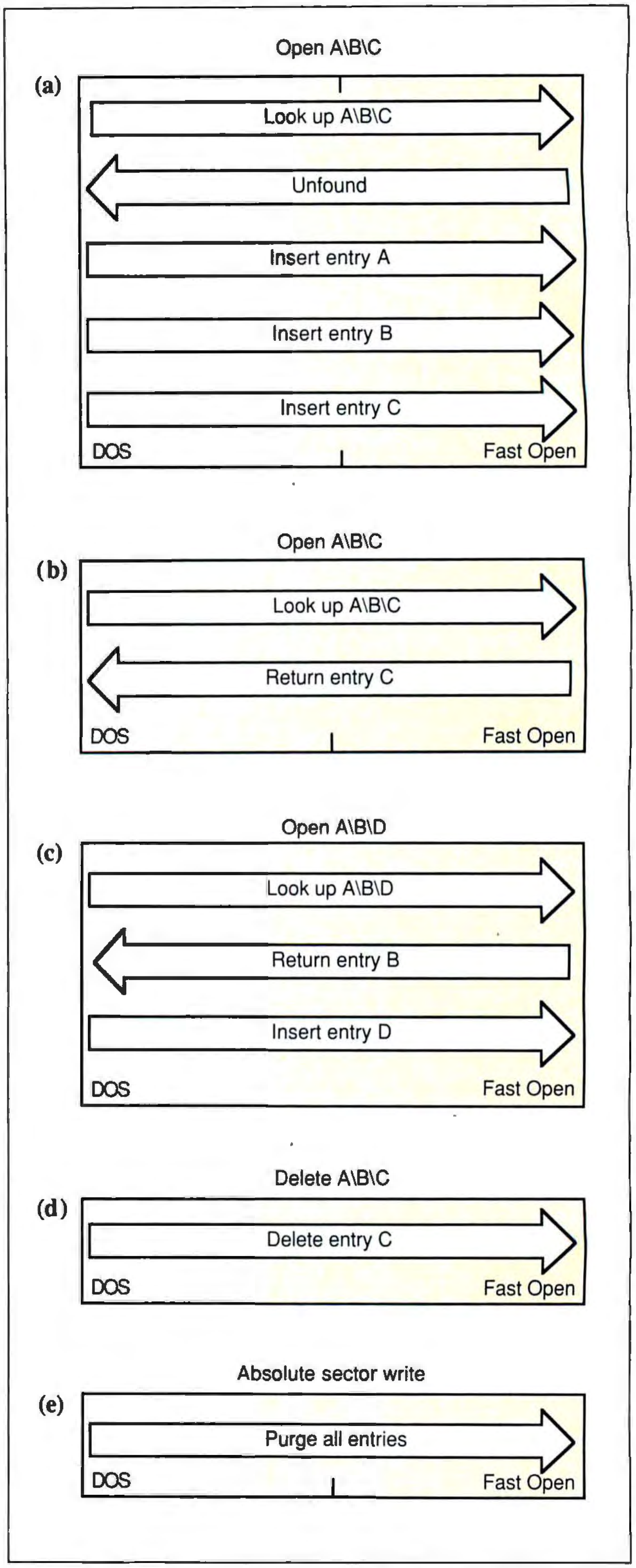

Figure 4: *The interactions between the DOS kernel and Fast Open operations:* **(a)** *initial Lookup;* **(b)** *Lookup with complete table;* **(c)** *Lookup for a different filename;* **(d)** *deleting an entry from Fast Open table;* **(e)** *absolute sector writes, which invalidate all entries.*

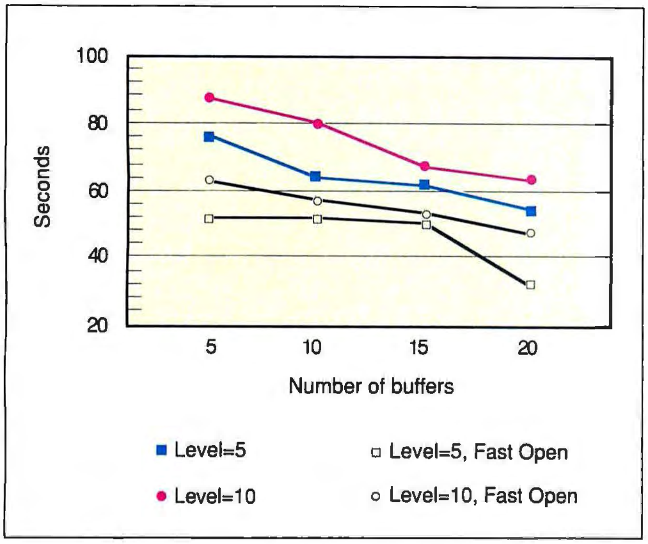

Figure 5: *The performance improvements from using 20 Fast Open caches. The test copied files from an N-level-deep subdirectory to another N-level-deep subdirectory for 10 iterations, where N is 5 or 10 and each subdirectory contains five 32K-byte files.*

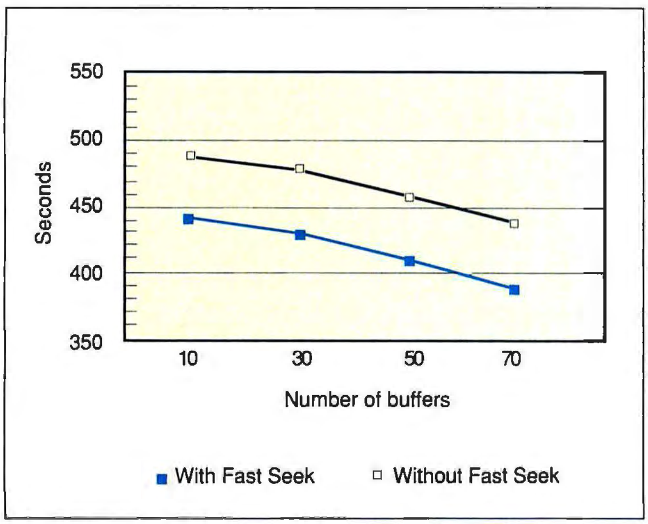

Figure 6: *The performance improvements from using Fast Seek for random-sector reads and writes in the same test as for large buffers (12,800 random-sector reads and writes on a 256K-byte file).*

position by tracing through the cluster chain.

Again, as in Fast Open, there are two possible causes for inefficient performance. First, each FAT sector may contain more than one file's cluster chain, and the chain may span more than one FAT sector. To trace through one file's cluster chain, DOS has to read FAT sectors into system buffers, wasting the buffer space and reducing the accuracy of the LRU scheme for system buffers. Second, it's inefficient to trace through the cluster chain if the physical clusters are contiguous and the destination cluster number can be easily computed by adding an offset to the starting cluster number. The intent of Fast Seek is to provide a very dynamic structure for the file's cluster numbers so that the search for the cluster chain is performed in the most efficient way.

The second parameter of the FASTOPEN command specifies the number of cache entries for Fast Seek. Essentially, each cache entry contains the information on which file extents are defined as contiguous blocks of clusters. The extent is represented by the starting physical cluster number and the number of subsequent contiguous clusters. The more contiguous the file is, the fewer cache entries are used. If cache entries are exhausted by more than one opened file or randomly distributed file, Fast Seek uses an LRU scheme to reuse the cache entries.

The interfaces between the DOS kernel and Fast Seek are the following:

- *Open.* When a file is opened, Fast Seek creates a new file header (if it doesn't exist) or finds it from the close file list. The file header is made the most recently used.
- *Close.* When a file is closed, Fast Seek moves the file header and its cache entries to the close list.
- *Lookup.* The DOS kernel always issues a lookup to Fast Seek before reading the file's cluster chain from the disk. Fast Seek results in one of two conditions: *found* or *partially found.* The found condition returns the exact physical cluster number that needs to be positioned. The partially found condition returns the closest physical cluster number that Fast Seek has recorded. The worst case would be a return of the starting physical cluster number of the file.
- *Insert.* Inserts the file cluster information for Fast Seek—for instance, when a file is accessed for the first time after it has been opened.
- *Delete.* Frees a file header and its cache entries from Fast Seek—for example, when a file is deleted.
- *Truncate.* Truncates the file cluster information from Fast Seek—for instance, when the file size is truncated.
- *Purge.* Purges all cluster information from Fast Seek—for example, when the disk is formatted or the absolute sector write (INT 26H) function is issued.

Figure 6 presents the performance test figures of Fast Seek. The performance test case used was the same as the one shown for large buffers. The results indicate that Fast Seek consistently saves about 49 seconds when 10 cache entries are specified. To reach the same level of performance (443 seconds) without Fast Seek, 60 more buffers are needed—the equivalent of 30K bytes of memory compared to 5.8K bytes of Fast Seek memory. These results normally happen when there are sufficient cache entries to save all the file cluster information. The worst case happens when a file is huge, noncontiguous, and very scattered on the disk. In this event, if random I/O is frequently issued, the LRU scheme becomes overcommitted, and Fast Seek doesn't return useful information. One solution to this problem is to temporarily shut down Fast Seek until cache entries stop recycling.

Bringing DOS Up to Date

With the four new features described above, you can fine-tune your system with CONFIG.SYS commands to improve the performance of applications. You will find that the same programs, running on the same computer, will have faster file access. ■

Fetchi Chen is an operating-systems designer for IBM in Boca Raton, Florida. He specializes in performance optimization and is one of the architects of PC-DOS. He can be reached on BIX c/o "editors."

Canis lupus

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AN END TO DUELING RULES

A new program called Spot helps you validate and verify rule bases

Alex Lane

The Prolog programming language is one of several tools currently used for constructing expert systems. Expert systems are programs that use AI techniques to solve problems that usually require the attention of a human expert to resolve. However, as the popularity of expert-system tools grows and new applications for expert systems are found, problems have begun to arise.

I've written a Prolog program called Spot that examines Prolog rule bases for defects that might pop up to cause problems later on.

Dueling Rules

Things started out innocently enough one evening as I entered the following pair of rules in Prolog:

```
offspring(X,Y) :- father(Y,X).
father(alex,natalie).
```

Translated, the first rule states that X is the offspring of Y if Y is the father of X. The second rule (called a fact because there is no "if" operator present) states that alex is the father of natalie. If offspring/2 is queried with ?- offspring(A,B)., the answer will be

```
A -> natalie
B -> alex
```

If you try to elicit another answer, Prolog's backtracking attempts will fail. With only the two rules shown, there is only one valid solution to the query.

I cleared the first two clauses (or so I thought) and entered the following rules:

```
offspring(X,Y) :- parent(Y,X).
parent(Y,X) :- mother(Y,X); father(Y,X).
father(alex,natalie).
```

This miniature rule base works much the same way as the first, illustrating how Prolog backward-chains through the predicate parent/2 to satisfy offspring/2. It is a common practice to denote Prolog predicates by name followed by a slash and the *arity* of the predicate. (The arity of a Prolog predicate refers to the number of arguments passed with the predicate call.) Thus, parent/2 denotes the predicate *parent*, which is called with two arguments.

My initial attempt to clear the Prolog environment failed, a victim of a typographical error. As a result, two errors were introduced in this five-rule miniature knowledge base. The first error, and the most apparent, is the presence of two identical father/2 rules. The existence of this duplicate is an error because a query to parent/2 will now obtain two answers while backtracking. (Even though the clauses are clones of one another, they are separate and, thus, fair game for the Prolog inference engine.)

The second (and maybe less obvious) error results in queries to offspring/2 generating more answers than expected. For each father/2 clause, offspring/2 gives two answers upon backtracking; one as a result of the first clause I entered, and another as a result of the clause that backward-chains. With two duplicate father/2 clauses, Prolog thus continues to backtrack until four answers are obtained.

So many problems in just five Prolog clauses! With a bit more care on my part, I could have avoided these problems, but these and more serious problems become increasingly likely as rule-oriented knowledge bases grow in size. In this respect, the perils that threaten rule bases are analogous to the pitfalls encountered in traditional software development efforts.

Parallels in Software and Knowledge Engineering

Someone once remarked that every program does something. By the same token, it can be said that every knowledge base proves something. The trick in both cases is to ensure that what the program does and what the knowledge base proves are what

continued

Listing 1: *Definitions of Spot predicates that pick apart Prolog rules.* dissect/2 *takes a structure and returns a list.* massage_null_arity_predicates/2 *helps normalize those lists.*

```
dissect(H,Z) :-

     structure(H),
     H =.. D,
     !,
     dissect2(D,Z).

dissect1(H,Z) :-
     H =.. D,
     [H] \== D,
     !,
     dissect2(D,Z).
dissect1(H,H).

dissect2([],[]) :- !.
dissect2([H|T],Y) :-
     dissect1(H,Z0),
     dissect2(T,Z1),
     Y = [Z0|Z1],!.

massage_null_arity_predicates(In,Out) :- % Massage
       Null

Arity Predicates
     In = [Operator,Operand1,Operand2],
     current_op(_,_,Operator),
     deatomize(Operand1,NewOperand1),
     massage_null_arity_predicates(Operand2,
       NewOperand2),
     Out = [Operator,NewOperand1,NewOperand2],!.
massage_null_arity_predicates(In,In) :- !.

deatomize(In,[In]) :-
     not(list(In)),
     not(structure(In)),
     atomic(In),
     !.
deatomize(X,X).
```

Listing 2: *Terms in AUX.ARI. These predicates help find errors and prevent excessive output from Spot. This file must be augmented if it is to be used with a test file other than TEST.OUT.*

```
std_predicate(write).
std_predicate(read).
std_predicate(fopen).
std_predicate(read).
std_predicate('!EOF').
std_predicate(write).
std_predicate(nl).
std_predicate(assert).
std_predicate(fclose).
std_predicate(inc).
std_predicate(!).

irregular(male(X),female(X)).
irregular(father(X,Y),mother(X,Y)).
irregular(father(X,Y),father(Y,X)).
```

the original designer intended. Let's take a look at some ways in which rule-oriented knowledge bases can go wrong, and a prototype program, written in Prolog, designed to find such errors.

There are a number of parallels between traditional software engineers (e.g., those who program in C) and knowledge engineers (those whose tools go by names like KEE and Nexpert, and even Lisp and Prolog). Perhaps the most obvious is the problem of maintaining a life-size program or knowledge base. No matter how careful you may be, a defect will creep in somewhere along the way.

As I see it, a major difference between software and knowledge engineers is that the software engineers have developed a formidable array of tools, such as "lint," to help them maintain code. By contrast, knowledge engineers still maintain their knowledge bases "by hand."

Now, this practice might have been acceptable for the early knowledge bases that were put together with great deliberation, like programs on the first Altair microcomputers. However, expert-system programs that use such knowledge bases have ceased to be laboratory curiosities and today are making increasingly greater inroads in the real world.

Currently deployed examples include an expert system that schedules IBM's semiconductor manufacturing steps, and another system that assists in the authorization of credit at American Express. Just a few years ago, you could count the number of implemented expert systems on one hand; today, that effort would be a full-time occupation.

The proliferation of expert systems into the real world has also given rise to requirements that make effective maintenance of knowledge bases a very urgent topic in AI circles. Most important is the need to verify and validate the knowledge that goes into such systems. Verification can be thought of as the process that answers the question "Are we doing the job right?" while validation answers the question "Are we doing the right job?" Although verification and validation (often considered one subject, known as "V and V") are generally well understood in traditional software engineering circles, they are just starting to be addressed in the AI world.

Why Prolog?

Before an expert system can do its job, it must be supplied with knowledge. A knowledge engineer embeds such knowledge, obtained from a variety of sources including human experts, in a knowledge base in one of a number of different forms. The most common form is a set of IF...THEN rules, conceptually similar to IF...THEN statements in programming languages such as BASIC and C.

Among high-level languages, however, none uses the IF...THEN rule format quite like Prolog. Prolog programs may rightly be viewed as collections of rules. In addition, Prolog implementations that follow the so-called Edinburgh syntax have a powerful set of predicates that simplify manipulation of the various parts of rules. The more I thought about it, the more it became clear that the types of errors I was encountering in non-Prolog rule bases could be easily reproduced in Prolog, and that code could be developed to find those errors.

For these reasons, I decided to implement a knowledge-base-checking tool, or at least a prototype of one, in Prolog. By analogy with the lint utility used by C programmers, I christened my program Spot. I did most of the development effort on Spot in Arity/Prolog (version 4.0), although I also used Cogent Prolog to ensure I retained some semblance of portability. Turbo Prolog enthusiasts, however, may be disappointed to find that they cannot run Spot without heavy modification.

How Spot Works

Spot works in two ways: It parses the rule base and then checks it for errors. Since I wanted to concentrate on the error-checking feature, I decided to forego a bulletproof routine to allow input of the name of the file to check; the name is, therefore, embedded into the initialization predicate.

The program uses the `read/2` predicate to read rules from the input file. `Read/2` denotes the predicate *read*, which is called with two arguments. The `read/2` predicate has the advantage of immediately grabbing an entire rule and ignoring embedded comments. The program stores rules with a numerical tag that helps distinguish them and gives the program the option of using the `for/3` predicate (a passable implementation of a FOR loop in Prolog) to cycle through the rules.

The predicates `dissect/2`, `dissect1/2`, and `dissect2/2` work together to pick apart each rule (see listing 1). First, `dissect/2` checks to see that its first parameter is a structure (i.e., not an atom). The `univ` operator (`=..`) then transforms the parameter into a list. For example, the term `con(A,B,C) :- ant (D,E,F)` becomes `[:-, con(A,B,C), ant (D,E,F)]`. The `dissect1/1` predicate then passes this list as an input parameter to the `dissect2/2` predicate. The `dissect2/2` predicate then recursively "walks" down the list and subjects each member to a similar procedure that calls `dissect1/2` for the head of the input list, and `dissect2/2` for the tail. In the end, the above example looks like

```
[:-, [con,A,B,C], [ant,D,E,F]].
```

One weakness of this routine is that it cannot distinguish between an atom and a name of a zero-arity predicate, so that a term like `con(A,B,C) :- ant` dissects into `[:-,[con,A,B,C],ant]`. For the sake of consistency, the predicate `ant` should be enclosed in list brackets in this example. On the other hand, a term like `open(X,Y,r)`, where `r` is an atom, dissects correctly into `[open,X,Y,r]`.

The program compensates for the weakness of the dissection predicates by calling the `massage_null_arity_predicates/2` predicate. This code assumes that if the first element of the input parameter is an operator, then the remaining elements of the list should be processed; otherwise the input parameter is left unchanged. This predicate correctly changes `[:-,[con,A,B,C],ant]` into `[:-,[con,A,B,C],[ant]]` but leaves `[open,X,Y,r]` alone.

Another important step changes all rules of the form `X.` to `X :- true.` (which is what the first form implies), thus giving each rule a consequent and an antecedent part. Although traditional logic statements position antecedents to the left and the consequent to the right of the implication sign, as in this example:

```
Antecedent -> Consequent
```

the positioning is just the reverse in the well-written Prolog clause, like so:

```
Consequent :- Antecedent(s).
```

Once the rule base is completely normalized, the error checking can begin.

What Spot Does

There are a number of interesting and subtle ways that a knowledge base can go wrong, and let me say up front that Spot doesn't go after them all. The prototype presented here does, however, attempt to illustrate some of the more common problems and ways in which you can detect them.

Perhaps the easiest check you can perform on a Prolog rule base is for duplication. As shown in the opening example, duplicate rules invite erratic program behavior. If Spot finds two rules that unify (which is a bit more subtle than simply saying they're identical), then a duplicate has been found.

The next test performed by Spot looks for what I call "irregularities." When the `find_irregular_rules` predicate is called, Prolog looks for instances of `irregular/2` in its

continued

Listing 3: *Test file TEST.ARI. This is the file of Prolog terms to be checked by Spot.*

```
test_predicate(X,Y) :-                        % Rule 1
   demonstrate(five(levels(of(nesting(X,Y))))).

run :-                                        % Rule 2
   write($Enter name of file to dissect: $),
   read(X),
   fopen(H,X,r), % note not much protection!
   run1(H).

run(H) :-                                     % Rule 3
   read(H,Term),
   Term \= '!EOF',
   write(Term),
   nl,
   assert(rule(Term)),
   run(H).

run(H) :-                                     % Rule 4
   fclose(H).

mother(alice,john) :- true.                   % Rule 5

grandparent(X,Y) :-                           % Rule 6
   parent(X,Z),parent(Z,Y).
grandparent(X,Y) :-                           % Rule 7
   parent(X,Z),parent(Z,Y),has(X,gray_hair).

female(galina).                               % Rule 8
female(leslie).                               % Rule 9

father(X,Y) :- parent(X,Y), male(X).          % Rule 10
father(tom,jerry).                            % Rule 11
father(william,edward).                       % Rule 12
father(alex,andrew).                          % Rule 13
father(joe,jennifer).                         % Rule 14
father(ken,karen).                            % Rule 15
father(tom,jerry).                            % Rule 16
father(A,B) :- male(A), parent(A,B).          % Rule 17

male(alex).                                   % Rule 18
male(andrew).                                 % Rule 19
male(ken).                                    % Rule 20
male(leslie).                                 % Rule 21

parent(galina,natalie).                       % Rule 22
parent(alex,andrew).                          % Rule 23
parent(ken,karen).                            % Rule 24

parent(X,Y) :- father(X,Y).                   % Rule 25

for(X,X,X) :- !.                              % Rule 26
for(X,Y,X).                                   % Rule 27
for(X,Y,Z) :- inc(X,X1),for(X1,Y,Z).          % Rule 28
```

Orphans are just errors waiting to happen as long as they are present.

database. An example of an irregular relationship is:

```
irregular(male(X),female(X))
```

which simply notes that X cannot be both male and female. Currently, the only irregularities that Spot considers are those that involve contradictions, but there is certainly room for expansion in this direction. As my example shows, the user must separately compile these `irregular/2` clauses and then make them part of either the Spot source code or a file that is consulted in conjunction with Spot. In preparation for further error checking, Spot combs through the rule base and picks out all the predicates on the antecedent side of each rule.

Once the program finds the antecedents for each rule, Spot can perform additional error detection.

A less serious yet notable error in rule bases is the presence of what I call "orphan rules." These are rules that will never fire, because the consequent of the rule never appears as an antecedent in any other rule. In some cases, these orphans are nothing more than utility predicates (included by the software developer) that have no direct bearing on the code. Most of the time, however, these orphans do nothing but take up space and are errors waiting to happen as long as they are present.

Using Prolog's powerful `findall/3` predicate, Spot finds such rules quickly. It's important to note that every Prolog program has at least one orphan, specifically the name of the predicate that you query to get the whole thing started.

Analogous to orphan rules are "unfireable rules." These are rules that will never fire because at least one of the consequents to the rule has no way of being satisfied. For example, the rule

```
A:-X,Y,Z.
```

will always fail if no clauses exist in the database for X, Y, or Z. I have found this error to be fairly common in working with rule bases, and to be one of the most difficult to trap without closely examining the rule base text. The program cannot differentiate between user-written predicates that are unfireable and standard predicates that, by definition, have no defining clauses in the rule base.

To remedy this weakness and cut down on the volume of Spot's output, I used the `std_predicate/1` clause, which checks to see whether a predicate is a standard predicate before Spot judges a rule to be unfireable. I combined and maintained the `std_predicate/1` and the `irregular/2` predicates in a separate file for ease of use (see listing 2).

continued

Finally, the last error that Spot tries to identify deals with *subsumption*. Simply stated, two rules subsume one another if they both have the same consequent and one rule's antecedents are a subset of the other rule's antecedents.

This relationship is, perhaps, better illustrated in the following example:

```
grandparent(X, Y) :-
  parent(X,Z),parent(Z,Y).
grandparent(X, Y) :-
  parent(X,Z),parent(Z,Y),has(gray_hair,X)..
```

Notice that for the two rules shown, it is immaterial whether X has gray hair, as long as X is the parent of Z, and Z, in turn, is the parent of Y. This rule is sure to fire at least once, and erroneously twice if has(gray_hair,X) is true.

Listing 4: *The output file TEST.OUT. This output is produced by Spot after reading and checking the file TEST.ARI.*

```
Initializing...28 rules.
Transforming...normalizing....
   I/O, I/O, it's off to work we go!

DUPLICATIONS.........

RULES 16 and 11 have been found to be duplicate.
The rule reads: father(tom,jerry).


IRREGULARITIES........

Rules 21 and 9 appear to be contradictory.
male(leslie) <--> female(leslie)

ORPHAN FACTS.........

Consequent predicate test_predicate in RULE 1 isn't
   used as antecedent.
Consequent predicate run in RULE 4 isn't used as
   antecedent.
Consequent predicate mother in RULE 5 isn't used as
   antecedent.
Consequent predicate grandparent in RULE 6 isn't used
   as antecedent.
Consequent predicate grandparent in RULE 7 isn't used
   as antecedent.
Consequent predicate female in RULE 8 isn't used as
   antecedent.
Consequent predicate female in RULE 9 isn't used as
   antecedent.
Consequent predicate run in RULE 2 isn't used as
   antecedent.
Consequent predicate run in RULE 3 isn't used as
   antecedent.


UN-FIREABLE RULES.....

RULE 1 cannot fire because 'demonstrate' doesn't
   appear as consequent.
RULE 1 cannot fire because 'five' doesn't appear as
   consequent.
RULE 1 cannot fire because 'levels' doesn't appear as
   consequent.
RULE 1 cannot fire because 'of' doesn't appear as
   consequent.
RULE 1 cannot fire because 'nesting' doesn't appear as
   consequent.
RULE 7 cannot fire because 'has' doesn't appear as
   consequent.


SUBSUMED RULES........

The antecedents of RULES 6 and 7 subsume one another.
The antecedents of RULES 10 and 17 subsume one
   another.
```

Running Spot

I cooked up a trial rule base that includes examples of all the problems Spot is designed to detect and, as mentioned before, embedded the name of the file in the initialize_rule_base/0 predicate. In a few seconds, Spot processed the nearly 30 rules in the test case (see listing 3). I found it convenient to redirect the program output to disk from within Prolog by issuing the query

```
?- tell('test.out'),run,told.
```

This query opens the file TEST.OUT, runs the program, and then closes the file (see listing 4).

The Future

There is tremendous room for expanding the scope of this prototype. Spot's most obvious limitation is its ability to deal only with Prolog rules. Yet, despite this constraint, you could write extensions to allow for the modularization of a program among several Prolog source files and still keep Spot from identifying spurious errors (which would be along the lines of going to great efforts to keep lint from producing meaningless warnings).

There are a number of conceptual error-detection hurdles that the user must understand and overcome as well. For example, Spot does not yet detect the error that occurred with offspring/2 at the beginning of the article. There, when Prolog proves that parent/2 is true, the program effectively proves that father/2 is true as well. This procedure results in what I call an indirect subsumption.

Other errors that you may run across include detection of infinite recursion, detection of synonyms and aliases, and comparison to a set of legal values.

Despite its limitations, Spot is still a useful program, primarily because of the handful of things it does, such as finding duplications, contradictions, and orphans, and the fact that it does things that need to be done and there are few tools around that perform these functions. With more tools like Spot, knowledge engineers will have greater control over the rule bases they create; eventually, the tools will provide a means to reliably verify and validate rule bases.

ACKNOWLEDGMENT

The inspiration to actually sit down, consolidate my notes, and write the code came from a tutorial session presented by R. A. Stachowitz and C. L. Chang at the Seventh National Conference on Artificial Intelligence, held in St. Paul, Minnesota, last year.

Editor's note: *Listings that accompany this article are available in a variety of formats.* *See page 5 for details.*

Alex Lane is a knowledge engineer with Technology Applications, Inc., in Jacksonville, Florida. He can be reached as "a.lane" on BIX, where he moderates the prolog conference.

BIX CALENDAR JUNE

Display this month's BIX activities

J U N E

THURSDAY, 6/1, 8:30 PM EST. "The Philosophy of Ada"

Ada thinkers Randy Brukardt, Dan Stock, and Geoff Gilpin lead a CBix discussion on the philosophy of Ada and software engineering with Ada, and answer questions about R.R. Software's JANUS/Ada line of products. (join janus.ada/cbix)

TUESDAY, 6/6, 9 PM EST. "It's That Time of the Month, Again"

It's the first Tuesday of June, and BIX's IBM PC conference members meet for their monthly CBix session. (join ibm.pc)

THURSDAY, 6/8, 9 PM EST. "Computer Viruses, Past and Present"

"Doctor" Ross Greenberg, creator of the anti-virus program *Flu Shot,* outlines the history of computer viruses and prescribes the latest preventive medicine. Co-hosted by Howard Shubs, moderator of the BIX Security conference. (join security/cbix)

SUNDAY, 6/11, 9 PM EST. "32-Bit Quick Draw—'The Big Picture' "

Ponder the future of 32-bit Quick Draw, with Larry Loeb, BIX Mac Exchange Editor, and invited guests. (join cbix)

TUESDAY, 6/20, 9 PM EST. "Security in a Networked Environment"

What common-sense security measures can network administrators take? Find out from Dr. Bob Harbort, chairman of the Computer Science Department at Southern Tech., and Bob Brown, director of Information Systems for the Georgia Medical Care Foundation. (join data.center/cbix)

All-Month Conferences

The Cold Fusion Discovery is the hot topic of BIX's tojerry conference, hosted by Jerry Pournelle. One conference member—a physics professor at a large, midwestern university—announced that much information appeared on BIX before it reached the physicists' grapevine. (join tojerry/journal)

You-saw-it-here-first Department—Not only did *BYTE*'s Mac SE/30 coverage scoop its print competition in February, full details of it appeared on BIX just moments after Apple's announcement. BIX readers were enjoying an in-depth report on Sun Microsystem's SPARCStation 1 just hours after it made its debut. Look for more scoops this month as the Microbytes staff reports from PCExpo in New York. (join microbytes)

In-depth Conference Topics

BYTE's In-Depth section this month is on Computer Security, an issue that's widely discussed on BIX, as well. You'll find it in such conferences as Security, Unix, Software.Eng (software engineering), BBS, and in many individual computer conferences. In addition to these important discussions, here is a partial list of security-related files from which you may wish to download:

Amiga Listings Area

avbb55.arc—Antivirus bootblock version 5.5. Finds and kills SCA and ByteBandit virus in memory.

bootback.arc—Boot Block backup program with executable and source in Amiga/Programs. For virus protection.

sb221.arc—SafeBoot2.21 fixes bug found when used with WB1.3. Saves and restores bootblocks. Useful after virus has altered bootblock.

IBM PC Listings Area

flu4.txt— A warning regarding a trojan called. flu4txt.com.

fsp__152.arc—Ross Greenberg's Flu Shot +, V1.52, anti-Virus/trojan protection program. Protects your system against viruses, trojans, and dumb mistakes.

Macintosh Listings Area

ferret11.sit—Larry Nedry's virus seeker and killer.

gatekeep11.sit—Gatekeeper provides anti-viral monitoring of your system.

repair15.sit—Repairs and removes the nVIR virus from application and system files.

rwatcher.sit—Written for those non-MPW programmers seeking some virus protection, but not willing to use Vaccine.

vaccinat.bin—Checks for nVIR virus and kills it.

Utilities Listings Area

bombfree.arc—A group of programs to help protect your data from worm and trojan horse software.

chk4bomb.arc—Checks for trojan horse programs.

chkfat.arc—Checks the File Allocation Tables (FAT) on disk match.

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THE ULTIMATE UPGRADE

The BYTE Lab turned a standard IBM PC AT into a personal workstation—but was it worth it?

Stanford Diehl

Remember the days when you had to assemble almost every product you bought? You would grit your teeth, pull your hair, grunt and curse and lament, but once that bicycle or stereo was built, you could step back and savor a true sense of accomplishment. Computers were like that, too. You had to partition drives and configure ports and set up the system. Now, it seems, you just turn them on and watch them go. But if you've got patience and plenty of hair, you can still do it yourself.

In that spirit, the BYTE Lab staff set out to create a high-performance, multitasking workstation from a standard IBM PC AT. Keeping a sharp eye on price, we customized a system, component by component, and evaluated the results. Then we took a step back to decide whether that special sense of accomplishment was worth the cost, the time, and the headaches.

Plugging in the Power

Our first inclination was to start from scratch with a new 80386 motherboard, complete with 32-bit slots and high-speed memory. Somehow, though, that didn't seem fair. After all, we would end up with only that stark beige case to remind us of our roots. So, instead we went with an 80386 enhancement board. We solicited two different products, the Intel Inboard 386 and the AOX Master 386, and tested them both for performance, ease of installation, and compatibility (see photos 1 and 2).

We started by installing the Inboard. This, it turns out, was a mistake. We have since discovered that you should install your hard disk drive and peripherals first. Installation software for both of the enhancement boards evaluates your system configuration to determine the optimal setup parameters. So we set up our Inboard for the standard AT configuration, not for the souped-up system we ended up with.

Unfortunately, it is much harder to go back and change the enhancement board settings to enable new components. For one thing, you have to run the setup program before installing the board. Note, however, that you can modify the settings yourself with a little extra effort.

Intel offers two versions of the Inboard 386, one without memory for $1395 and one with a megabyte of 32-bit, 120-nanosecond RAM for $1995. Get the additional memory. Without it, your 32-bit processor will have to access 16-bit memory from the system bus. According to our benchmarks, memory fetches will be slower than they were without the 80386. You can also add an additional 1 megabyte ($795) or 2 megabytes ($1495) of 32-bit memory

continued

ILLUSTRATION: ROBERT TINNEY © 1989

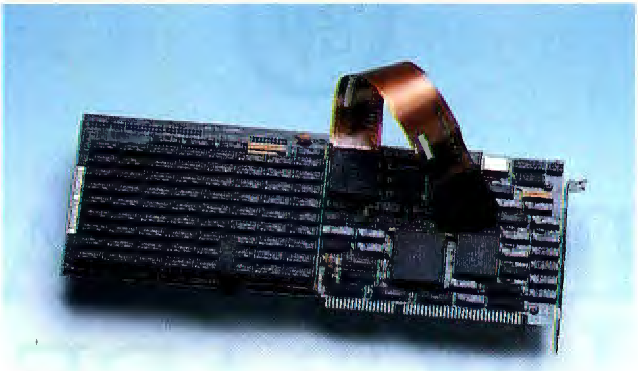

Photo 1: *The Intel Inboard 386 provided our souped-up AT with a megabyte of 32-bit, 120-nanosecond RAM for $1995.*

with an Inboard piggyback card. The card snaps onto the Inboard 386, allowing the processor to directly access the additional fast memory. At this writing, you are limited to 3 megabytes of 32-bit RAM with the Intel card. The Inboard will support other memory cards, such as the AST RAMpage Plus or the Intel Above Board 286, but you're back to the slower, 16-bit variety.

Intel's HARDSET program prompts you for various system parameters before determining the best way to set the Inboard's two banks of DIP switches. You then flip the switches, attach the piggyback card, crack the system cover, and remove both the 80286 and the 80287. If you have a 6-MHz AT, you'll also have to replace the crystal. A $200 installation kit provides all the necessary tools, along with an 80287 plug, the Inboard cable, and documentation.

Both boards slide into one 16-bit slot, leaving room for an 8-bit card alongside the piggyback card. A cable runs from the 80286 socket to the Inboard. We also set a jumper to disable 256K bytes of our motherboard's 512K bytes of conventional memory. This lets you swap the system's slow conventional memory with the Inboard's 32-bit RAM. You end up not only with faster memory, but also with the full 640K-byte complement. The Inboard also provides zero-wait-state memory caching for all installed memory, including any 16-bit RAM. Inboard software utilities enable expanded memory, speed selection, and hard disk caching.

The Best of Both Worlds

For those who are skittish about making the 80386 plunge, AOX offers some solace by keeping your familiar 80286 snugly plugged in its slot. By simply loading a device driver, you can then hot-key between the two processors. Even when the 80386 takes precedence, the 80286 does not lie dormant. It acts as an intelligent controller, busily polling interrupts and passing control to its more powerful cousin. This makes the installation of the AOX board much easier than that of the Inboard.

And the advantages don't stop there. AOX offers not only a 16-MHz board ($1595) but a 20-MHz model as well ($1895). And although the optional memory board takes up a full 16-bit slot, it also provides up to 15 megabytes of directly accessible 32-bit RAM. No need to resort to slow memory here.

The AOX Master memory board ($700 plus $605 per megabyte of RAM) slides into a slot adjacent to the Master 386. A pair of short cables provides a direct 32-bit path to the processor, and a bank of DIP switches controls caching, wait states, direct-memory-access channels, ROM addresses, and swapping of slow system memory with 32-bit RAM. You can cache all your memory, the ROM BIOS, and video ROM. The video cache significantly improved the system's performance on our suite of video benchmarks.

The 20-MHz AOX board scored better than the 16-MHz Inboard on our CPU index, even though the Inboard negotiated string moves faster. Both boards more than doubled the performance of the AT. Floating-point operations ran over five times faster. Again, the Master 386 performed slightly better than the Inboard, posting a 5.40 floating-point index to the Inboard's 4.71.

A Juggling Act

Oh, the limitations of DOS. Both cards do their best to deal with DOS, but problems crop up, especially when juggling memory. Eventually, when we install our multitasking operating system, we won't have to worry about memory allocation. Under Unix, we would simply make all memory extended and let the operating system handle it. Even OS/2 would avert the 640K-byte barrier. Still, the memory-allocation problems under DOS expose the shortcomings of plugging an 80386 card into a 16-bit bus versus running 32-bit system memory on a true 80386 machine.

Both enhancement boards allow you to switch slow conventional memory with onboard 32-bit RAM. Intel does it with 80386 control software while AOX does it in ROM. The 16-bit RAM cards provide expanded memory (between 640K bytes and 1 megabyte). The remaining 32-bit memory is mapped as extended memory (beyond 1 megabyte).

DOS application programs

continued

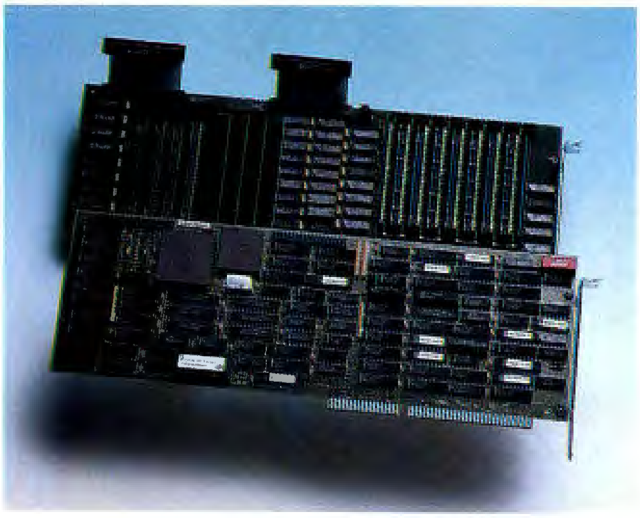

Photo 2: *You can easily install the AOX Master 386 enhancement board. Two configurations are available—a 16-MHz model ($1595) and a 20-MHz model ($1895).*

OKIDATA introduces a line of PC modems that run so cool they're guaranteed for 5 years.

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PC DIGEST ... gave five stars to our 1200 bps modem and top-rated our 2400 bps modem.

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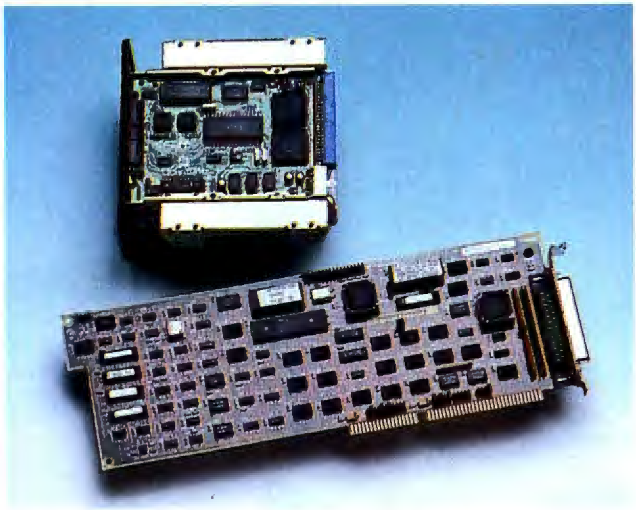
Photo 3: *We found that the Columbia SCSI system, which came complete with an 84-megabyte Quantum hard disk and a Western Digital 7000-FASST controller, is best installed before the enhancement board.*



cannot directly use extended memory, although those programs conforming to the LIM/EMS can use expanded memory. Included Inboard utilities allow you to swap 16-bit expanded memory with 32-bit extended memory, thereby boosting the performance of programs that conform to LIM/EMS. Memory management software such as Quarterdeck's QEMM will similarly juggle the AOX memory.

But all this memory swapping invites trouble. While the 80386 chip is executing in virtual mode under 80386 control software, no other 80386 control software can access it. The Inboard would not run our 80386-specific benchmarks (doubleword-wide string moves) for just this reason. Memory swapping will also confuse a disk controller that reserves high memory to load its BIOS. Sometimes you simply can't swap. And if you end up using the motherboard RAM for conventional memory, the 80386 chip must take control of the AT bus to fetch 16-bit memory, slowing your system to a crawl. As much as your AT would like to run with the big boys, it can't quite break free of the 16-bit bottleneck.

The Hard Disk Dilemma

Choosing a hard disk drive becomes a question of interfaces. And again, the cost-versus-performance equation rears up. If you stay with the ST-506 interface, you can retain the services of your standard AT disk controller and end up with high-capacity disk storage at a bargain price. You are, however, saddled with a sluggish controller—but it's still the simplest solution. We found that out by hitching a Priam 130-megabyte hard disk drive ($2385) to our existing WD1003-WA2 controller; it was quick and painless.

Another alternative is to go with ESDI. We selected the AT 90 drive and ESDI controller from CORE International. At first, we had some problem with the controller's BIOS, but an included device driver remapped the BIOS to low memory. The entire package ($1916 for the drive and $476 for the controller) costs roughly the same as the Priam disk alone, but the CORE drive contains only 90 megabytes of storage space. If you really want to soup up your disk drive, you can go with a high-end ESDI controller like the PM3011 from Distributed Processing Technology ($1150 with half a megabyte of on-board cache) or the Powerstor caching ESDI disk controller from Consensys ($1045 with half a megabyte of RAM). Each of these controllers is specifically designed for the Unix or Xenix operating system.

As the interface gets fancier, so too does the installation. The Columbia SCSI system is shipped with an 84-megabyte Quantum hard disk and the Western Digital 7000-FASST controller ($1645 for the package). (See photo 3.) The first few times we tried to install this drive, the boot-up routine would drop us into BASIC—this was evidently another problem with ROM mapping. Finally, we removed the enhancement board, installed the drive on the standard AT, and then reinstalled the 80386 card. It turned out that the drive installation was fast and easy. Again, your best bet would be to install the disk drive and peripherals first and then plug in the enhancement board.

In any case, the SCSI drive returned the best disk benchmarks and earned a place on our workstation. The drive has an average access time of 19 milliseconds, a 64K-byte programmable cache, 1-to-1 interleave, and an integrated SCSI controller.

High-Resolution Video

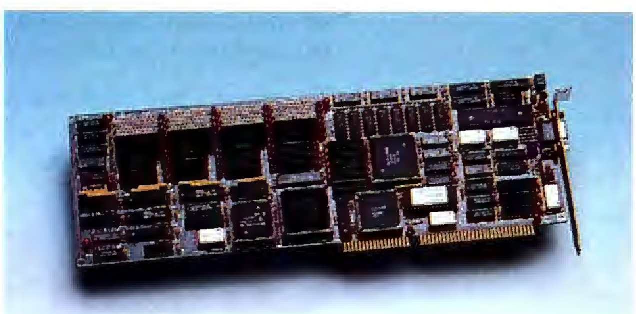
No workstation worth its salt is without high-resolution graphics. As we showed in the March Product Focus on large-screen monitors, the NEC MultiSync XL sets the standard for flexibility and ease of use. It offers a 19-inch screen and 1024- by 768-pixel resolution and currently sells for $3499. The XL can plug into a wide variety of graphics adapters. We went with the NEC MVA 1024 adapter ($1499). Based on the Texas Instruments TMS 34010, the MVA 1024 supports the XL's maximum resolution, and an optional 384K bytes of video RAM ($300) provides a 256-color palette (see photo 4).

Western Digital Imaging has introduced a high-end graphics coprocessor card for CAD applications.. The card, compatible with the MultiSync XL, packs 2 megabytes of video memory and displays 256 colors at 1024- by 768-pixel resolution. The Verticom HX-256/AT sells for $3495. The card was not available for this evaluation.

If you can accept a lower-resolution graphics standard,

continued

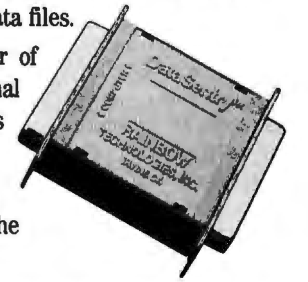
Photo 4: *The NEC MVA 1024 graphics adapter ($1499) supported the maximum resolution of our new monitor, the NEC MultiSync XL. The optional 384K bytes of video RAM cost $300 but enabled us to use a 256-color palette.*



#1 In A Series.

Ask The Doctor Your Most Important Questions About PC Data Security.

Escalating instances of PC data theft and misuse affecting both government and industry have shown the need for an effective yet easy-to-use data security product. U.S. Public law 100-235 now mandates that government agencies protect sensitive data files.



In response, Dr. Alan K. Jennings, Ph.D., inventor and co-founder of Rainbow Technologies, has designed the DataSentry™, an external hardware key that provides data file security without the problems associated with internal hardware and software-based protection.

In this first of a series of informational bulletins, Dr. Jennings answers some of the more frequently asked questions on PC data security and the DataSentry system from Rainbow Technologies.

Q. What is the DataSentry system?

A. The DataSentry protection system consists of a combination of a hardware encryption device - Personal Access Key - and associated software that runs on an IBM or compatible PC having a parallel printer port and a floppy disk drive. The DataSentry provides three types of security: mandatory use of the access key to open a file, encryption and password protection.

Q. What is inside the Personal Access Key?

A. Inside each pocket-sized Personal Access Key is a proprietary custom-designed integrated circuit, often referred to as an Application Specific Integrated Circuit (ASIC). This ASIC was designed by engineers at Rainbow Technologies specifically for the DataSentry system. The full capabilities of the ASIC are known only to Rainbow. In operation, the proprietary ASIC implements a special function called an algorithm, chosen from many thousands of possible algorithms when the key is being manufactured at the Rainbow factory.

Q. What is the disadvantage of password-only software protection?

A. The main disadvantage of password-only protection is that users find it difficult to remember a password unless it is something quite familiar to them - like their spouse's name, their dog or the street they live on. It was recently estimated that about 75% of ARPANET passwords could be discovered by trying these three choices. Choosing a less familiar name requires that it be written down. This, of course, is a security risk. As a result, password-only protection is fairly easy to defeat.

Q. What is the advantage of external hardware keys over internal security boards?

A. Some protection systems depend on circuit boards being installed inside the PC. In addition to objection to the expense of installation and training, many users are reluctant to open their PCs. IBM PS/2s and laptop PCs do not accept the standard add-in boards. As a result, nearly all PC users have a strong preference to the addition of low-cost external hardware to achieve the desired protection.

Q. Is the DES (Data Encryption Standard) government-specified algorithm available with the DataSentry system?

A. Yes. The DES algorithm as defined by U.S. government standard FIPS 46 is implemented in the DataSentry system.

Q. Can the DataSentry system be used on local area networks?

A. Yes. It can be used on LANS as long as the automatically protected files are stored on a local computer. It does not matter if the application is stored on the local PC, on a shared file server or on any other PC.

Q. Can a DataSentry system be used to secure mainframe data files?

A. Yes. The mainframe could send files to the PC for encrypting or decrypting.

Q. What are some of the new special features of the DataSentry system?

A. Audit trail, log-on identifiers, and automatic encryption/decryption of entire directories.

To consult Dr. Jennings and the DataSentry sales staff about your personal data security questions, call Rainbow Technologies today.

Data Sentry™

• Completely user-installable • Pocket-sized external device • Menu-driven, user-friendly interface • Single- or multi-user security system • Audit trail, log-on identifiers and automatic encryption/decryption of entire directories • Secures data transmitted by modems • Prevents recovery of data by utility programs

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Rainbow Technologies, Ltd., Shirley Lodge, 470 London Rd., Slough, Berkshire, SL3 8QY, U.K., Tel: 0753-41512, Fax: 0753-43610

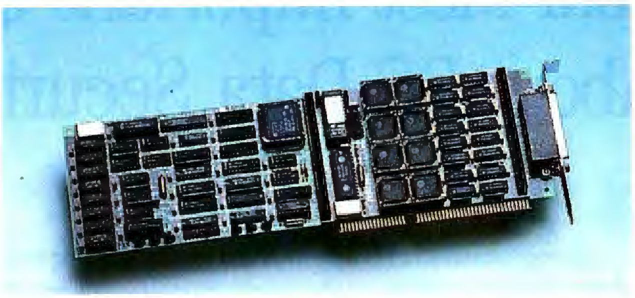

Photo 5: *We installed the DigiBoard Com/8i intelligent multiport board ($1195) in our workstation so that we could attach up to eight terminals to the asynchronous DB-25 connectors.*

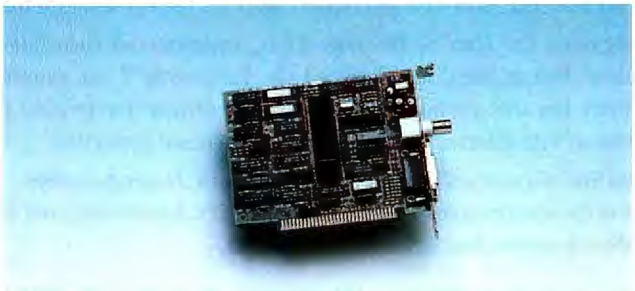

Photo 6: *An EtherCard Plus from Western Digital ($399) allowed us to connect to either a standard Ethernet LAN coaxial cable or a Thin Ethernet cable.*

you could go with one of the many VGA adapters on the market. Although they usually support resolutions to 800 by 600 pixels (or 1024 by 768 pixels in only 16 colors), the prices are considerably lower. The Orchid Designer VGA is a good choice. For $545, you can get 512K bytes of video RAM along with 800- by 600-pixel resolution in 256 colors or 1024- by 768-pixel resolution in 16 colors. Other offerings include the Paradise VGA-Plus ($399) and the 16-bit AST-VGA Plus ($599).

Odds and Ends

We addressed the connectivity issue from two different perspectives. Intelligent multiport boards have become an attractive option in the Unix world, especially for those users who don't have access to an existing LAN. These boards provide eight or more ports from one card, allowing you to connect multiple terminals directly to the central computer. The boards use their own CPU to manage independent parity checking and flow control, thereby freeing the system CPU from these tedious and time-consuming chores. On-board RAM enables file buffering and priority queuing of I/O jobs.

The DigiBoard Com/8i sports a 10-MHz Intel 80188 processor and 256K bytes of RAM (see photo 5). Given enough 16-bit slots, you can install up to four of these boards under SCO Xenix. With only one board, though, you can hook up to eight terminals to the asynchronous DB-25 connectors, which sprout from the board hydra-style. The DigiBoard costs $1195. Other boards in this class include the Computone IntelliPort AT8 ($1095) and the Powerports line from Consensys.

You could also plug your workstation into an existing network. There are many Ethernet cards available for the AT bus, but we chose the EtherCard Plus from Western Digital ($399). Two ports enable connectivity to either a standard Ethernet coaxial cable or a Thin Ethernet cable (see photo 6). An included "Superdisk" contains drivers for most major LAN software packages, including Novell's Advanced NetWare, Western Digital's ViaNet, Sun's PC-NFS, DEC's DECnet-DOS, and 3Com's 3+. A NetBIOS/Open Systems Interconnection interface supports Microsoft's MS-NET, and a complete TCP/IP package is also available.

You might consider a few other options to complete your new system. We solicited a Tecmar QIC-60E tape backup system but did not receive the unit in time for installation. You can pick up a good backup system for about $700. A serial mouse enhances the user interface, or, for intensive CAD work, you could select a digitizing tablet for graphics input (see the January Product Focus). Other options would depend on your applications.

Table 1: *When we tallied our tab at the end of our AT upgrade project, our costs totaled $13,507.*

Component	Price
AOX Master 386 (20 MHz)	$1895
Intel 80387 coprocessor (20 MHz)	$1150
AOX Master memory board (with 4 megabytes)	$3120
Columbia SCSI drive system (with host adapter)	$1645
NEC MultiSync XL 19-inch monitor	$3499
NEC MVA 1024 video adapter (with memory option)	$1799
Western Digital EtherCard Plus	$399
Total:	**$13,507**

Test-Driving the BYTE Lab 80386

Our complete system no doubt qualifies as a high-end personal workstation: dual 20-MHz 80386 and 10-MHz 80286 processors, 4 megabytes of 32-bit memory, a 20-MHz 80387 math coprocessor, an 84-megabyte SCSI hard disk drive, a 19-inch monitor supporting 1024- by 768-pixel graphics in 256 colors, eight intelligent asynchronous ports or an Ethernet connection, and standard serial/parallel ports. (Table 1 shows the price tag for the upgrade.)

Something, though, seemed to be lacking. Perhaps it was the underlying 16-bit AT bus or the problems enabling 32-bit conventional memory. Or maybe it was the benchmark results. Although the figures emphasize an impressive boost in performance compared to that of the original machine, the results placed our system in the same category as a standard 16-MHz 80386 computer. Or maybe it was just the familiar beige case that housed it all.

The 80386 enhancement boards are great for injecting some fresh blood into your tired 80286 system. And yet, to achieve the high performance required by a full-blown graphics workstation, you should build on a sturdy 32-bit foundation. All your expensive high-end components are, in the end, stunted by the AT architecture.

In fact, if your 80386 must take the 16-bit highway, your AT is actually degraded by the introduction of wait states. As the prices of low-end 80386 machines continue to fall, it will be-

Circle 172 on Reader Service Card

COMPANY INFORMATION

AOX, Inc.
486 Totten Pond Rd.
Waltham, MA 02514
(617) 890-4402
Inquiry 1162.

AST Research, Inc.
2121 Alton Ave.
Irvine, CA 92714
(714) 863-1333
Inquiry 1163.

Columbia
Data Products, Inc.
851 West 436, Suite 1061
Altamonte Springs, FL
32714
(407) 869-6700
Inquiry 1164.

Consensys Corp.
1301 Pat Booker Rd.
Universal City, TX 78148
(800) 387-8951
Inquiry 1165.

CORE International
7171 North Federal Hwy.
Boca Raton, FL 33431
(407) 997-6044
Inquiry 1166.

DigiBoard, Inc.
6751 Oxford St.
St. Louis Park, MN 55426
(612) 922-8055
Inquiry 1167.

Distributed Processing
Technology
132 Candace Dr.
Maitland, FL 32751
(407) 830-5522
Inquiry 1168.

Intel Corp.
5200 Northeast Elam
Young Pkwy.
Hillsboro, OR 97124
(800) 538-3373
Inquiry 1169.

NEC Home Electronics, Inc.
1255 Michael Dr.
Wood Dale, IL 60191
(312) 860-0335
Inquiry 1170.

Orchid Technology, Inc.
45365 Northport Loop W
Fremont, CA 94538
(415) 683-0348
Inquiry 1171.

Paradise Systems, Inc.
99 South Hill Dr.
Brisbane, CA 94005
(415) 468-7300
Inquiry 1172.

Priam Corp.
20 West Montague Expy.
San Jose, CA 95134
(408) 434-9300
Inquiry 1173.

The Santa Cruz Operation
(SCO)
400 Encinal St.
P.O. Box 1900
Santa Cruz, CA 95061
(408) 425-7222
Inquiry 1174.

Tecmar, Inc.
6225 Cochran Rd.
Solon, OH 44139
(216) 349-0600
Inquiry 1175.

Western Digital Corp.
2445 McCabe Way
Irvine, CA 92714
(800) 847-6181
Inquiry 1176.

Western Digital Imaging
800 East Middlefield Rd.
Mountain View, CA 94043
(415) 960-3353
Inquiry 1177.

come harder to choose the upgrade path. You might as well sell out and go with the packaged product. If you're a die-hard do-it-yourselfer, start with a 32-bit motherboard and build from there. That special sense of accomplishment loses its luster when the final product can't quite do the job. ■

Stanford Diehl is a testing editor for the BYTE Lab. He can be reached on BIX as "sdiehl."

MODERN MODEM METHODS

Clever modulation lets modems pack more into each second of communications

As we enter the 1990s—the second decade of the "computer revolution"—telecommunications will become an increasingly important part of what computers do for us. And whenever computers communicate over distances too great to be covered by a LAN (or even over smaller distances), the odds are overwhelming that a modem is somewhere in the loop. In this month's installment of "Under The Hood," I'll take a close look at how modern modems achieve high performance on regular, voice-grade phone lines. [Editor's note: *For a practical look at how modems perform using these new techniques, see this month's Product Focus on page 162.*]

Modulation Methods

The first and simplest modems used *frequency-shift keying* (FSK) to encode data. In FSK, the transmitted signal shifts back and forth between two frequencies: one representing a 1 and the other representing a 0. (In a sense, FSK is nothing more than a very simple form of frequency modulation.) Your modem probably uses FSK when it runs at 450 bps or less.

Frequency is only one characteristic you can vary to impress a signal upon a carrier. Another is *phase* (the position of the repetitive waveform of the carrier in time). Figure 1b shows two carrier signals that have the same shape but different phases. Both are sine waves of the same frequency and amplitude and can be represented by the equation

$$m(t) = A \cos (2\pi ft + \phi)$$

where t is the time, A is the amplitude of the carrier, f is the carrier's frequency, and ϕ (the Greek letter phi) is its phase. Only ϕ differs between the two waves shown; it's 0 for the top signal and 180 degrees (or π radians) for the bottom signal. This difference lets you shift the bottom signal a quarter of a cycle to the right.

If you were to shift the bottom signal 180 degrees more, it would look identical to the top one. (As you may remember from geometry, an angle of $\phi+360$ degrees—or 2π radians—is indistinguishable from an angle of just ϕ.)

Phase-shift keying (PSK) uses shifts in phase to signal 1s and 0s. How does it represent the bits in terms of phases? Suppose I had a PSK modulator that could transmit a sine wave with two possible phases separated by 180 degrees (the maximum possible separation). I could let one phase represent a 1 and another a 0; however, without two well-synchronized clocks—one at each end—the receiver would have no way of knowing which was which.

To avoid this problem, most PSK systems don't assign a logic level to each phase. Instead, they use a phase *transition* to indicate one logic level or no transition to indicate another. This is called *differential phase-shift keying* (DPSK). Table 1 defines a possible set of transition rules.

Phase-encoding schemes are often shown graphically with *phase-amplitude diagrams* (see figure 1). In this diagram, each possible phase and amplitude of the carrier can be represented by a point on the polar representation of a plane. The length of a straight line from the origin to a given point represents the amplitude; the angle made by the same line with the positive side of the horizontal axis represents the phase. Figure 1 shows the possible signals—or symbols—of the two-phase DPSK system described in table 1. Figure 1c, sometimes called a *phase-transition diagram*, adds arcs to show the transitions (or nontransitions) caused by 1 and 0 data bits.

The number of phase transitions per second in a PSK system is limited by the frequency of the carrier and the available bandwidth; typically, the transition rate can't exceed half the bandwidth. Thus, if you divide a phone line with 2400 Hz of bandwidth into two channels (one in each direction), you can have no more than 600 phase transitions per second on each channel.

This means that a PSK modem is limited to 600-bps operation over a normal phone line if you limit yourself to the two-state PSK method. However, it doesn't hold true if you use four possible phases instead of two, thus packing more than one bit of information into each phase transition. The pattern of possible states, usually called a *constellation*, is shown in figure 2. It allows four possible transitions (one of them back to the same state) from each of the four symbols—letting each transition signal the values of two data bits. Each of these symbols is called a *dibit*.

As in most data-encoding techniques that depend on transitions, DPSK encoding schemes must transmit the data synchronously and guarantee a certain number of transitions per unit time so that the receiver can synchronize with the transmitter's clock. To make sure that a long string of zeros—or any data pattern—doesn't cause a long period without transitions, DPSK modulators usually contain a *scrambler*. The scrambler doesn't destroy the data, but it makes the distribution of 1s and 0s sent over the line more even. A descrambler at the receiving end recovers the original data from the demodulated data stream.

The scrambler has one negative effect on modem performance: *It has a tendency to amplify errors.* One error received by the demodulator becomes three or more after it passes through the scrambler—some up to 17 bits later. The

continued

result is the i] or] pattern you often see when there's noise on the line.

Quadrature Amplitude Modulation

I've just shown how a four-state PSK modulation scheme lets you exchange data at 1200 bps over an ordinary phone line. But what if you want to go faster still? You could create an eight-state PSK system. Small differences in phase alone are hard to detect, and each error could cause as many as 6 bits to be received incorrectly, each of these errors compounded by a scrambler. Since the result would be a modem that was overly sensitive to line noise, a simple eight-state PSK system is seldom used.

If you vary amplitudes as well as phases, you can create more states without the weakness of a simple eight-state PSK system. This scheme is called Quadrature Amplitude Modulation, or QAM (see figure 3). Its robustness comes from the fact that there is a greater distance between the states, thereby giving the demodulator more information with which to deduce the correct bit pattern. Most 2400-bps modems, including ones that use the CCITT V.22-bis standard, use QAM.

Table 1: *Differential phase-shift keying. This table shows a possible set of transition rules for a two-phase DPSK modulation scheme. The phase shifts by 180 degrees to indicate a 1 bit but does not change for a 0 bit.*

bit	ϕ	ϕ
0	0	0
0	180	180
1	0	180
1	180	0

Extending QAM: Trellis Coding

A 2400-bps V.22-bis modem uses a QAM constellation consisting of 16 possible symbols (12 possible phase angles and three amplitudes). It transmits 600 symbols per second; each conveys 4 bits of information and is called a *quadbit*.

If it were possible to transmit signals of arbitrary amplitude over the phone line, it would be easy to keep the symbols apart as you add more of them to the diagram. But the dynamic range of a phone line is limited; by the time you reach a speed of 9600 bps, it's necessary to start packing the QAM symbols more closely in the phase-amplitude plane.

Trellis coding can reduce the number of errors this "tighter" pattern generates. In trellis-coded modulation, the constellation contains more symbols than are necessary to represent all the possible bit combinations, but not all transitions are possible. If the receiver sees a symbol that falls between the points of the constellation, it can use its knowledge of the previous symbols to rule out certain illegal symbols and choose the closest one that remains. Trellis coding also spreads the information needed to decode each bit among several symbols. The result is about 4 decibels (a little more than double) the signal-to-noise ratio of a nonencoded system.

Full-duplex 9600-bps modems that conform to the CCITT V.32 standard use trellis coding. They also have special circuitry to cancel echo noise. Echo-cancellation circuits can be complex and expensive to implement; they're the main reason modem manufacturers haven't unanimously embraced the V.32 standard. This will probably change now that companies like Rockwell are hard at work on complete V.32 modems that fit on only a few chips.

The demand for high-speed modems didn't wait for VLSI technology to catch up, however. In the absence of a clearly defined industry standard, modem makers have forged ahead with their own standards, some of which are vastly different from V.32. (See "High-Speed Modems" by John H. Humphrey and Gary S. Smock in the June 1988 BYTE.) The two most widespread (and novel) of these are Telebit's Packet Ensemble Protocol (PEP) and USR's High-Speed Technology (HST).

HST: An Asymmetrical Approach

USR's HST modems are *asymmetrical full-duplex modems*. They divide the available bandwidth into two asymmetrical channels—a high-speed channel in one direction (14,400, 12,000, 9600, 7200, or 4800 bps) and a low-speed channel in the other (450 bps). The 450-bps channel is more than adequate to handle the output of the fastest typist; the high-speed channel is well-suited for fast screen updates and downloads. (The two channels can change places when appropriate—during uploads, for instance.) The high-speed channel always uses trellis coding, but it adjusts the data rate and constellation according to line conditions. HST uses the V.32 constellation up to 9600 bps, and the constellation from V.33—a leased-line standard—at higher speeds. With data compression, the net throughput of an HST modem can be as high as 17,500 bps.

Half-duplex modems don't keep channels open in both directions simultaneously. They must "ping-pong" (i.e., change the direction of transmission periodically) to handle data traveling in both directions. Because HST modems

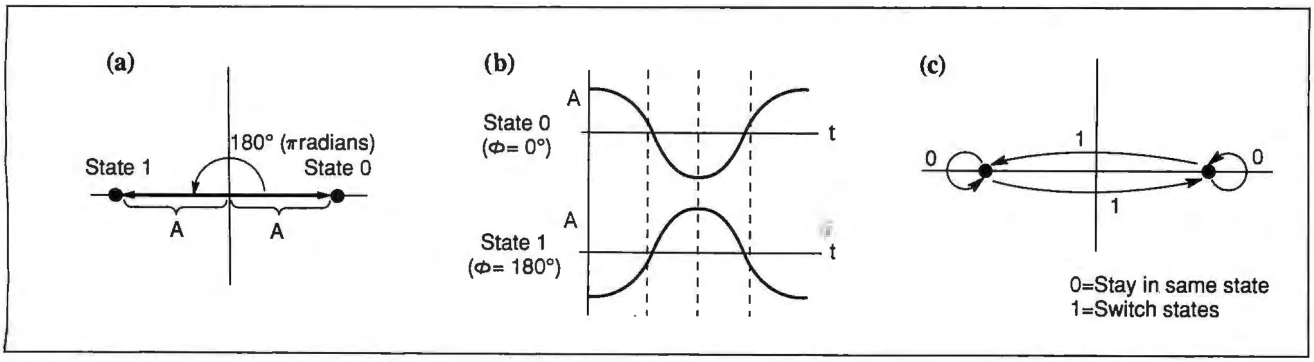

Figure 1: *The states and transitions for a two-state differential phase-shift keying modulation scheme.* **(a)** *The amplitude, which is the same for all states in PSK, is represented by the length of the line joining each point to the origin, while the phase is represented by the angle of that line relative to the positive half of the horizontal axis.* **(b)** *Two carrier signals that have the same shape but are 180° out of phase.* **(c)** *A possible way of encoding 1 and 0 bits as transitions between the states.*

always keep a slow channel open in the "reverse" direction, this *round-trip echo response time*—the delay between the time you press a key and the time you see a response—is lower than for a half-duplex modem.

A Thousand Twanging Instruments

Telebit Corp.'s Trailblazer modems, which have gained popularity in the Unix world, use a patented technique called Dynamically Adaptive Multicarrier Quadrature Amplitude Modulation (DAMQAM) (see figure 4). This scheme uses a large number of very small channels—up to 512 of them, spaced only 7.8125 Hz apart. Some quick multiplication shows that the total bandwidth required to use all the channels would be 4000 Hz—more than the rated bandwidth of a basic voice line (specified to be only 400 to 3000 Hz). However, the modem does not expect to be able to use all these channels; instead, it tests each one individually to see if it can be used.

In the absence of a clearly defined industry standard, modem makers have forged ahead with their own standards.

It's possible to use different modulation schemes on different channels; some of the lower-quality channels can be encoded with two-phase DPSK, while the better ones use 4- or 6-bit QAM. On a typical dial-up line, a Telebit modem uses 400 channels in the range from 300 to 3400 Hz, encompassing more bandwidth than a less adaptable scheme.

Trailblazer modems are half-duplex and use a special protocol (Packet Ensemble Protocol, or PEP) to exchange packets of data by distributing the bits across the available channels. The original Telebit modems were excellent at handling large volumes of data because of high bandwidth utilization, but they had poor echo response—at a signaling rate of 7.8 Hz, each packet took a minimum ⅓ second to transmit. To solve this problem, Telebit recently added another modulation scheme that divides the available bandwidth into channels about 88 Hz wide; packets sent at this speed (called micropackets) get through 10 times faster and give you a better "feel" during interactive sessions.

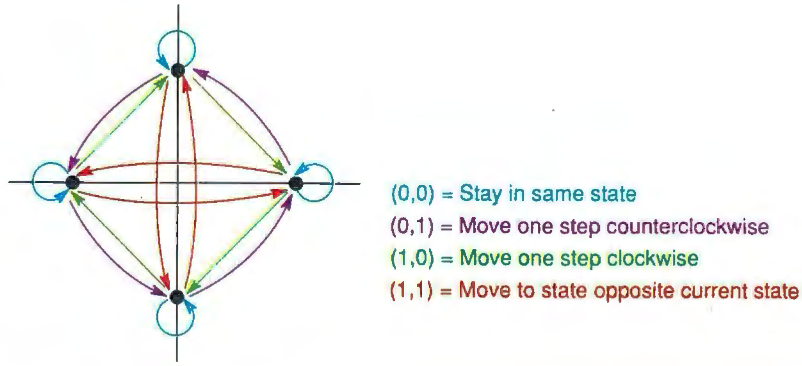

Figure 2: *Four-state differential phase-shift keying. This phase-amplitude diagram shows a set of states and transitions for a four-state DPSK modulation scheme.*

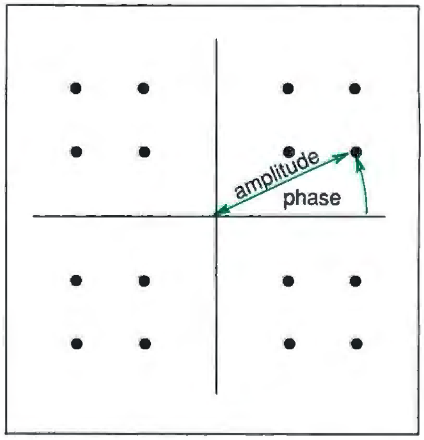

Figure 3: *A Quadrature Amplitude Modulation constellation. Each point in the graph of a 16-point constellation represents a phase-amplitude state that the encoding scheme uses. CCITT V.22 bis uses a 16-point constellation.*

Protocol Spoofing

The Telebit modems have another noteworthy feature that makes them especially good for bulk-file transfers. Since PEP has its own error correction, and the modems handle flow control using either hardware handshaking or XON/XOFF characters, the error-checking and pacing mechanisms built into most file transfer protocols (e.g., Kermit, XMODEM, YMODEM, and the UUCP G protocol) are redundant. In fact, if the modems at both ends must "turn the line around" (i.e., switch directions) to transfer acknowledgment sequences (e.g., XMODEM's ACK character or Kermit's short Y packets), the transfer will proceed much more slowly.

Telebit solves this problem by implementing a feature called *protocol spoofing*. When it recognizes that a protocol transfer is going on, the modem on the sending side of the transfer assumes responsibility for getting each packet through and acknowledges blocks of data on behalf of the receiver. The modem at the receiving end does its part by "absorbing" the receiving system's acknowledgment packets rather than sending them back. As a result, it virtually eliminates delays in the line and delays due to turnaround time.

It's theoretically possible for any error-correcting modem to do protocol spoofing (and especially desirable for half-duplex modems). At present, however, Telebit is the only manufacturer offering this feature.

Other Schemes

USR and Telebit's high-speed modulation techniques, while the most interesting, are not the only proprietary schemes that operate at 9600 bps and above. The Hayes V-series modems, for instance, use a half-duplex scheme based on V.32. Microcom's MNP Class 6 and the FAST-COMM UPTA modems use the half-duplex CCITT V.29 modulation scheme—the same one used in fax machines. Table 2 shows a comparison of some of the most popular schemes.

Who will win the high-speed modem "protocol wars"? At the time of this writing, there's no clear winner among

continued

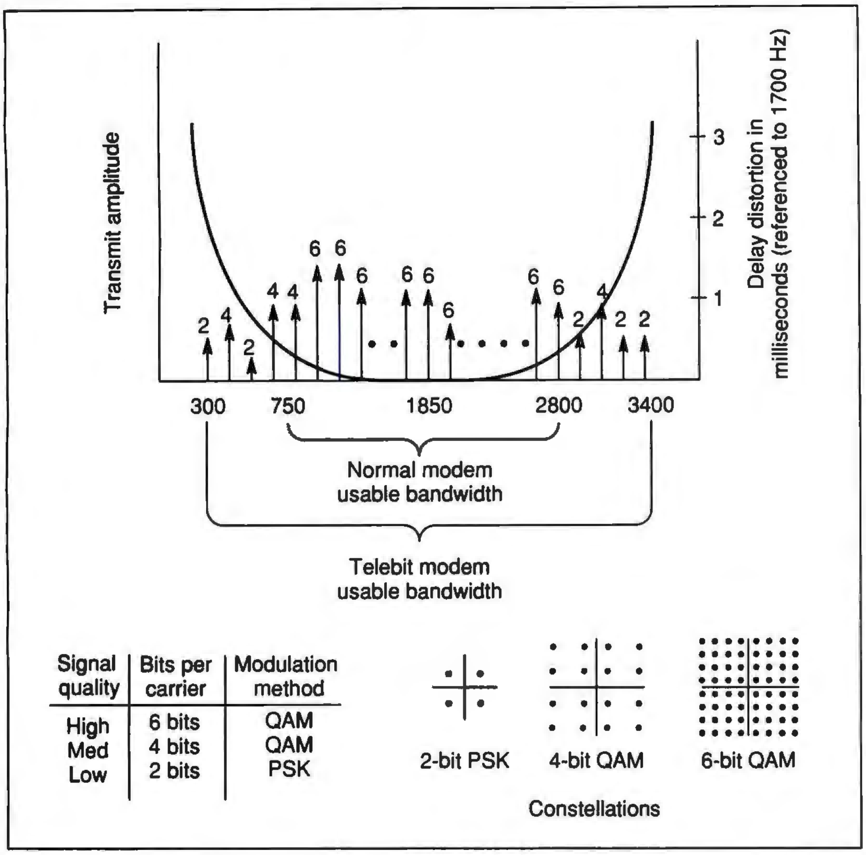

Figure 4: *Telebit's Dynamically Adaptive Multicarrier Quadrature Amplitude Modulation encoding scheme. The Telebit Trailblazer modems use many small channels, modulated at low speeds, to make the best use of a phone line's available bandwidth. The signal quality of each 7.8-Hz channel determines what modulation scheme, if any, is used for that channel.*

Table 2: *A comparison of the modulation schemes.*

	Bit rate	Modulation	Duplex	Round-trip echo response time (approx.)
Hayes V-series	9600	Trellis-coded QAM (based on V.32)	Half	140 ms
USR HST	14,400 12,000 9600 7200 4800	Trellis-coded QAM (based on V.32 or V.33)	Full (asymmetrical)	140 ms
Microcom MNP Class 6	9600	V.29	Half	155 ms
Telebit PEP	Variable up to 18,000	Multicarrier QAM or PSK	Half	≥ 250 ms (ordinary packets) ~ 100 ms (micropackets)
V.32	9600 4800	Trellis-coded QAM	Full	100 ms

the proprietary protocols, but it looks as if nearly all manufacturers are preparing to offer compatibility with the CCITT V.32 standard. Some will make V.32 their primary standard, while others—the ones with the largest investments in proprietary schemes—will offer it as an option. (Initially, V.32 modems will cost more than most others, but prices should fall once VLSI implementations are available from multiple chip vendors.)

The bottom line: If you need a fast modem now but want to be sure you will be able to speak the lingua franca of high-speed modem standards a year or two down the road, you may want to ask your vendor if it provides—or at least promises—an upgrade path to V.32.

Error Correction and Modems

As modems reach speeds beyond 2400 bps, errors become common enough that there's a real need for automatic error correction within the modems themselves. Usually, this is done via a packet-oriented protocol in which packets of data are bundled with a cyclic redundancy check (CRC) designed to catch errors.

The two major contenders among modem error-correction protocols are MNP Classes 1 through 4, developed by Microcom, and LAPM, a standard promoted by Hayes that is based on the LAPB and LAPD link-level protocols used in X.25 and ISDN systems. Both are "windowed" packet protocols (i.e., they can send several packets in a burst without waiting for an acknowledgment).

Even the promoters of the two standards agree that there isn't much of a performance difference between MNP and LAPM; they are now covered by the CCITT V.42 standard (LAPM is a primary part of the standard, while MNP is "Annex A"). It's even possible to build a modem that incorporates both standards. At present, MNP seems to be more widespread in the marketplace, and so may be the more useful one to look for.

Error-correcting modems let you use "streaming" file transfer protocols, like YMODEM G and the Hayes FAST protocol, which implement only minimal error checking. Unless you are using a modem like the Telebit Trailblazer to communicate to another Trailblazer (in which case the protocol spoofing eliminates the acknowledgment delays in most protocols), it's probably worth your while to look into FAST and YMODEM G for use with your error-correcting modem.

continued

Compression

Most high-end modems offer data compression as well as error correction. The most commonly implemented standard is MNP Class 5, which must be licensed from Microcom. USR, Telebit, and others implement this standard. The high-end Telebit modems use MNP only up to speeds of 9600 bps; at higher rates, they use a proprietary Lempel-Ziv algorithm integrated into the PEP protocol. Hayes's V-series modems also offer data compression.

Microcom claims that it can obtain a 60 percent increase in average throughput as a result of data compression; this is a typical number for most compression schemes. The mileage that you get may vary, of course, depending on the amount of redundancy in the data that you're transferring. And, of course, the modem at the other end must implement the same compression algorithm that yours does. This is another reason to look carefully at the fine print when choosing a modem.

Will Modems Soon Be Obsolete?

Many have said that, with the advent of ISDN, modems will soon become obsolete. The odds are that this will indeed happen, but probably not "soon"—it may take a long time before ISDN is available outside large cities and major corporate plants (currently, the only installations). If you buy a high-speed modem now, you can expect to get at least a decade's use from it before you retire it to the closet and plug your computer directly into a data outlet in your wall. ■

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L. Brett Glass is a freelance programmer, author, and hardware designer residing in Palo Alto, California. He can be reached on BIX as "glass."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

Part 2

DIRECTORY ASSISTANCE

The tour of file-systems continues, with stops at MS-DOS, Unix, and the Macintosh HFS

These days, many of us use more than one computer, often running different operating systems. Most of us also use hard disk drives, which are growing larger every day. Those large hard disk drives place a greater burden on an operating system's directory structure. Understanding the directory structure of your operating system can help if (or when) something goes wrong with your hard disk drive.

Last month, I looked at the file-systems of three classic operating systems: Apple DOS 3.3, ProDOS, and CP/M. This month, I'll examine three operating systems that are currently in wider use: MS-DOS, Unix, and the Macintosh Hierarchical File System (HFS).

MS-DOS

The MS-DOS file-system structure has some strong similarities to CP/M's structure (see last month's column): The directory information is stored on contiguous sectors following the boot sector (and reserved sectors used for partitioning information), each entry in a directory is 32 bytes long, and files claim space in multisector clumps referred to as *clusters* (similar to the CP/M allocation block).

To make the similarities apparent, I've left out some details. Actually, the layout of an MS-DOS disk looks something like this:

Boot sector
Reserved sectors
FAT
FAT copy (optional)
Root directory
Everything else (files and subdirectories)

The FAT is the file allocation table, a linked-list structure that's intimately tied to the directory, as you'll soon see.

The system can deduce the specifics of where important structures are located on a disk by examining key locations in the boot sector (logical sector 0). Some of the more important entries in the boot sector are as follows (a word is equivalent to 2 bytes):

- Number of bytes per sector—a word value at offset 11.
- Number of sectors per FAT—a byte value at offset 22.
- Number of FATs on the disk—a byte value at offset 16.
- Number of entries in the root directory—a word value at offset 17.
- Number of reserved sectors—a word value at offset 14.
- Number of sectors per cluster—a byte value at offset 13.

An MS-DOS directory entry consists of a filename, an extension, an attribute byte, the time and date that the file was created (or last modified), a pointer to the file's starting cluster, and the size of the file in bytes. (See figure 1 for a diagram of a directory entry's layout.)

The first byte of the filename is significant: A 00 (null) indicates that the entry has never been used and is therefore the directory's current "high-water" mark. A hexadecimal E5 in the first position indicates that the entry has been deleted. (If a deleted file is a fresh kill—in other words, if you haven't done any write operations to the volume that the file was on—then the remainder of the file's information is intact. This is what allows undelete utilities to work.) Finally, a 05 as the first character indicates that the first character is really a hexadecimal E5 (which, on my AT clone, maps to a lowercase Greek sigma). Any alphanumeric character implies a real file and is part of the file's name.

The file-attribute byte is actually a set of bit fields that indicate whether the file is hidden, if it has been archived, whether it's read-only, and so on (see table 1). This byte is also used to indicate a subdirectory entry, in which case the entry's starting cluster-number pointer indicates a cluster that holds the entries of the subdirectory.

Subdirectories always begin with the familiar "." and ".." that are the first to come rolling out after you've issued a DIR command. The "." element is a self-referencing entry whose starting cluster number points to the head of the current directory. This allows a program to find the beginning (and therefore the contents) of whatever your current directory is—no matter how many subdirectories deep you may have wandered into the volume.

The ".." entry references the parent; The starting cluster number of ".." points to the head of the subdirectory's parent's directory. As you issue CD (change directory) commands, moving into subdirectories of subdirectories, the system can always find the route back to the root directory by following the trail of ".." entries.

The system locates a file's contents by following an imaginary thread through the FAT. In figure 1, you can see that the file entry's starting cluster number actually points to two things. Not only does it give the starting cluster of the file's data, it also acts as an index into the FAT: specifically, an index to the first FAT entry in a chain that guides you to the location of the rest of the file.

Each entry in the FAT corresponds to a cluster on the volume. So, assume your file's first cluster number is 4. To find the file's second cluster number, locate the entry in the FAT corresponding to

continued

cluster 4; it'll point to another cluster number (say, 10). So, 10 is the file's second cluster. To find its third cluster number, you locate the FAT entry corresponding to cluster 10, see where that points, and so on.

FAT entries can be either 12 or 16 bits long. You'll find 12-bit FATs on disks that hold fewer than 4087 clusters (e.g., 360K-byte disks usually accommodate 354 clusters of 1K byte each). All other disks will use 16-bit FATs.

As a safety measure, some disks may maintain two FATs. Both are updated whenever the disk is modified. In this way, if one FAT becomes corrupted due to a failed sector, you can still recover files using its twin. (The CHKDSK command verifies that both FATs—if there are two—are consistent.)

Notice that the FAT is nothing more than a singly linked list. This means that, unless the system can keep the FAT in memory at all times, the file-system's response time will suffer as files grow large and fragmented. And as multiple hard disk drives become more prevalent—especially in a network environment—a FAT can consume a substantial amount of memory. For example, on my AT clone with its 20-megabyte hard disk drive, the FAT is over 20K bytes.

Unix

Unix is unique among the operating systems I'm covering in this series in that it's a multiuser operating system. This means that the designers of Unix had considerations in mind that designers of the other operating systems didn't have to contend with. Chief among these were access and security controls, and you'll see how this affected the design.

If you stand far away, a Unix file-system looks like most of the other file-systems I've described. The disk is arranged as a series of blocks—the minimum allocation unit—each of which is usually 1K byte big (although the actual size depends on which version of Unix you're running). The first block is the boot block, and this is followed by the superblock. The superblock contains information such as the file-system size, the number of i-nodes (short for "index node"—I'll explain further in a moment) in the system, where the root directory's i-node is located, and so on. As its name implies, the root directory is the base for the entire directory structure on the file-system; you can get anywhere from the root directory. The superblock is followed by blocks used by the i-node list, which in turn are followed by file and directory data blocks.

The Unix directory structure is actually in two parts. The first holds the stuff humans are interested in: the names of the files and subdirectories. Each entry is 16 characters long and consists of a 2-byte i-node number followed by 14 bytes for the name of the file or subdirectory. The i-node number is a unique identifier for each entry in the file-system. More important, it is an index into the *i-list*, the second part of the Unix directory.

The i-list is a structure on the disk where Unix keeps the information that *it* is interested in. Each element of the i-list is an i-node, and although the detailed structure of an i-node may vary from Unix system to Unix system, its overall format is the same no matter what Unix machine you're on. As a real-world example, on the Definicon DSI-32 Unix System V that I use, the i-node layout is as shown in table 2.

Subdirectory entries look just like file entries. The only difference is a bit set in the file-mode field that marks this entry as a subdirectory. As in MS-DOS (although MS-DOS borrowed this from Unix, not vice versa), the first two entries in a Unix directory are "." and "..," referring to the current directory and the parent directory, respectively.

Since the directory consists of no more than i-node numbers and filenames, a given file's contents may be referenced by more than one path name. This is the

continued

Table 1: *MS-DOS directory entry's file-attribute byte. Each bit indicates its associated attribute when set to 1.*

Bit	Description
0	File is read-only.
1	File is hidden.
2	Indicates a system file (will not show up on directory displays).
3	This entry is a volume label. Such entries can exist only in the root directory.
4	The entry is a subdirectory.
5	This bit indicates whether the file has been archived; it is set to 1 whenever the file is modified.

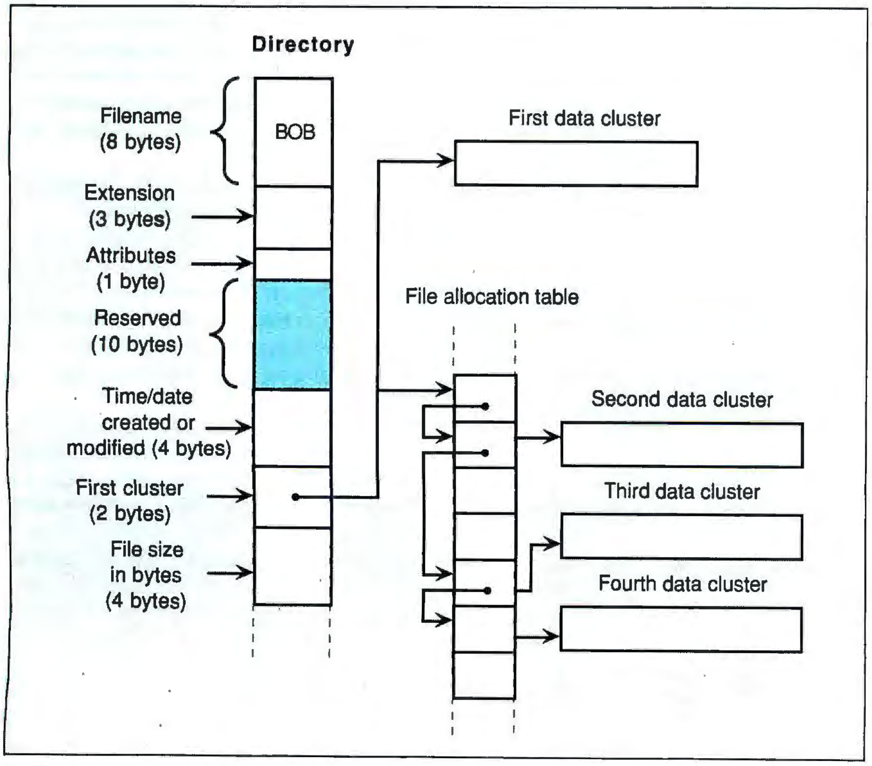

Figure 1: *How an MS-DOS system finds the contents of file BOB. Note that the format of an MS-DOS directory entry is defined here.*

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reason for the i-node's link field: It's a counter that tallies the number of alternate references to the i-node. This lets you provide access to one of your files (or subdirectories) to another user without giving that user access to all your on-line data.

For example, if you've created a file named BOB and you want a friend to have access to it, you can create an entry in your friend's home directory with the name FRANK and an i-node number that is the same as BOB's. The associated i-node's link field would now show a count of 2. If you delete BOB, the link field count drops to 1, but your friend still has access to the file's contents through FRANK. Only when your friend deletes FRANK is the complete file removed.

Keeping track of the file's data is managed by a clever scheme. Each i-node holds a set of 13 pointers. The first 10 pointers are direct pointers; they contain the block numbers of the file's first 10 data blocks. The next pointer field is a single-indirect pointer; it holds the number of a block of pointers that points to the actual data blocks. Following the single-indirect pointer is the double-indirect pointer, which points to a block of pointers, each of whose entries points to a block of pointers that points to the data (gasp). Next comes the triple-indirect pointer, and, before I get tongue-tied describing it, I'll refer you to figure 2.

The Unix design bears a remarkable resemblance to the arrangement used by ProDOS, where a file begins as a sapling file (using only a direct pointer), and as it grows, the direct pointer becomes an indirect pointer and then a double-indirect pointer.

On the DSI-32 system, file pointers are 3 bytes each in the i-node and 4 bytes each in the disk pointer blocks. Since a disk block is 1K byte, each pointer block can hold up to 256 entries. So, a file can hold up to 17 billion characters—provided you can find a disk large enough and the system administration permissions allow you to make a file that big.

Unix doesn't use a bit map to keep track of unused blocks (as Apple DOS 3.3 and ProDOS did). When a file-system is created, Unix builds a linked list of blocks, each member of which holds a table of free block numbers. The first member is kept in the superblock, along with a pointer to the next member. As new blocks are needed, their numbers are retrieved from the table kept in the first member. When this table is exhausted, the system follows the link to the second member of the chain and copies its contents into the superblock, along with a pointer to the third member of the chain (so Unix will know where to go when the second member's table is empty).

Notice that the arrangement favors small files. Data toward the front of a file is accessed most rapidly. This encourages users to keep programs small and atomic so they will load faster.

It's also significant that designers of Unix broke the directory structure into two parts. When you give Unix a filename to locate, the operating system can scan the current directory rapidly since all it has to sift through are entries consisting of names and i-node numbers. All the extraneous baggage that Unix isn't concerned with during a file search is over in the i-node. Once Unix locates your file, *then* it dips into the i-node to determine such things as access permissions.

Table 2: *I-node format for the DSI-32 Unix System V. The user and group IDs serve to control access to the file. For example, if the proper bits are set in the mode field, anyone with the same group as the owner's group ID can read, write, or execute the file.*

Byte offset	Description
0	File mode (word). This field is actually a series of bit flags that indicate (among other things) the entry's read, write, and execute permissions, whether the entry is a directory, and whether the entry defines the driver for a physical device.
2	Number of links (word).
4	Owner's user ID (word).
6	Owner's group ID (word).
8	File size in bytes (doubleword).
12	File pointers—set of 13 (3 bytes each).
51	Unused.
52	Time and date that the entry was last accessed (doubleword).
56	Time and date that the entry was last modified (doubleword).
60	Time and date that the file was created (doubleword).

Macintosh

Back when the Macintosh first came out, the file-system portion of the operating system was the infamous Macintosh File System. MFS was a "flat" directory scheme that—through some clever programming—created the illusion of a hierarchical directory. (You may remember that, when you called up a dialog box under MFS, you got a list of every file on the disk.) MFS has been superseded by the HFS, a true multidirectory file system. I'll restrict the discussion here to the HFS; if you are interested in MFS, I suggest that you consult *Inside Macintosh.*

On the Macintosh, "allocation block" again means the minimum storage quantity. Typically, an allocation block is 512 bytes, but, as with the other operating systems I've discussed, HFS does carry provisions for handling allocation blocks of other sizes.

The first two allocation blocks on an HFS volume (the Mac equivalent of a file-system) are given over to start-up data that contains information like the number of files that can be opened simultaneously, the initial size of the system heap, and so on. The third allocation block (offset 2) holds data describing the HFS volume. In it you'll find items like the number of allocation blocks in the volume, the start of the volume bit map, the volume's name, and the number of directories and files on the volume. Table 3 highlights some of the more important information.

Recall that a physical sector is the absolute minimum amount that can be allocated to a file (without fancy and time-consuming manipulation that I won't go into here). The allocation block—which is the minimum amount by which a file grows—is a multiple of physical sectors; it was created to strike a balance between access speed and wasted bytes.

HFS has taken the "allocation block" idea a step further with the use of *clump size.* HFS defines the clump size as a multiple of allocation blocks, and a file grows by clump-size leaps. You can assign different clump sizes to different files. So if you've got a file for which rapid access is a must, you can minimize fragmentation of the file by giving it a large clump size. Of course, this presumes that your disk has enough free space to allocate large contiguous regions of allocation blocks.

The actual directory is maintained in a B*-tree structure, which is an elaboration of the B-tree structure that I described in my "Trees 'n Keys" series beginning in the January issue. The HFS B*-tree differs from what I presented there in four ways:

1. Keys may be duplicated in the file; specifically, keys that exist in nonleaf nodes will also appear in leaf nodes.
2. Nonleaf nodes do not carry pointers to data; they carry only pointers to leaf nodes. Furthermore, there is only one pointer per key on each node.
3. Leaf nodes do not contain data pointers—they contain the data itself.
4. Leaf nodes are cross-connected with forward- and backward-link pointers. This means that, once on a

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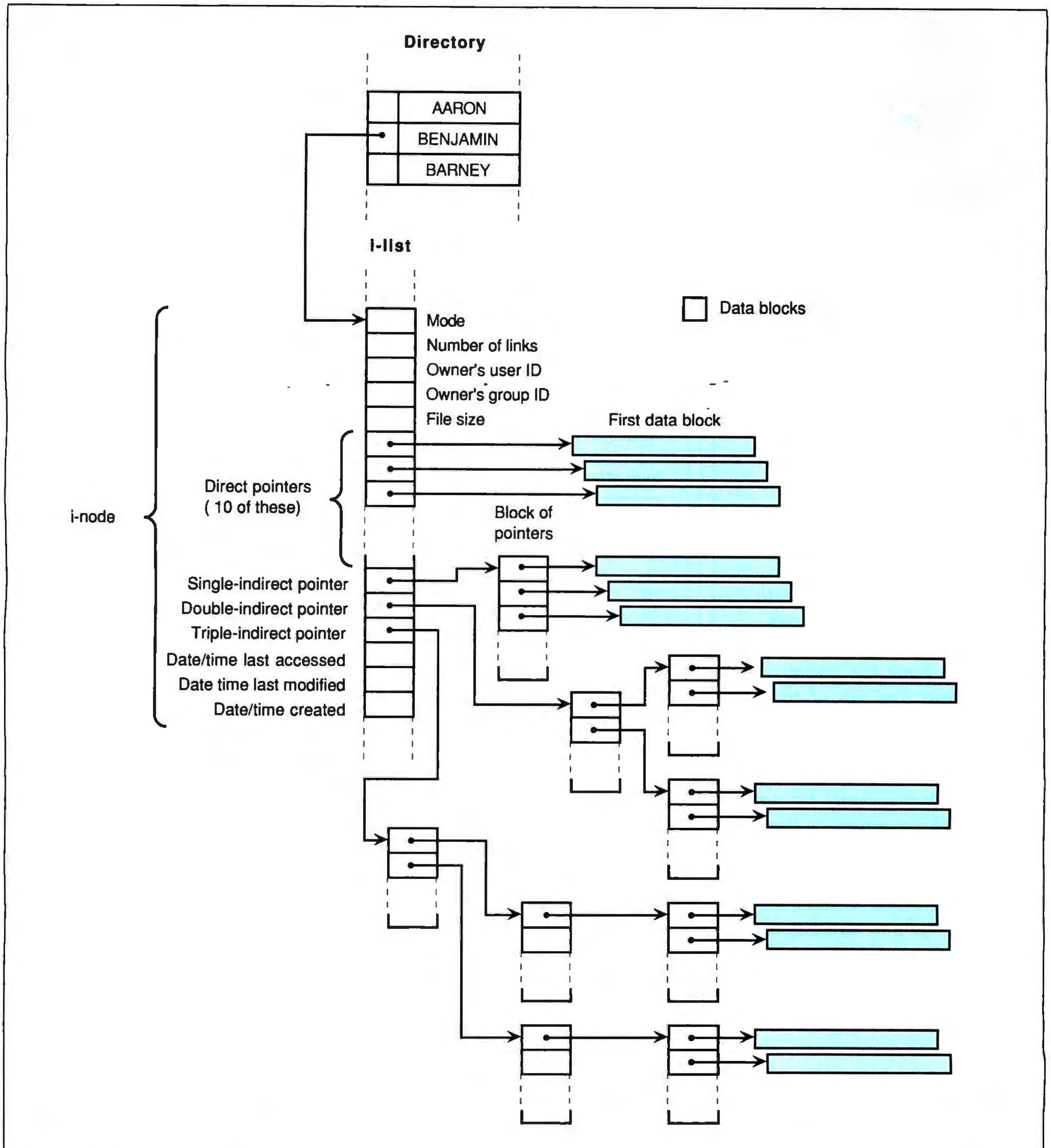

Figure 2: *Finding the file BENJAMIN on the Unix system consists of searching the directory for the filename and using the associated i-node number to retrieve the physical location from the i-list structure.*

leaf node, you can access all other leaf nodes in linear fashion.

You will see how the use of this elaborate structure (rather than the linked lists of Unix) solves some problems created by the clump-size idea and speeds up file access in very large collections of files. (Figure 3 shows a portion of a sample B*-tree structure as it might appear on a Macintosh HFS.)

Data in the volume information block points to a header record for the start of the catalog B*-tree. This header record contains parametric information for the catalog tree, such as where its root is and what blocks allocated to the tree are used or empty (the free and used blocks are kept track of by a bit map). The actual catalog B*-tree follows this header block. Once the system locates the B*-tree's root record, it can rapidly locate the information it needs for any file or directory in the system.

Each leaf entry in the HFS catalog tree can contain file, directory, or thread information that ties the subdirectory entry back to the location of its parents. Table 4 shows some of the more important fields for file, directory, and thread entries. (If you want the complete layout, see *Inside Macintosh*, vol. IV.)

To find the contents of a file, you have to look in the file entry's extent record. (Keep in mind that, on a Macintosh, each file can have two distinct components: a data fork—the standard data—and a resource fork.)

The resource fork holds objects (called *resources*) that can be anything from a program to the binary data that describes a color palette associated with the data fork. The system associates an extent record with each fork. (For the purposes of this discussion, you can assume that the file-system treats each fork equally.)

An extent record is a three-element

continued

Table 3: *Some of the more important locations in the HFS volume information block (for a complete description, see* Inside Macintosh, *vol. IV).*

Byte offset	Description
2	Date and time the volume was initialized (doubleword).
6	Date and time the volume was last modified (doubleword).
12	Number of files in the directory (word).
14	First block number of the volume bit map (word).
18	Number of allocation blocks on the volume (word).
20	Number of bytes per allocation block (doubleword).
24	Default clump size (doubleword).
30	Next unused directory or file ID (doubleword).
34	Number of unused allocation blocks (word).
36	Volume name; first byte is byte count.
64	Date and time that the volume was last backed up (doubleword).
82	Number of directories in root.
134	Extent record for extents tree (6 words).
150	Extent record for catalog tree (6 words).

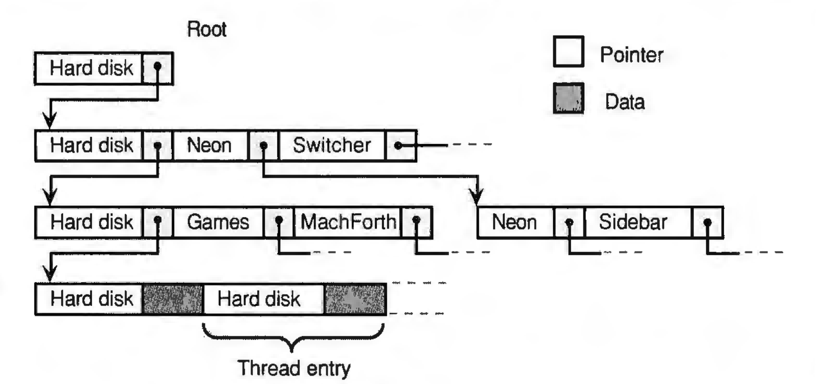

Figure 3: *A portion of a Macintosh HFS catalog B*-tree. Once the system locates the root, it can rapidly locate the information for any file or directory.*

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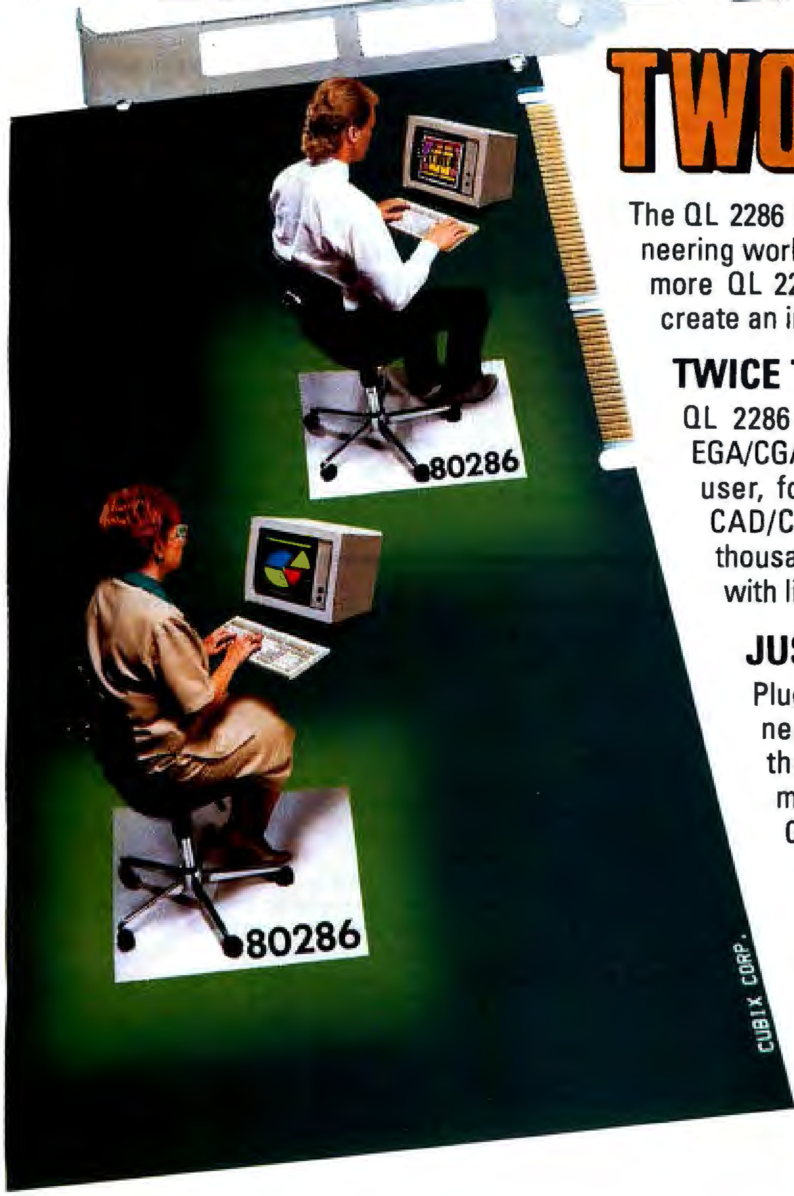

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structure; each element contains a block number and a block count. Each number refers to a "starting" allocation block on the disk, and each count refers to the number of contiguous allocation blocks (beginning with the starting block) that have been given to the file.

When you create a file under HFS, the system will attempt to allocate contiguous blocks to the file so that it uses only the first element of the extent record to point to the file's contents. Of course, as you close the file, then reopen it and add to it, then close it again, and so on, the system cannot continue assigning contiguous blocks to the file; it must use the other two elements of the extent record to keep track of the fragmenting file. If you open, write, and close the file enough times with intervening file operations for other files, you will require more than three records.

When these three extent records are used up and the file grows by a noncontiguous block, the HFS has yet another B*-tree—called the "extents tree"—on hand in which the system records the file's additional extents. The format of an entry in the extents tree is shown in table 5; each entry contains another three-element extent record.

Take, for example, a file named BOB whose data fork contains 100 allocation blocks; all three extent-record elements in the file's catalog tree entry are used up, and you add another block to the file. What happens? HFS locates a new allocation block and records an entry in the extents tree whose key says, "I hold the information to the data fork of BOB starting with allocation block 101."

Thus, when the system receives a request for BOB's block 101 and discovers

continued

Table 4: *Important fields in the Macintosh HFS* **(a)** *file entry,* **(b)** *directory entry, and* **(c)** *thread entry. A thread entry always appears adjacent to a directory entry and points to that directory's father directory.*

(a)

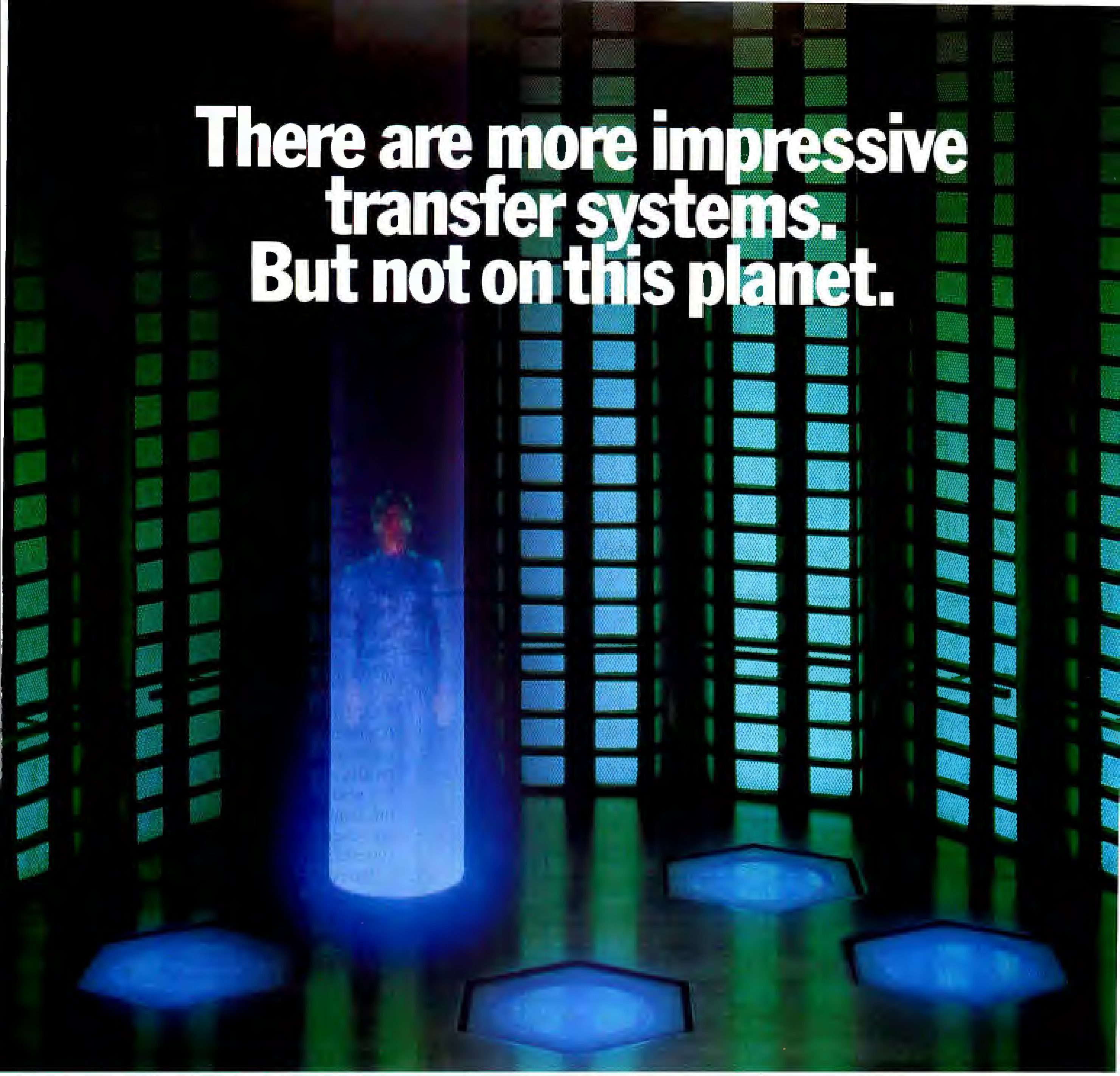
Byte offset	Description
2	Flags (byte). Bit 0 is set to 1 if the file is locked.
20	File number (doubleword). This unique number is assigned by the system when the file is created.
26	Data fork's logical end of file (doubleword).
30	Data fork's physical end of file (doubleword). This entry counts any unused bytes at the end of the file's last allocation block.
36	Resource fork's logical end of file (doubleword).
40	Resource fork's physical end of file (doubleword).
44	File's creation date/time (doubleword).
48	File's last modification date/time (doubleword).
52	File's last backup date/time (doubleword).
72	File's clump size (word).
74	Data fork's first extent record (6 words).
86	Resource fork's first extent record (6 words).

(b)

Byte offset	Description
0	Reserved (4 bytes).
4	Number of entries in this directory; includes files and subdirectories (word).
6	Directory ID; this unique number is assigned by the system when the directory is created (doubleword).
10	Directory's creation date/time (doubleword).
14	Directory's last modification date/time (doubleword).
18	Directory's last backup date/time (doubleword).

(c)

Byte offset	Description
0	Reserved (10 bytes).
10	ID of parent directory (longword).
14	Name of associated directory (length depends on the length of the name).



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that only the first 100 blocks are recorded in BOB's catalog entry, the system does a rapid search in the extents B*-tree for the entry I've just described. Figure 4 should give you a picture of how this works. Without using a structure like the B*-tree, there would be a terrible degradation in seek operations for files with extents because, unlike Unix and MS-DOS, record size is determined by a variable (the clump size).

The HFS directory structure is by far the most complex of the systems that I've looked at in this series. It's also potentially the most powerful. If you can manage to put files on your HFS so that no fragmentation occurs, then the system can theoretically keep track of each file using no more than one extent record in the file's catalog entry. Each of the other directory structures that I've presented so far must use multiple pointers to handle a file larger than about 10K bytes, even if the contents of that file have been stored contiguously on the disk. This means that an HFS volume responds wonderfully to a good defragmentation program.

For example, I use Disk Express about once every six months on my Mac Plus's 20-megabyte hard disk. When I was digging around on the volume to write this column, I found only four entries in my extents file, even though I've used up over 16 megabytes of space. This means that practically all of my files' contents are accessed via the extent records in the catalog. Things were more contiguous than I imagined.

Table 5: *An entry in the HFS extents tree. The first 8 bytes of the entry make up the key; the rest is the entry's data.*

Byte offset	Description
0	Key length (byte).
1	0 for data fork, 255 for resource fork (byte).
2	File number (doubleword).
6	Allocation block number within file defined by this extent record (word).
8	Extent's first allocation block (word).
10	Number of allocation blocks in this extent (word).
12	Two more extent elements (4 words total).

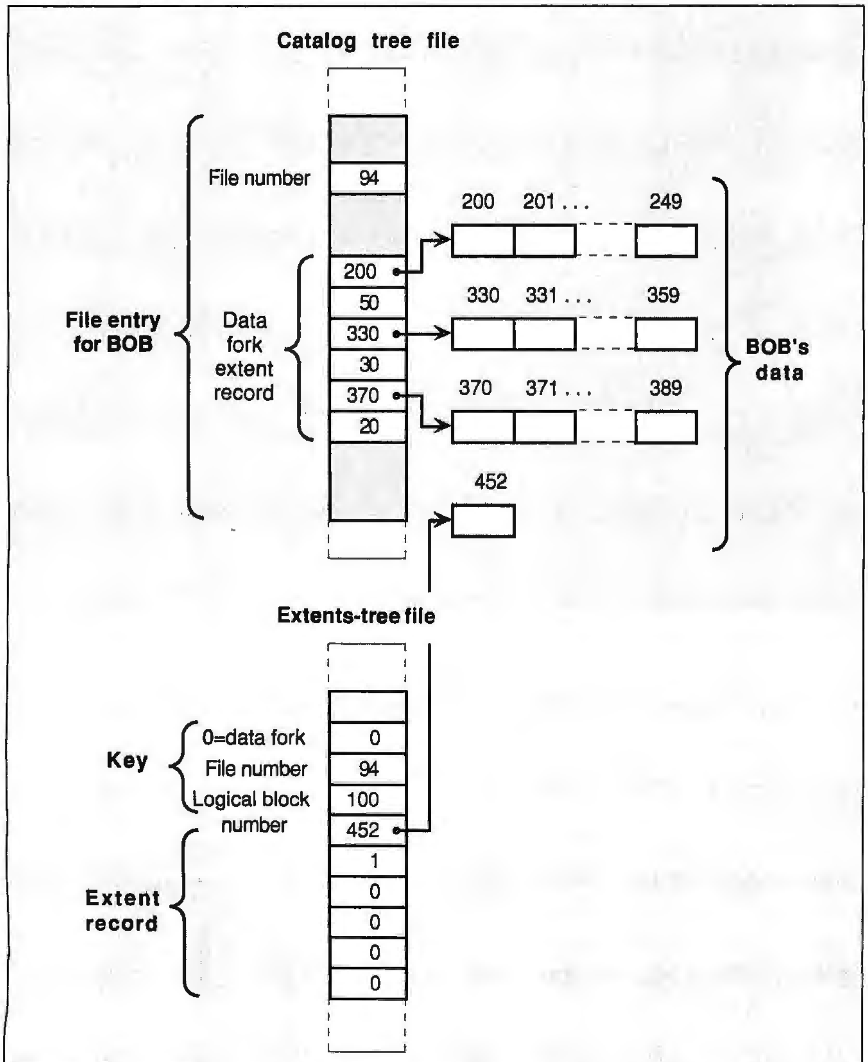

Figure 4: *The file BOB is stored on the HFS volume. The file's data fork has become so fragmented that the system has had to create an extents-tree entry.*

Last Entry

It's interesting to see how software engineers have solved a problem that occurs on all computer systems with disk drives. It's also interesting how similar some of the components of directory structures are, even for vastly dissimilar operating systems.

Directory structures are growing more complex in order to carry the burden of larger hard disk drives. Some structures can run their file-systems into trouble as the storage media get bigger and faster and as systems that were once single-user become part of a network.

I wrote this column on an MS-DOS machine with two hard disk drives and thousands of files. You may have a computer like mine, or a Mac or an Apple II, or even a Unix machine. Like me, you probably have your favorite programs and your most important data files on the hard disk, and you're satisfied with the speed with which your computer calls up your data. Maybe you've been lucky and your system has never lost a file. But if it ever does, now you'll know where to go to look for it. ■

Rick Grehan is the director of the BYTE Lab. He has a B.S. in physics and applied mathematics and an M.S. in computer science/mathematics from Memphis State University. He can be reached on BIX as "rick_g."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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	65MB RLL 40ms	1649	1929	1809	2069	2229
	122MB RLL 28ms	1949	2229	2109	2369	2529
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5101	256x4	450ns (CMOS)	~~2.95~~ 2.49
6116P-1	2048x8	100ns (16K) CMOS	~~3.95~~ 3.19
6116P-3	2048x8	150ns (16K) CMOS	~~3.49~~ 2.79
6116LP-1	2048x8	100ns (16K) LP CMOS	~~4.39~~ 3.59
6116LP-3	2048x8	150ns (16K) LP CMOS	~~3.95~~ 3.09
6264P-10	8192x8	100ns (64K) CMOS	~~9.95~~ 9.49
6264P-15	8192x8	150ns (64K) CMOS	~~9.25~~ 7.49
6264LP-10	8192x8	100ns (64K) LP CMOS	~~10.95~~ 10.25
6264LP-12	8192x8	120ns (64K) LP CMOS	~~10.49~~ 8.95
6264LP-15	8192x8	150ns (64K) LP CMOS	~~10.25~~ 7.95
6514	1024x4	350ns CMOS	~~3.75~~ 3.49
43256-10L	32.768x8	100ns (256K) Low Power	26.95
43256-15L	32.768x8	150ns (256K) Low Power	25.25
62256LP-85	32.768x8	85ns (256K) LP CMOS	29.95
62256LP-10	32.768x8	100ns (256K) LP CMOS	27.95
62256LP-12	32.768x8	120ns (256K) LP CMOS	27.25

DYNAMIC RAMS

THM91000L-10	1.048.576x9	100ns 1MEGx9 SIP	~~390.95~~ 329.95
THM91000S-10	1.048.576x9	100ns 1MEGx9 SIM	~~390.95~~ 299.95
THM91000L-80	1.048.576x9	80ns 1MEGx9 SIP	~~419.95~~ 349.95
THM91000S-80	1.048.576x9	80ns 1MEGx9 SIM	~~419.95~~ 339.95
TMS4416-12	16.384x4	120ns	~~6.75~~ 5.95
TMS4416-15	16.384x4	150ns	~~6.25~~ 5.49
4116-15	16.384x1	150ns (MM5290N-2)	~~1.39~~ 1.25
4128-15	131.072x1	150ns (Piggyback)	5.29
4164-100	65.536x1	100ns	3.49
4164-120	65.536x1	120ns	2.95
4164-150	65.536x1	150ns	2.59
41256-60	262.144x1	60ns	~~11.99~~ 10.99
41256-80	262.144x1	80ns	~~10.19~~ 8.95
41256-100	262.144x1	100ns	~~9.75~~ 8.49
41256-120	262.144x1	120ns	~~8.95~~ 7.95
41256-150	262.144x1	150ns	~~8.49~~ 7.49
41264-12	64Kx4	120ns Video RAM	19.95
41464-10	65.536x4	100ns	~~14.49~~ 11.95
41464-12	65.536x4	120ns	~~11.95~~ 9.95
41464-15	65.536x4	150ns	~~10.95~~ 8.95
51258-10	262.144x1	100ns Static Column	~~13.95~~ 11.95
85227-10PL	262.144x9	100ns 256x9 SIP	~~149.95~~ 105.95
85227-10PS	262.144x9	100ns 256x9 SIM	~~149.95~~ 105.95
511000P-10	1.048.576x1	100ns (1 Meg)	~~25.95~~ 21.95
511000P-80	1.048.576x1	80ns (1 Meg)	~~35.95~~ 24.95
514256P-10	262.144x4	100ns (1 Meg)	~~34.95~~ 29.95
514258-10	262.144x4	100ns Static Column	31.95

EPROMS

TMS2516	2048x8	450ns (25V)	~~6.95~~ 5.95
TMS2532	4096x8	450ns (25V)	~~5.95~~ 4.95
TMS2532A	4096x8	450ns (12.5V)	~~4.49~~ 3.25
TMS2564	8192x8	450ns (25V)	~~6.95~~ 4.95
TMS2716	2048x8	450ns (-5V, +5V, +12V)	~~6.95~~ 6.49
1702A	256x8	(1µs)	4.95
2708	1024x8	450ns	6.95
2716	2048x8	450ns (25V)	3.75
2716-1	2048x8	350ns (25V)	~~4.25~~ 3.95
27C16	2048x8	450ns (25V) CMOS	~~4.25~~ 3.75
2732	4096x8	450ns (25V)	3.95
2732A-20	4096x8	200ns (21V)	4.25
2732A-25	4096x8	250ns (21V)	3.95
27C32	4096x8	450ns (25V) CMOS	~~4.95~~ 4.25
2764-20	8192x8	200ns (21V)	4.25
2764-25	8192x8	250ns (21V)	3.59
2764A-25	8192x8	250ns (12.5V)	3.69
27C64-15	8192x8	150ns (12.5V) CMOS	5.95
27128-20	16.384x8	200ns (21V)	~~6.95~~ 6.49
27128-25	16.384x8	250ns (21V)	5.95
27128A-15	16.384x8	150ns (12.5V)	7.75
27128A-20	16.384x8	200ns (12.5V)	~~6.75~~ 5.25
27C128-25	16.384x8	250ns (21V) CMOS	5.95
27256-15	32.768x8	150ns (12.5V)	8.95
27256-20	32.768x8	200ns (12.5V)	~~6.95~~ 6.25
27256-25	32.768x8	250ns (12.5V)	5.49
27C256-15	32.768x8	150ns (12.5V) CMOS	7.95
27C256-25	32.768x8	250ns (12.5V) CMOS	~~6.25~~ 5.49
27512-20	65.536x8	200ns (12.5V)	10.95
27512-25	65.536x8	250ns (12.5V)	9.95
27C512-25	65.536x8	250ns (12.5V) CMOS	~~10.25~~ 9.49
27C1024	131.072x8	200ns (12.5V) CMOS (1 Meg)	27.95
68764	8192x8	64K 450ns (25V) (Chip Enable)	19.95
68766	8192x8	64K 350ns (25V) (Output Enable)	19.95

6500/6800 68000 Series

Part No.	Price
6402	3.95
6502	2.65
6502A	2.75
65C02 (CMOS)	7.75
6520	1.95
6522	2.95
65C22	4.25
6532	~~5.49~~ 4.95
6551	2.95
65C802 (CMOS)	~~15.95~~ 14.75
6800	~~1.95~~ 1.49
6802	2.95
6808	1.95
6810	~~1.25~~ .99
6820	2.49
6821	1.75
68B21	1.95
6840	~~3.49~~ 2.95
6845	~~2.75~~ 2.49
6850	~~1.95~~ 1.49
6852	~~.75~~ .59
MC68000L8	9.95
MC68000L10	~~11.95~~ 10.95
MC68010L10	~~49.95~~ 39.95
MC68020RC12B	99.95
MC68701	14.95
MC68705P3S	~~9.95~~ 8.95
MC68705U3L	10.95
MC68705U3S	10.95
MC68450L10	49.95
MC68881RC12A	129.95
MC68881RC16A	149.95

Commodore

WD1770	~~8.95~~ 7.49
SI3052P	~~1.25~~ .99
6504A	1.19
6510	12.95
6526	~~14.95~~ 13.95
6526A	15.95
6545-1	3.95
6560	~~10.95~~ 8.95
6567	24.95
6572	~~10.95~~ 7.95
6581 (12V)	~~12.95~~ 10.49
6582 (9V)	~~14.95~~ 12.95
8502	7.95
8564	~~4.95~~ 2.95
8566	~~9.95~~ 7.95
8701	9.95
8722	~~13.95~~ 10.95
*82S100PLA**	15.95
901225-01	~~15.95~~ 13.95
901226-01	~~15.95~~ 13.95
901227-02	4.95
901227-03	15.95
901229-05	15.95
901460-03	1.95
901486-06	2.95

*No specs available
**Note: 82S100PLA = U17 (C-64)

74C/CMOS

74C00 Sale 19		74C174 Sale 39
74C02 Sale 19		74C175 Sale 59
74C04 Sale 19		74C192 Sale 99
74C08 Sale 19		74C194 Sale .49
74C10 Sale 15		74C221 Sale 1 79
74C14 49		74C240 Sale .75
74C32 Sale 19		74C244 1 79
74C74 .49		74C373 Sale 1.49
74C85 1.49		74C374 Sale 1 49
74C86 Sale 19		74C911 6.95
74C89 2.95		74C912 Sale 7 95
74C90 99		74C915 Sale 1 19
74C151 Sale 1 49		74C917 Sale 3.95
74C154 Sale 2.75		74C920 Sale 3 95
74C157 Sale 1.25		74C921 Sale 2 95
74C160 Sale 49		74C922 3.95
74C161 Sale .49		74C923 3 95
74C162 Sale .49		74C925 5 49
74C173 59		74C926 5.95

MISC. COMPONENTS

TANTALUM CAPACITORS

TM.1/35 .1µf @ 35V	.19	TM4.7/35 4.7µf @ 35V	.45
TM1/35 1µf @ 35V	.19	TM6.8/35 6.8µf @ 35V	.49
TM2.2/35 2.2µf @ 35V	.25	TM10/35 10µf @ 35V	.59

POTENTIOMETERS

Values available (insert ohms into space marked "XX"): 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 1MEG

43PXX 3/4 Watt, 15Turn .99	**63PXX** 1/2 Watt, 1Turn .89

TRANSISTORS AND DIODES

PN2222	.13	PN2907	.13	1N4004	.12
2N2222A	.29	2N4401	.12	1N4148	.07
2N3055	.65	1N270	.25	1N4735	.29
2N3904	.12	1N751	.15	C106B1	.49

SWITCHES

JMT123 SPDT, On-On 1.19	206-8 SPST, 16-pin DIP 1.25
MPC121 SPDT, On Off-On 1.19	MS102 SPST Momentary .39

D-SUB CONNECTORS

DB25P Male, 25-pin .69	DB25S Female, 25-pin .75

LEDS

XC556R T1¾, Red .13	XC556Y T1¾, Yellow .17
XC556G T1¾, Green .17	XC556C T1¾, Clear/Red .17

IC SOCKETS

Low Profile		Wire Wrap (Gold) Level #2	
8LP	.11	8WW	.59
14LP	.12	14WW	.65
16LP	.13	16WW	.69
24LP	.25	24WW	1.19
28LP	.27	28WW	1.39
40LP	.29	40WW	1.89

Soldertail Standard (Gold & Tin) & Header Plug Sockets Also Available

74HC HI-SPEED CMOS

Part No.		Price	Part No.		Price
74HC00	SALE	.17	74HC175		.59
74HC02	SALE	.17	74HC221	SALE	.69
74HC04	SALE	.17	74HC240	SALE	.59
74HC08	SALE	.17	74HC244		.79
74HC10	SALE	.19	74HC245	SALE	.69
74HC14		.29	74HC253	SALE	.39
74HC30	SALE	.19	74HC259		.49
74HC32	SALE	.25	74HC273	SALE	.49
74HC74	SALE	.29	74HC373		.69
74HC75	SALE	.29	74HC374	SALE	.59
74HC76	SALE	.29	74HC595		1.29
74HC85		.55	74HC688	SALE	1.25
74HC86	SALE	.25	74HC943	SALE	7.95
74HC123	SALE	.49	74HC4040	SALE	.79
74HC125		.49	74HC4049	SALE	.25
74HC132	SALE	.39	74HC4050	SALE	.25
74HC138		.45	74HC4060	SALE	.69
74HC139	SALE	.35	74HC4511	SALE	.99
74HC154		1.49	74HC4514		1.79
74HC163	SALE	.39	74HC4538	SALE	.99
74HC174		.59	74HC4543	SALE	.99

74HCT-CMOS TTL

74HCT00	SALE	.15	74HCT139	SALE	.29
74HCT02	SALE	.15	74HCT157	SALE	.19
74HCT04	SALE	.17	74HCT174	SALE	.25
74HCT08	SALE	.15	74HCT175	SALE	.25
74HCT14	SALE	.29	74HCT240	SALE	59
74HCT32	SALE	.17	74HCT244	SALE	.49
74HCT74	SALE	.25	74HCT245	SALE	.49
74HCT86	SALE	.15	74HCT373	SALE	.45
74HCT138		.39	74HCT374	SALE	.45

LINEAR

TL071CP	.59	LM1489N	.45
TL072CP	.79	DS14C89N (CMOS)	1.19
TL074CN	.99	LM1496N	.69
TL081CP	.49	LM1871N	1.95
TL082CP	.49	LM1872N	1.95
TL084CN	.89	ULN2003A	.75
LM301N	.35	XR2206	3.95
LM307N	.39	XR2211	2.95
LM308N	.59	XR2240	1.49
LM309K	1.25	26LS29	2.95
LM310N	1.29	26LS31	.99
LM311N	.39	26LS32	.99
LM317T	.65	26LS33	1.49
LM318N	.99	ULN2803A	1.19
LM319N	1.29	LM2901N	.25
LM323K	3.49	LM2907N	1.29
LM324N	.35	LM2917N (8 pin)	1.79
LM335Z	1.39	MC3470P	1.19
LM336Z	.99	MC3479P	3.95
LM337T	1.09	MC3486P	1.19
LM337T	1.09	MC3487P	.99
LM338K	4.49	UDN3613M	.39
LF347N	1.49	LM3900N	.49
LM348N	.69	LM3905N	1.19
LF351N	.39	LM3909N	.89
LF353N	.49	LM3914N	1.79
LF356N	.79	NE5532	.69
LF357N	.89	NE5534	.69
LM358N	.49	7805K (LM340K-5)	1.29
LM380N	.89	7812K (LM340K-12)	1.29
LM386N-3	.89	7815K (LM340K-15)	1.29
LM393N	.39	7805T (LM340T-5)	.45
LF398N	1.95	7812T (LM340T-12)	.45
LF411CN	.79	7815T (LM340T-15)	.45
LF412CN	1.29	7905K (LM320K-5)	1.35
NE555V	.29	7905T (LM320T-5)	.49
XRL555	.59	75113	1.19
LM556N	.45	75150	1.19
LM565N	.89	75154	1.19
LM566CN	1.19	75174	2.95
LM567V	.75	75175	2.95
LM723CN	.39	75176	2.29
LM741CN	.29	75451	.39
LM747CN	.49	75452	.39
LM1458N	.35	75492	.79
LM1488N	.45	MC145406P	2.95
DS14C88N (CMOS)	1.19		

PARTIAL LISTING • OVER 4000 COMPONENTS AND ACCESSORIES IN STOCK! • CALL FOR QUANTITY DISCOUNTS

RAM'S SUBJECT TO FREQUENT PRICE CHANGES

Circle 138 on Reader Service Card

Worldwide • Since 1974

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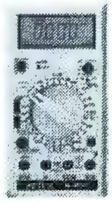
15th ANNIVERSARY YEAR 1974 - 1989

TEST EQUIPMENT

Metex Digital Multimeters



M4650 Pictured

Metex General Specs:
• Handheld, high accuracy • AC/DC Voltage, AC/DC Current, Resistance, Diodes, Continuity, Transistor hFE • Manual ranging w/overload protection
M3650/B & M4650 only:
• Also measures frequency and capacitance
M4650 only:
• Data Hold Switch
• 4.5 Digit

M3610	3.5 Digit Multimeter	$49.95
M3650	3.5 Digit w/Freq. & Capacitance	$69.95
M3650B	Same as M3650 w/Bargraph	$79.95
M4650	4.5 Dig. w/Freq., Capacitance and Data Hold Switch	$99.95

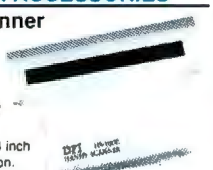
Metex Autoranging Jumbo Readout DMM

• AC/DC Voltage, AC/DC Current, Resistance, Diodes, Continuity and Frequency • 3.75 Digit (.8" High) • Ruggedized, Water-resistant case • Easy-to-use pushbutton switches

M80 .... $59.95

COMPUTER ACCESSORIES

DFI Handy Scanner and 3 Button Mice for IBM PC/XT/AT



FREE DPE Software with HS3000!

The HS3000 offers a full 4 inch window at 400dpi resolution. Scan photos, logos, drawings, etc. Can be used with today's most popular applications.

HS3000 Pictured

HS3000	Handy Scanner	$199.95
DMS200	200DPI 3-Button Ser. Mouse	$49.95
DMS200S	200DPI 3-Button Ser. Mouse with Dr. Halo Software	$59.95

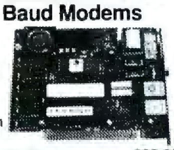
IBM Compatible Cases and Power Supplies

JE1030 Pictured

JE2010 Pictured

JE1010	Flip-Top Standard PC/XT Case	$34.95
JE1017	Flip-Top Baby AT Case ~~$69.95~~	$54.95
JE1018	Slide Baby AT Case ~~$69.95~~	$59.95
JE1030	150 watt PC/XT Power Supply	$59.95
JE1032	200 watt Baby AT Power Supply	$89.95
JE2010	Tower Case w/250 watt Pwr. Supply	$279.95
JE2014	Flip-Top Baby XT Turbo Case	$69.95

2400/1200/300 Baud Modems *Datatronics*

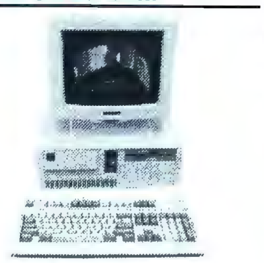


• Hayes command compatible • Bell 103/212A compatible • Auto-dial/auto-answer • FCC approved • 1-year warranty • Includes MaxiMite Communication Software (except 1200P)

1200P	1200/300 Baud Pocket Size Modem	$99.95
1200H	1200/300 Baud Internal Modem	$69.95
2400H	2400/1200/300 Baud Internal Modem	$129.95
1200C	1200/300 Baud External Modem	$99.95
2400C	2400/1200/300 External Modem	$169.95

Jameco 12MHz IBM AT Compatible Kit With 512K RAM

- ***Free! QAPLUS Diagnostic Software Included!***
- ***Free! PC Write Word Processing Software Included!***
- ***512K RAM Included, Expandable to 4MB***
- ***AMI BIOS ROMs Included***
- ***8 or 12MHz Operation***
- ***Regular $832.52 value for only $699.95!***
- ***Flip-Top Case w/200 Watt Power Supply***
- ***1.2MB Disk Drive***
- ***13.7 Norton SI Rating***
- ***101-Key (Enhanced) Keyboard***



Shown with EGA Option (not included) JE1059 Monitor and Adapter Card $499.95 (See Below)

JE3008	12MHz IBM AT Comp. Kit ~~$799.95~~	$699.95
EZDOS	Digital Research MS/PC-DOS Comp. Operating Sys.	$49.95
EZDOSP	Same as above with TrueBASIC	$69.95

IBM COMPATIBLE DISPLAY MONITORS

SALE

QC1478 Pictured

AMBER	12" Amber Mono.	$99.95
HD55H	14" RGB 640x240	$249.95
TM5154	EGA 14" 720x350 ~~$399.95~~	$369.95
JE1059	EGA Monitor & Card ~~$519.95~~	$499.95
TM5155	14" Multiscan 800x560 ~~$549.95~~	$499.95
QC1478	14" VGA 720x480 ~~$449.95~~	$399.95
JE2055	VGA Monitor & Card ~~$649.95~~	$599.95

JAMECO IBM PC/XT/AT COMPATIBLE CARDS

JE1041	20/40MB Hard Disk Controller Card (PC/XT)	$79.95
JE1043	360K/720K/1.2MB/1.44MB Floppy Disk Controller Card (PC/XT/AT)	$49.95
JE1044	360K/720K/1.2MB/1.44MB Floppy/Hard Disk Controller Card (PC/XT)	$129.95
JE1045	360K/720K/1.2MB/1.44MB Floppy/Hard Disk Controller Card (AT)	$149.95
JE1050	Monochrome Graphics Card w/Parallel Printer Port (PC/XT/AT)	$59.95
JE1052	Color Graphics Card w/Parallel Printer Port (PC/XT/AT)	$49.95
JE1055	EGA Card w/256K Video RAM (PC/XT/AT)	$159.95
GC1500	Orchid 8-Bit VGA Card w/256K Video RAM (PC/XT/AT) ~~$269.95~~	$249.95
GC1501	Orchid 8/16-Bit VGA Card w/256K Video RAM (PC/XT/AT) ~~$349.95~~	$329.95
JE1060	I/O Card w/Serial, Game, Printer Port & Real Time Clock (PC/XT)	$59.95
JE1061	RS232 Serial Half Card (PC/XT)	$29.95
JE1062	RS232 Serial Half Card (AT)	$34.95
JE1065	I/O Card w/Serial, Game and Parallel Printer Port (AT)	$59.95
JE1071	Multi I/O Card w/Controller & Monochrome Graphics (PC/XT)	$119.95
JE1081	2MB Expanded or Extended Memory Card (zero-K on-board) (AT)	$119.95

SEAGATE HALF-HEIGHT HARD DISK DRIVES

ST225	20MB Drive only (PC/XT/AT)	$224.95
ST225XT	20MB w/Controller (PC/XT)	$269.95
ST225AT	20MB w/Controller (AT)	$339.95
ST238	30MB Drive only (PC/XT/AT)	$249.95
ST238XT	30MB w/Controller (PC/XT)	$299.95
ST238AT	30MB w/Controller (AT)	$389.95
ST251	40MB Drive only (PC/XT/AT)	$379.95
ST251XT	40MB w/Controller (PC/XT)	$419.95
ST251AT	40MB w/Controller (AT)	$489.95
ST251-1	40MB Fast 28ms (Drive only)	$469.95

Your One-Stop Center for Hard Disk Drive Needs!

ST225XT Pictured

Seagate 60MB Hard Disk Drives Also Available!

IBM PC/XT/AT COMPATIBLE MOTHERBOARDS

JE1001	4.77/8MHz (PC/XT)	$89.95
JE1002	4.77/10MHz (PC/XT) ~~$109.95~~	$99.95
JE3005	Baby 8/12MHz (AT) ~~$329.95~~	$299.95
JE3010	Baby 8/16MHz *NEAT* (AT) ~~$469.95~~	$399.95
JE3020	Baby 16MHz 80386 (AT)	$1199.95
JE3025	Baby 20MHz 80386 (AT)	$1499.95
JE3026	Full-Size 25MHz 80386 (AT)	$2299.95

JE3025 Pictured

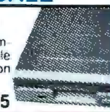
IBM PC/XT/AT COMPATIBLE 3.5"/5.25" DISK DRIVES

352KU	3.5" 720KB (PC/XT/AT)	$109.95
356KU	3.5" 1.44MB (PC/XT/AT)	$129.95
JE1020	5.25" 360KB (PC/XT/AT) Black	$89.95
JE1021	5.25" 360KB (PC/XT/AT) Beige	$89.95
JE1022	5.25" 1.2MB (PC/XT/AT) Beige	$99.95

JE1022 Pictured

SUPER SONY SALE

720KB 3.5" Floppy Drive



• For use with IBM PC/XT/AT and compatible computers • Double-sided, double density • 135TPI • 160 tracks • Rotation speed: 300rpm • Size: 4"W x 6"D x 1"H

MPF11 .... $79.95

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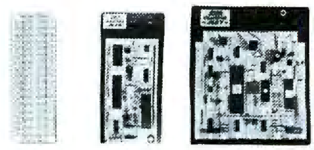

JE23 JE24 JE27

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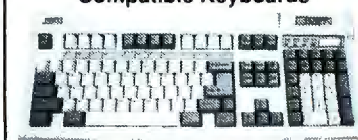

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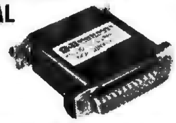

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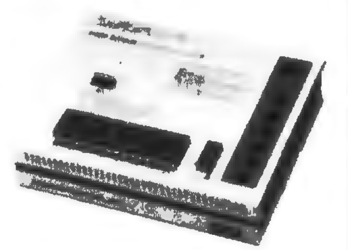

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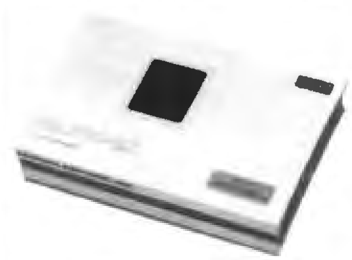

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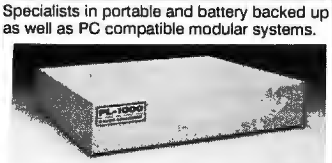

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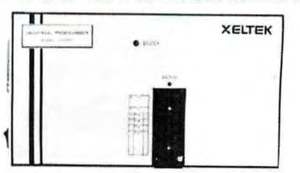

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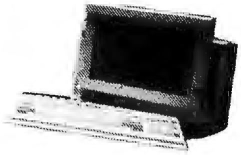

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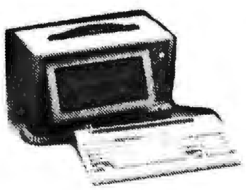

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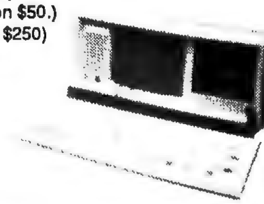

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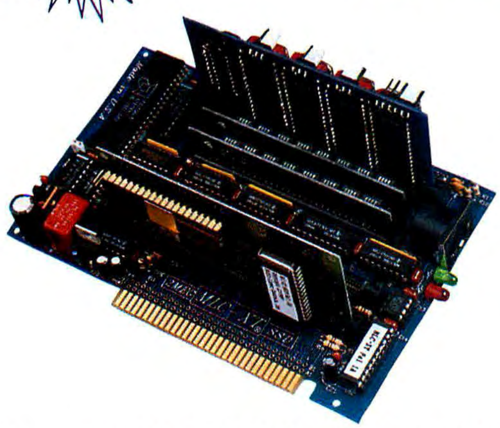

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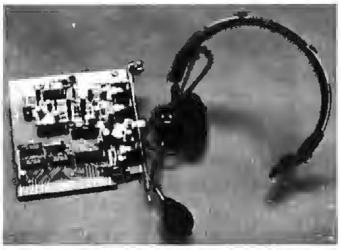

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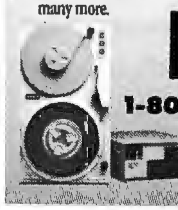

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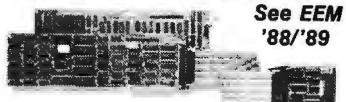

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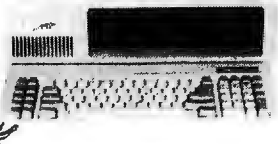

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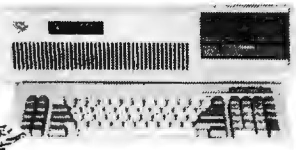

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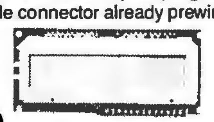

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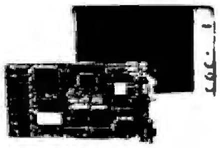

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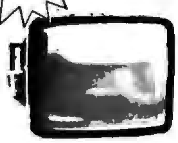

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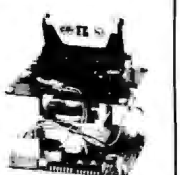

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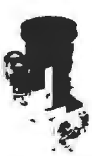

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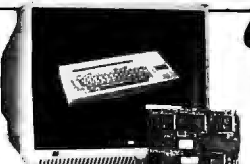
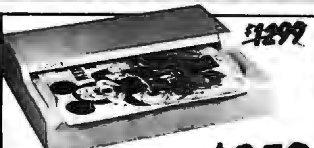


Color Monitor Better Than EGA $219

Ideal for CAD/CAM and Desk Top publishing applications. The Roland CD/240 color monitor has a resolution of 720 pixels by 400/480 lines on a .31mm dot pitch 12" non-glare screen. VGA specifications in text mode EGA in graphic mode.
California Digital has made a special purchase and is able to offer the CD/240 EGA/VGA RGB color monitor for only $219.
Full featured, 132 column, multi-resolution video color adapter card available for only $159 additional. Comparable card package would retail for $1095.



Saba Scanner $359

~~$1299~~

The Saba Scanner inputs a printed page in less than three seconds. OCR software allows your computer to transfer printed pages into ASCII files or directly to spreadsheets and word processing programs.
Archival data, legal briefs... No problem. Simply inset the page into the Saba and in seconds the document is digested into your computer and ready for editing. Also does line drawings that do not require gray tones. Limited quantities available. Original price $1299; now only $359.

Hitachi Plotter $595

The Hitachi 672/XD is a four color 11 by 17 (B size) plotter with superior accuracy and repeatability (.3mm). The 672 accepts HPGL 7475 commands and is both serial and Centronics compatible.
The 672 plots at a fast eight inches per second in axial direction and eleven inches at an angle of 45 degrees. The plotter also features a self contained digitizing function that allows data to be entered into your computer from printed graphs and blue prints.

As Low As $279 Digitizers

California Digital offers over 50 different digitizers. We have two which appear to offer the best values. Both are 12" by 12", one thousand line per inch resolution, are supplied with four button cursor.
The first digitizer is the Genius Tablet priced at only $279. This is a new product from KYE of Taiwan.
The other unit, pictured above, is the Puma Pro manufactured by Hitachi and warrantied for ten years. The Puma boast a .0015" repeatability.
Only $359 and includes a stylus.

Build Your Own Computer $35

AT Case Only

California Digital has all the components needed to customize your own computer. Buy as much computing power as you need now, and up grade when the need arises. Here are some examples of components available:

8 slot 10 MHz Mother board	$89
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Full size five drive AT case	35
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MonoGraphics (hercules) printer port	45
Color Graphics card	49
EGA Color Multi Resolution II	159
I/O card, serial & parallel	35
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Disk I/O, disk control, clock, game	59

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SABA SCANNERS		
page scanner with OCR software	1299	359
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OCR software for hand held		59
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1000 flat bed page scanner	special pricing	
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DFI HandiScan 300 with Halo	359	239
PRINCETON GRAPHICS LS-300	1095	789
PANASONIC		
RS505 Image page scanner	1499	999
RS506 Page scanner	1899	1259
DATACOPY		
730 flat bed scanner	1800	1159
840 flat bed scanner	6800	4159
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XEROX Ventura PC Publisher	895	499
ALDUS PageMaker PC	795	459
COMPLETE PC FaxCard 4800	399	279
QUADRAM JT FaxCard 4800	395	259

MONITORS

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945CN, 20" f.freq. 31.5KHz. 1300x900	1895	659
1019, 20" autosysc .31 dot 1024x580	2395	1687
MITSUBISHI		
AUM 1381 13" diamond scan 800x600	889	519
HJ 6905ATK 20" multiscan	3650	2297
HITACHI		
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4115 15" 1280x1024, 65 KHz.	1990	1159
CONRAC 7250, 19" multi. 1024x1024	2995	1999
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MAGNIVOX 9CM082, 14" 640x480	649	459
NEC MultiSync II, 14" 800x560	949	597

PLOTTERS

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DMP 52 single pen, 16 ips, C&D	3295	2495
DMP 56C size A-E, 16 ips	5695	3095
DMP61 single pen, 32 ips, A-D	4295	3095
PC695A 4 pen, size "B" 3 ips	799	595
CALCOMP PLOTTERS		
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1043GT size A-E, 8 pen, 24 ips	7995	5495
HEWLETT PACKARD		
7475A 6 pen size "B"	1895	1495
7550A 8 pen size "B" 32 ips	3900	2995
7595A 8 pen, size A-E, 24 ips	9990	7595
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LP3700MP 8 pen size "E" 10 ips	4695	3495
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HDG 3648, 36x48"	5357	
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MANNESMANN TALLY 905, HP/II	1995	1295
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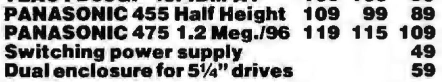
40 Meg. Tape Back-up $239

~~$659~~

Head Crash, Power Spikes or just poor disk maintenance...
Don't loose data because you didn't back up. The Alloy/40 is an inexpensive way to save and restore files in the event that your data has been distroyed. This 40 megabyte half height tape back is manufactured by North Americas largest producer of data retrieval equipment.
No need to purchase a separate tape controller... the Alloy/40 attaches directly to your existing floppy disk controller. Supplied software allows your computer to back up any time Day or Night. Come back in the morning and 40 megabytes of irreplacable data has been stored on one Scotch DC/2000 data cassette. Back up entire hard disk, modified files only, or by file name. Loss of data is inevitable but when you are backed up on an Alloy/40 its not a catastrophe.



	One	Two	Ten
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MITSUBISHI new 501 half ht.	119	109	105
MITSUBISHI 504A AT comp.	149	139	135
TEAC FD55BV half height	89	85	79
TEAC FD55FV 96 TPI, half ht.	119	109	105
TEAC FD55GF for IBM AT	109	105	99
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TEAC 35FN 720 K/Byte	129	119	115
TEAC 35HN/30, 2 Meg.	159	149	145
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Amstrad

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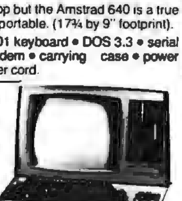
- Supertwist LCD display
- 16 color RGB/CGA output
- Full feature 101 keyboard

~~$1379~~ $695

Take it to school, court, news events or anywhere that you require "computing power" on the go. Built in 2400 bps hayes compatible modem allows you to transfer data files with your home office or any World wide data base.
A little to large to be called a laptop but the Amstrad 640 is a true battery operated IBM compatible portable. (17¾ by 9" footprint).
Includes: full featured AT style 101 keyboard • DOS 3.3 • serial port • printer port2400 bps. modem • carrying case • power adapter and cigarette lighter power cord.

Heath H/89 Computer $179



Hard to believe... but we found a stash of brand new fully factory assembled Zenith/Heath Model H/89s. These computers feature 64K/byte of memory, the Zilog Z-80 CPU and operate under CP/M. The unit incorporates a 12 inch green screen, three serial ports and one 5¼" disk drive.
Zenith's original price was $1895. We have still 97 units available for sale, while supplies last we are offering the H/89 at only $179.
CP/M operating system available $24.95

40 Megabyte Hard Disk Kit $397

Forty megabyte internal hard disk drive, controller and cables all for only $397.
The kit includes the a 40 millisecond Miniscribe 3650 drive and a half slot Western Digital controller.

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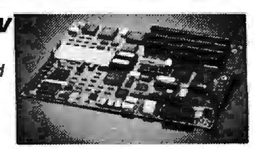

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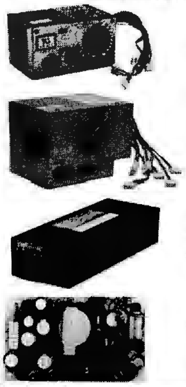

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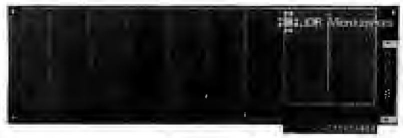

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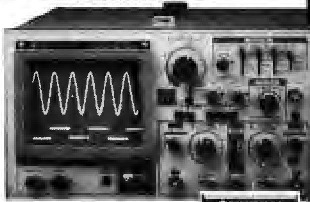

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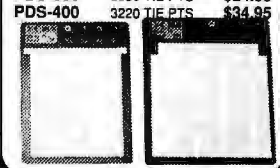

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DESCRIPTION	ORDER BY	CONTACTS 10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WIREWRAP HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WIREWRAP HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.63	.89	.95	1.29	1.49	1.69
RIBBON HEADER	IDMxx	--	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	.85	1.25	1.35	1.75	2.05	2.45
10' RIBBON CABLE	RCxx	1.60	3.20	4.10	5.40	6.40	7.50

FOR ORDERING INSTRUCTIONS, SEE D-SUBMINIATURE CONNECTORS BELOW

D-SUBMINIATURE CONNECTORS

DESCRIPTION		ORDER BY	CONTACTS 9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.45	.59	.69	.69	1.35	1.85
	FEMALE	DBxxS	.49	.69	.75	.75	1.39	2.29
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	.49	.69	--	.79	2.27	--
	FEMALE	DBxxSR	.55	.75	--	.85	2.49	--
WIREWRAP	MALE	DBxxPWW	1.69	2.56	--	3.89	5.60	--
	FEMALE	DBxxSWW	2.76	4.27	--	6.84	9.95	--
IDC RIBBON CABLE	MALE	IDBxxP	1.39	1.99	--	2.25	4.25	--
	FEMALE	IDBxxS	1.45	2.05	--	2.35	4.49	--
HOODS	METAL	MHOODxx	1.05	1.15	1.25	1.25	--	--
	PLASTIC	HOODxx	.39	.39	--	.39	.69	.75

ORDERING INSTRUCTIONS: INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED. EXAMPLE : A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR

MOUNTING HARDWARE .59

IC SOCKETS/DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 8	14	16	18	20	22	24	28	40
SOLDERTAIL SOCKETS	xxST	.11	.11	.12	.15	.18	.15	.20	.22	.30
WIREWRAP SOCKETS	xxWW	.59	.69	.69	.99	1.09	1.39	1.49	1.69	1.99
ZIF SOCKETS	ZIFxx	--	4.95	4.95	--	5.95	--	5.95	6.95	9.95
TOOLED SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
TOOLED WW SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIERS	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
DIP PLUGS (IDC)	IDPxx	.95	.49	.59	1.29	1.49	--	.85	1.49	1.59

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE CONNECTORS ABOVE

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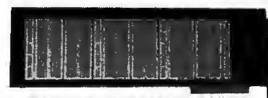

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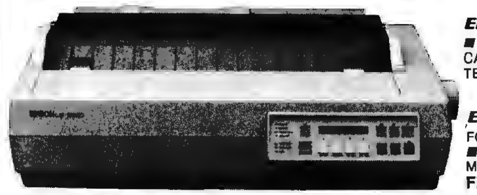

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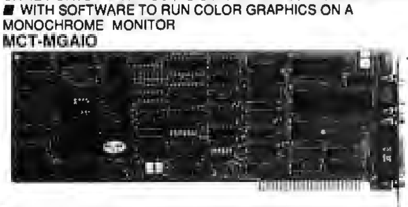

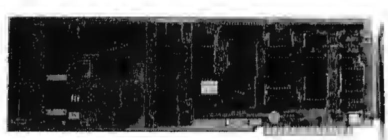

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COMING UP IN BYTE

PRODUCTS IN PERSPECTIVE:

The front of BYTE will feature, as always, Microbytes, What's New, and Short Takes. July's Short Takes, BYTE's hands-on look at new and interesting products in an abbreviated format, will include Hewlett-Packard's DeskJet Plus; PixelPaint 2.0 from SuperMac Technology; HyperPAD, an IBM PC desktop manager from Brightbill-Roberts; the Mitsubishi Smart Mouse; an add-in security-card device called Counterpart from Fifth Generation Systems; and Culture 1.0, a Macintosh program from Cultural Resources with a unique perspective on Western civilization.

Our **First Impression** for July will feature Apple's Color QuickDraw, an upgrade to the Macintosh II family's core graphics primitives that significantly expands their capabilities while retaining compatibility to existing Mac applications.

The **Product Focus** will cover five of the most popular file-server-oriented LAN operating systems.

One scheduled **system review** will look at the IBM PS/2 Model 70. Another one will be on the NCR PC916sx, the company's entry into the curious 16-bit 80386SX field.

Our **hardware reviews** are set to include the Tektronix Phaser CP, a new low-cost entry in the PostScript-compatible color thermal-transfer printer field. Additionally, we plan to look at the Elite 16 Plus HyperCache, an EMS 4.0 board from Profit Systems with an on-board 16K- or 32K-byte memory cache that gives it a performance edge.

For **software reviews**, we have on tap Phar Lap Software's 386|VMM. An extended DOS environment puts the 80386 CPU into flat memory mode; that is, it uses the 32-bit capabilities of the 80386 chip to address large amounts of memory. We also hope to include Ithaca Software's HOOPS (Hierarchical Object-Oriented Picture System), a library that provides support for three-dimensional imaging to C or FORTRAN programs.

In the **application reviews** section, we'll look at Folio Views from Folio Corp., a synthesis of several applications for DOS machines: text retrieval, hypertext linking, word processing, directory management, and electronic publishing. Another article will examine the much-ballyhooed WingZ, a spreadsheet for the Macintosh that also provides flexible, presentation-quality charts based on your worksheets.

IN DEPTH:

The July subject will be **distributed processing**. In it, we'll focus on the state of the art with articles on such topics as remote procedure calls, the benefits of transparency in distributed systems, and distributed personal-computer-based document image processing.

FEATURES:

In addition to our **Hands On** and **Expert Advice columns**—Under the Hood, Some Assembly Required, Computing at Chaos Manor, Down to Business, Macinations, Applications Plus, and OS/2 Notebook—we'll have a new Expert Advice column on communications, Net/Works.

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(Enter by pushing the numbers and # - symbols enclosed in the boxes on telephone pad ignoring blank boxes)
Enter ☐☐☐☐☐☐☐☐☐ # #

6) When TIPS says "Enter magazine code & issue code"
Enter 1 # 6 9 # #

ENTER YOUR INQUIRIES

7a) When TIPS says "Enter (next) Inquiry Number"
Enter one inquiry selection from below (ignore blank boxes)

b) Repeat 7a as needed (maximum 17 inquiry numbers)

1. ☐☐☐☐ # #　6. ☐☐☐☐ # #　10. ☐☐☐☐ # #　14. ☐☐☐☐ # #
2. ☐☐☐☐ # #　7. ☐☐☐☐ # #　11. ☐☐☐☐ # #　15. ☐☐☐☐ # #
3. ☐☐☐☐ # #　8. ☐☐☐☐ # #　12. ☐☐☐☐ # #　16. ☐☐☐☐ # #
4. ☐☐☐☐ # #　9. ☐☐☐☐ # #　13. ☐☐☐☐ # #　17. ☐☐☐☐ # #
5. ☐☐☐☐ # #

END SESSION

8) End session by entering # #

9) Hang up after hearing final message
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Company ____________________

Address ____________________

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A. What is your level of management responsibility?

1 ☐ Senior-level Management
2 ☐ Other Management
3 ☐ Non-Management

B. What is your primary job function/principal area of responsibility? (Check one.)

1 ☐ Administration
2 ☐ Accounting/Finance
3 ☐ MIS/DP/Information Center
4 ☐ Product Design and Development
5 ☐ Research and Development
6 ☐ Manufacturing
7 ☐ Sales/Marketing
8 ☐ Purchasing
9 ☐ Personnel
10 ☐ Education/Training
11 ☐ Other: ____________

C. Please indicate your organization's primary business activity: (Check one.)

Computer-Related Businesses:

1 ☐ Manufacturer (Hardware, Software)
2 ☐ Computer Retail Stores
3 ☐ Consultants
4 ☐ Service Bureau/Planning
5 ☐ Distributor/Wholesaler
6 ☐ Systems House/ Integrator/VAR
7 ☐ Other: ____________

Non-Computer-Related Businesses:

8 ☐ Manufacturing
9 ☐ Finance, Insurance, Real Estate
10 ☐ Retail/Wholesale
11 ☐ Education
12 ☐ Government
13 ☐ Military
14 ☐ Professions (Law, Medicine, Engineering, Architecture)
15 ☐ Consulting
16 ☐ Other Business Services
17 ☐ Transportation, Communications, Utilities
18 ☐ Other: ____________

JUNE
IRSD002

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Company ______________________

Address ______________________

City ______________ State ______ Zip ______

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2 ☐ Other Management
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B. What is your primary job function/principal area of responsibility? (Check one.)
1 ☐ Administration
2 ☐ Accounting/Finance
3 ☐ MIS/DP/Information Center
4 ☐ Product Design and Development
5 ☐ Research and Development
6 ☐ Manufacturing
7 ☐ Sales/Marketing
8 ☐ Purchasing
9 ☐ Personnel
10 ☐ Education/Training
11 ☐ Other: ______________

C. Please indicate your organization's primary business activity: (Check one.)

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7 ☐ Other: ______________

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9 ☐ Finance, Insurance, Real Estate
10 ☐ Retail/Wholesale
11 ☐ Education
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M50	M51	M52	M53	M54	M55	M56	M127	M128	M129	M130	M131	M132	M133	M204	M205	M206	M207	M208	M209	M210	M281	M282	M283	M284	M285	M286	M287
M57	M58	M59	M60	M61	M62	M63	M134	M135	M136	M137	M138	M139	M140	M211	M212	M213	M214	M215	M216	M217	M288	M289	M290	M291	M292	M293	M294
M64	M65	M66	M67	M68	M69	M70	M141	M142	M143	M144	M145	M146	M147	M218	M219	M220	M221	M222	M223	M224	M295	M296	M297	M298	M299		
M71	M72	M73	M74	M75	M76	M77	M148	M149	M150	M151	M152	M153	M154	M225	M226	M227	M228	M229	M230	M231							

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A. Do you have management responsibilities within your company?
1 ☐ Senior-level management
2 ☐ Other management
3 ☐ Non-management

B. Reason for request: (Check all that apply.)
1 ☐ Business use for yourself
2 ☐ Business use for your company
3 ☐ Personal use

C. For how many Macintosh personal computers do you *currently* buy, specify or approve brands of products?
1 ☐ 10 or less
2 ☐ 11–25
3 ☐ 26–99
4 ☐ 100 or more

D. For how many Macintosh personal computers will you buy, specify or approve brands of products *within the next two years?*
1 ☐ 10 or less
2 ☐ 11–25
3 ☐ 26–99
4 ☐ 100 or more

E. *In total*, how many Macintosh personal computers is your *entire* organization considering for purchase within the next two years?
1 ☐ 10 or less
2 ☐ 11–25
3 ☐ 26–99
4 ☐ 100–499
5 ☐ 500 or more

F. What type of personal computer do you primarily use?
1 ☐ IBM AT or 80286-based compatible
2 ☐ Compaq 386 or 80386-based compatible
3 ☐ IBM PS/2 (with Micro-Channel) or compatible
4 ☐ Apple Mac (except Mac II)
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6 ☐ Other

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M120	M121	M122	M123	M124	M125	M126
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M218	M219	M220	M221	M222	M223	M224
M225	M226	M227	M228	M229	M230	M231

M232	M233	M234	M235	M236	M237	M238
M239	M240	M241	M242	M243	M244	M245
M246	M247	M248	M249	M250	M251	M252
M253	M254	M255	M256	M257	M258	M259
M260	M261	M262	M263	M264	M265	M266
M267	M268	M269	M270	M271	M272	M273
M274	M275	M276	M277	M278	M279	M280
M281	M282	M283	M284	M285	M286	M287
M288	M289	M290	M291	M292	M293	M294
M295	M296	M297	M298	M299		

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