SETTING THE STANDARDS
15
YEARS

BYTE

SEPTEMBER 1989

A McGRAW-HILL PUBLICATION

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THE WORLD'S FIRST 486

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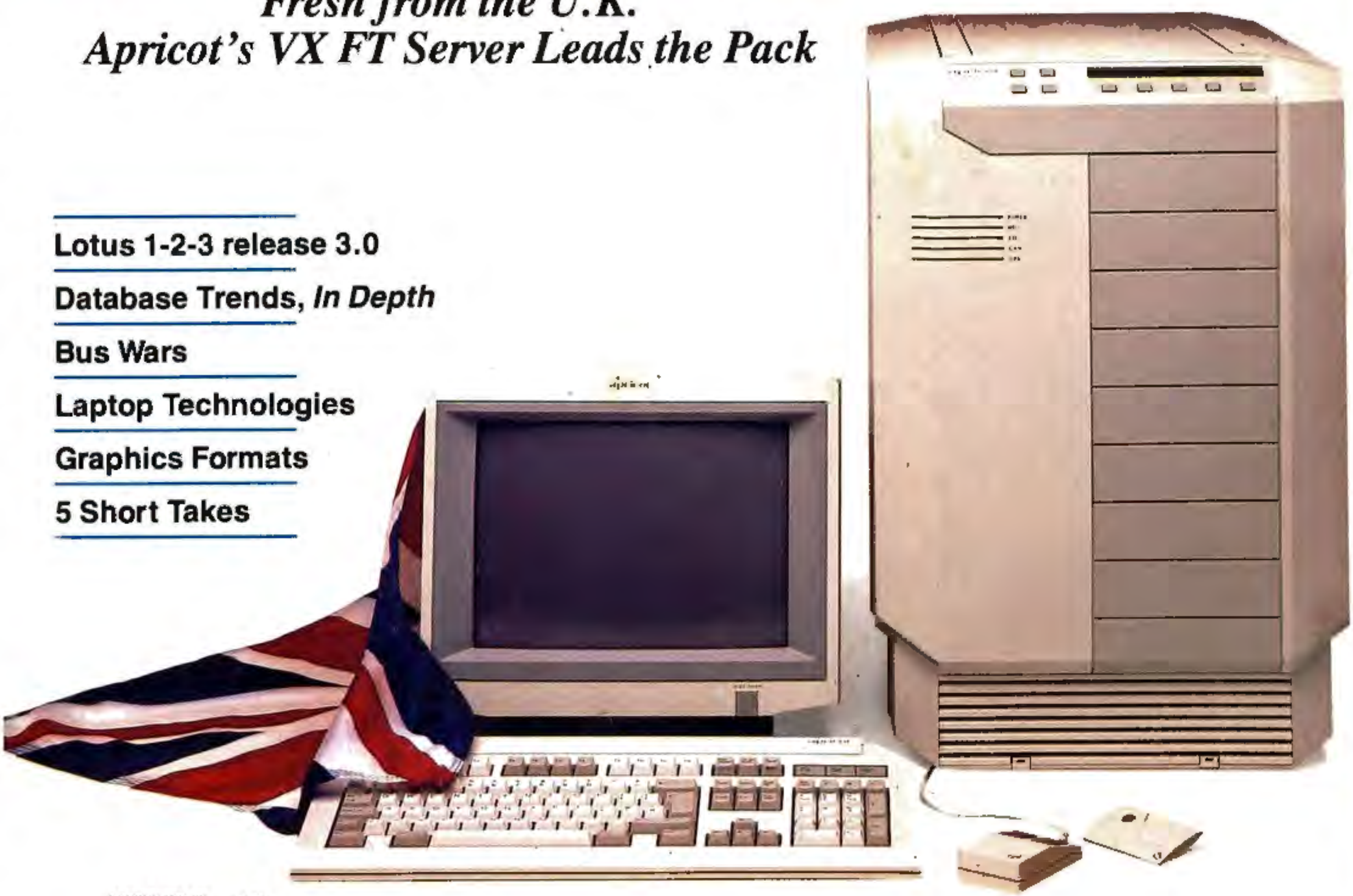

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SEPTEMBER 1989 BYTE APRICOT 80486 • MULTIUSER OPERATING SYSTEMS • DATABASE TRENDS Volume 14, Number 9

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PC MAGAZINE EDITOR'S CHOICE

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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 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 drive controller.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
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△ **Extended Service Plan pricing starts at $251.***

40 MB TTL Monochrome System	$3,699
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Prices reflect 1 MB of RAM. 150 and 322 MB configurations also available.

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Expandable, affordable access to 386 architecture.

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- Page mode interleaved memory architecture.
- VGA systems include a high performance 16-bit video adapter.
- LIM 4.0 support for memory over 1 MB.
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100 MB Super VGA Color System (800x600)	$3,899

Prices reflect 1 MB of RAM. 150 and 322 MB configurations also available.

THE DELL SYSTEM® 220
20 MHz 286

It's faster than many 386 computers. But selling for much less. The footprint is small, too.

STANDARD FEATURES:

- 80286 microprocessor running at 20 MHz.
- Choice of 1 MB, 2 MB, or 4 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 16-bit AT expansion slots available.

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40 MB VGA Monochrome System	$2,999
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100 MB VGA Monochrome System	$3,599
100 MB VGA Color Plus System	$3,899

Prices reflect 1 MB of RAM. External 5.25" 1.2 MB diskette drive available.

THE NEW DELL SYSTEM® 210
12.5 MHz 286.

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

STANDARD FEATURES:

- Intel 80286 microprocessor running at 12.5 MHz.
- 512 KB, 640 KB,†† 1 MB, or 2 MB of RAM expandable to 16 MB (using 6 MB on system board).
- Socket for Intel 80287 math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Integrated diskette and high performance 16-bit VGA video controller on system board.
- LIM 4.0 support for memory over 1 MB.
- Page mode interleaved memory architecture.
- Integrated high performance hard disk interface on system board.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 3 full-sized 16-bit AT expansion slots available.

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20 MB VGA Color Plus System	$1,999
40 MB VGA Monochrome System	$1,899
40 MB VGA Color Plus System	$2,199

Prices reflect 512 KB of RAM. ††640 KB versions of the above systems are available for an additional $80. 100 MB configurations also available.

****Performance Enhancements (Systems 325, 310, 316 and 220): within the first megabyte of memory, 384 KB of memory is reserved for use by the system to enhance performance. 4 MB configurations available on all systems. Call for pricing.***

THE DELL SYSTEM® 325 25 MHz 386.

When you need a truly high-performance 386 computer, this is it.

STANDARD FEATURES:

- Intel 80386 microprocessor running at 25 MHz.
- Choice of 1 MB, 2 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 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 drive controller.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 200-watt power supply.
- 8 industry standard expansion slots (6 available).

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

40 MB VGA Monochrome System	$5,499
100 MB VGA Color Plus System	$6,299
100 MB Super VGA Color System (800 x 600)	$6,399
150 MB Super VGA Color System (800 x 600)	$6,899

Prices reflect 1 MB of RAM. 322 MB configurations also available.

All systems are photographed with optional extras.

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THE DELL 386 SYSTEM 325 HAS A 25 MHz CLOCK RATE, CACHE MEMORY CONTROLLER, IDE OR ESDI HARD DISK DRIVE, PAGE MODE INTERLEAVED MEMORY, AND 100% COMPATIBILITY WITH MS-DOS, OS/2 AND UNIX SYSTEM V.

Technically speaking, the Dell System® 325 is the most advanced 386™ computer we've ever built. And, according to PC Magazine, it's one of the most advanced 386 computers they've ever tested.

In benchmark after benchmark, the 25 MHz Dell System 325 ran circles around a field of 386-based system . A field that included the Compaq® 386/25.

A show of prowess that earned the System 325 PC Magazine's Editor's Choice award.

It was a goal we set for ourselves from the very beginning. And an objective anyone with a penchant for power and performance can appreciate.

THE FIRST PERSONAL COMPUTER THAT'S REALLY PERSONAL.

Of the more than 150,000 personal computers we've sold to date, each one has been individually configured to fit the needs of its owner.

The System 325 takes that idea to its logical extreme.

For example, it runs either MS-DOS,® MS®OS/2, or our own Dell UNIX® System V. Which is compatible with AT&T's System V Interface Definition. And the world of XENIX® applications.

If speed is of the essence, we can include an optional Intel® 80387 or WEITEK 3167 math coprocessor. And since nothing about this system is lightweight, the standard mass storage is a 100 MB hard disk drive. Or we can configure it with a 40, 150 or 322 MB hard drive.

As you might expect, the output is just as intense. You can choose between VGA monochrome with

paper-white screen, VGA Color Plus, or Super VGA for high resolution colors displayed on a larger screen.

Even though the 325 gives you all this performance, it still leaves you six open slots for whatever else you might want to add.

And once you've told us what you want, we'll make sure what you want works—by burning-in the entire system unit.

COMPUTER RETAILERS ARE NO KNOWS.

There are some good reasons computer retailers won't know much about the System 325.

First, with all the new and increasingly sophisticated systems they have to keep up with on a daily basis, you can hardly expect them to know everything.

Second, because Dell sells direct.

Which means you now have the unique opportunity to talk directly with the people who make them. And ask things like, "What is page mode interleaved memory?" or, "How much SIMM RAM should I add?"

In other words, the kinds of details that are important to people who make computers and people who use them.

So dealing direct not only can save you up to the 35% mark-up, but 100% of the frustration.

WE COME WHEN WE'RE CALLED.

One of the things that very clearly sets Dell systems apart from other computers is not just how they're sold but how they're supported.

Overkill was one description used in a recent PC Week article.

Perhaps.

But then, we think you'll agree, when something goes wrong, you want as much help as possible, right?

BEST OF ALL, YOU WON'T HAVE TO EXPLAIN TO A COMPUTER RETAILER WHAT ALL THAT MEANS.

Which is why every Dell system comes with a toll-free technical support line and self-diagnostic software. We're able to solve 90% of all problems right over the phone. The other 10% receive next-day, deskside service. Thanks to our new alliance with Xerox Corporation.

And you get all this help for a full year—whenever you need it—at no extra charge.△

As you've probably guessed, one of the things that drives us most is customer satisfaction.

So we'd like to give you the ultimate guarantee:

Try a System 325 in your office for a month. Run your toughest applications. Put it through its paces, at your pace. If you're not completely satisfied, send it back anytime within 30 days. And we'll refund your money.

No questions asked.

MAYBE YOU SHOULDN'T BUY ONE AFTER ALL.

No matter how many reasons we give you to buy a Dell system, sometimes it makes more sense to lease one instead.

Whether you need a single computer, or an entire office full, there is a leasing plan for your business that is just like 100% financing.

And just as we can custom configure your computers, we can see to it you get a custom designed lease plan to fit your exact business needs.† A fact that has not gone unnoticed. Especially by the Fortune 500. Over half of whom now own or lease Dell systems.

And just as we welcome their business, we welcome your business, too.

Just call us, toll-free. And don't be afraid to ask us the tough questions.

That's the part we like best.

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Now, what else would you expect from a company who is so committed to innovation and high-performance technology that we take you a step beyond. At ALR, we are concerned with your processing needs. Our technical support staff is available to assist you by one simple phone call. All our systems are backed by a one year warranty. Call today for more information on the new PowerCache 4 and the name of an authorized reseller nearest you.

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BYTE

SEPTEMBER 1989 VOL. 14/NO. 9

COVER STORY

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FIRST IMPRESSIONS

REVIEWS

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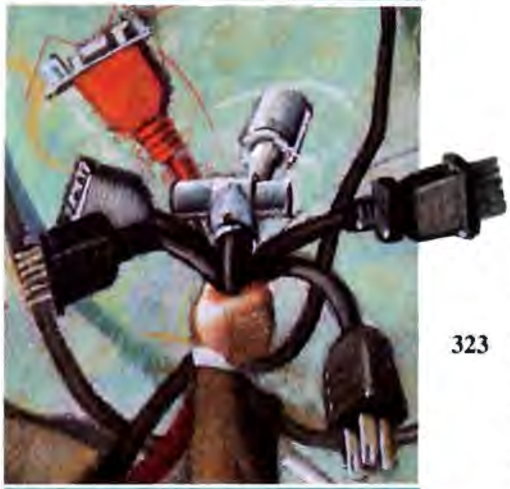
LAN SUPPLEMENT



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A BILLION BITS OF BYTE

BYTE enters its fifteenth year of publication—and you're the reason why

The following note was printed at the bottom of the first table of contents in the first issue of BYTE, back in September 1975: "From inception to press in seven weeks—surely a magazine creation record. Guinness please take notice."

Of course, what really mattered wasn't BYTE's speedy birth, but the rocket-like start of the microcomputer industry itself and the rapid emergence of a group of technically advanced, sophisticated microcomputer users. These people got the personal computer industry started, and the same sort of people drive the industry today. But you know that: You're part of that group.

You, along with millions of other advanced microcomputer users, have also shaped and driven BYTE for the last 15 years and have made it possible for BYTE to reach this computer publishing milestone. It's a happy anniversary for us, and we want to make it rewarding for you, too.

You'll see the fifteenth anniversary logo (above) on at least one specially commissioned article in each of the next 12 issues. These articles will offer valuable commentary on how the microcomputer industry has gotten where it is, what the major issues are today, and what's in store for the future. One example: Because this year is also the twenty-fifth anniversary of BASIC and the fifteenth anniversary of the original Microsoft BASIC written by Bill Gates, we've commissioned Bill to write an article on the state of BASIC today.

Readers Then and Now

Anniversaries are also a time to take stock. Over the years, the magazine has changed in some dramatic ways, evolving along with reader interests and with the changes in the industry. For example, "Photographic Notes on Wire Wrapping" was popular when it ran in 1976, but it would be pretty silly today.

Other things haven't changed at all. For example, like the original BYTE readers, today's readers are among the most knowledgeable, demanding, and eclectically minded microcomputer users there are. Like the readers 15 years ago, they still insist on making their own decisions. They demand objective, authoritative, and unbiased information on the entire spectrum of today's products and technologies—not just on one brand, or one architecture, or one operating system. That's why BYTE has been a platform-independent magazine since its inception.

BYTE readers won't accept superficial reporting. That's why we devote 25 to 50 pages a month to the In Depth section in order to provide you with enormous detail on an important topic. That's also why we rewrote our benchmarks from the ground up to make them the most complete and comprehensive available.

BYTE readers demand definitive product information. BYTE invented the microcomputer review and the head-to-head comparative review (one of each appeared in the very first issue of BYTE). Our benchmarks can be traced back to BYTE's third issue. And a de facto microcomputer lab—the industry's first—followed soon thereafter. Today, with upgrades to the LAN Lab and an expansion of the review staff, our product coverage is second to none.

Our readers insist on timely coverage of important new product announcements. That's why BYTE was first with coverage of the IBM PC and the Mac—long before there were any PC or Mac magazines. And that's why, just in this last year, we've been the first magazine to bring you news of the NeXT cube, the Mac SE/30, the first 33-MHz 80386s, Sun's PC-priced workstations, and this month's cover machine—the world's first 80486-based microcomputer.

Our readers are hungry for information on new technologies. That's why we track important developments from womb to tomb, through their complete life cycle. Breaking technology news appears in BYTE*week*, on BIX, and in the Microbytes section of each issue. The What's New, Short Takes, and First Impression sections follow technologies as they emerge from R&D departments and come to market. Meaty R&D information also appears in feature articles and in the In Depth section.

BYTE readers want to "push the envelope" and extend the usefulness of their computers into new, innovative, and practical areas. BYTE brought you that kind of coverage as far back as 1979, when we published "A Small Business Accounting System," the first solution-oriented microcomputing article.

BYTE readers demand information on the entire world of microcomputing, not just what happens in one place. That's why BYTE covers important microcomputer developments in the Far East, Europe, and North America.

Fifteen Years and Counting

With this issue, BYTE enters its fifteenth year of publication—the only general-circulation computer magazine ever to reach this milestone. The text alone of all those BYTEs adds up to some 150 megabytes—well over a billion bits. We're deeply honored that you've chosen to read BYTE, and we pledge to continue to do our best to meet your high standards—for the *next* billion bits, as well.

Guinness, please take notice.

—Fred Langa
Editor in Chief
(BIX name "flanga")

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PC WEEK POLL: C COMPILERS

	Overall Weighted Score	Overall Reliability	Complete of Command Descript.	Overall Perform.	Complete & Organiz. Document.	Document Clarity	Compiling Process Efficiency	Product Support Quality	Value Relative To Cost	Product Support Access.
Turbo C 2.0 (Borland International)	81	87	79	84	77	78	86	72	70	93
C Optimizing Compiler 5.1 (Microsoft Corp.)	76	83	80	81	78	74	76	68	67	70
C++ 1.07 (Zortech Inc.)	66	68	64	71	63	63	69	60	58	76

"Microsoft was No. 1, but they have been unseated by Borland." PC Week, May 8, 1989

PC WEEK POLL: SOFTWARE DEBUGGERS

	Overall Weighted Score	Overall Reliability	Effective. Programmer Interface	Document. Clarity	Complete. Command Descript.	Complete. & Organize. Document	Overall Perform.	Integration Within Programming Environment	C Compiler Compatibility	Product Support Quality	Product Support Access	Value Relative To Cost
Turbo Debugger 1.0 (Borland International)	84	89	90	81	81	81	89	88	81	73	72	93
Codeview 2.2 (Microsoft Corp.)	73	80	71	72	74	74	74	74	78	67	64	72

"Borland's Debugger outshines Microsoft's Codeview." PC Week, May 15, 1989

It's two winners in one.

Turbo C,* the core of Turbo C Professional, was the outright winner in *PC Week*'s Poll of Corporate Satisfaction on C compilers. Overall, Borland won with 81. Microsoft® placed second.

Turbo Debugger,* also included in Turbo C Professional, was the outright winner in EVERY category in *PC Week*'s Poll Of Corporate Satisfaction on Debuggers. And, once again, we topped the score with 84, overall. Microsoft came in second-best, 11 points behind.

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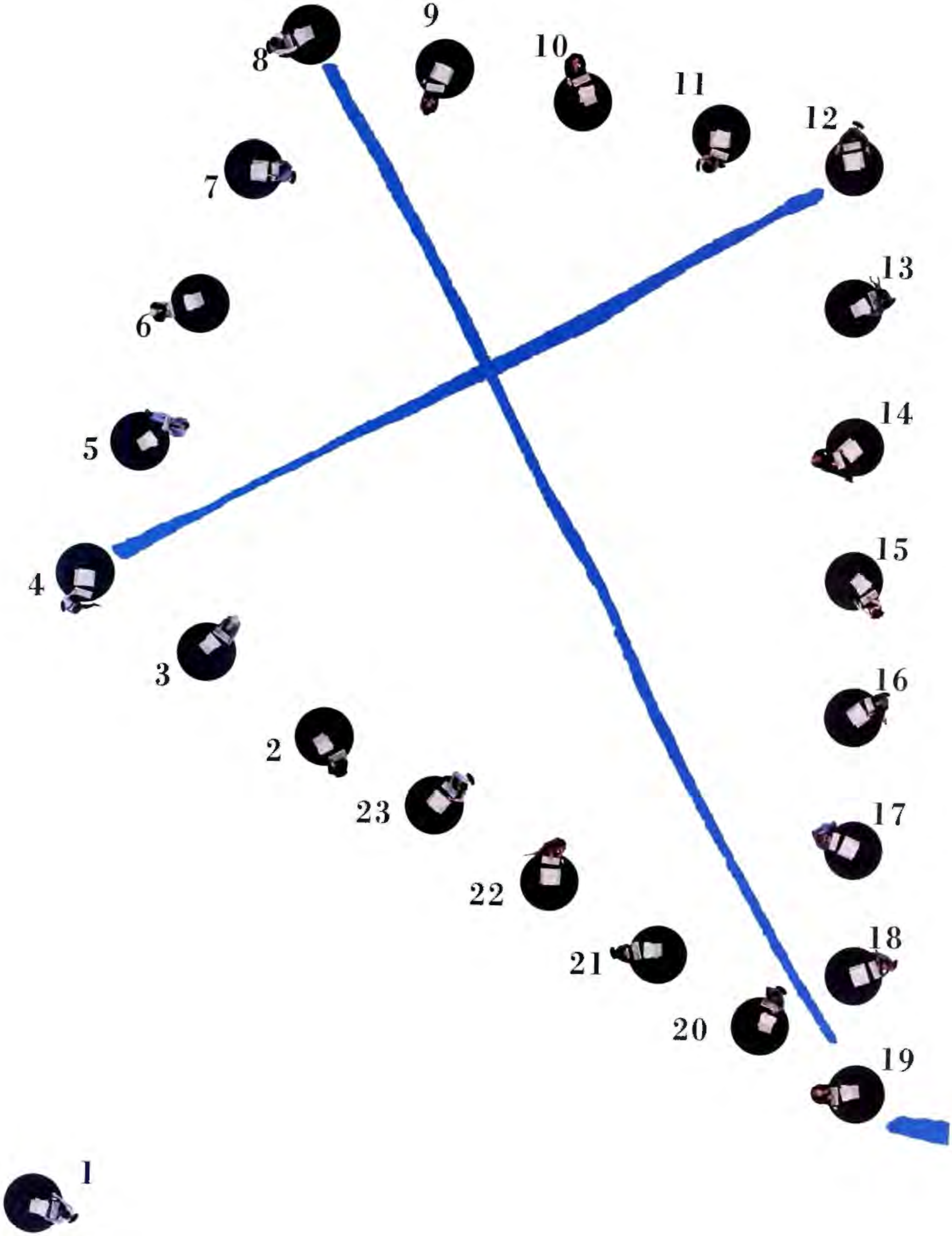
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Staff-written highlights of developments in technology and the microcomputer industry, compiled from Microbytes Daily and BYTEweek *reports*

Mac-Like Interface Brings Another Look to Unix

Unix users who don't like the new user interfaces from the Open Software Foundation (OSF/Motif) or AT&T-backed Unix International (Open Look) will have another choice. A small company called Visix Software (Arlington, VA) is developing a graphical user environment for Unix systems that's similar to the Macintosh Finder. Looking Glass, which will run on any Unix machines that support the X Window System, will provide graphical means for managing directories and files, as well as desktop icon panels, an application launcher, environment control utilities, an on-line help system, and other typical end-user control functions.

Looking Glass's big selling point will be the way it performs and its efficient use of memory, said Visix chairman and CEO Jay Wettlaufer. The Looking Glass interface uses only about 800K bytes of memory, a small amount in the Unix world. A comparable interface based on the Motif interface would use at least twice the memory, Wettlaufer said. He claimed the low memory requirements will make Looking Glass attractive for X Window terminals, which do not support paged memory and therefore must use memory more efficiently.

While Motif and Open Look provide specifications and toolkits for developing a consistent user interface, Looking Glass already is a complete, ready-to-use, end-user interface. So far, no one has released interfaces or applications that conform to Motif or Open Look, although Sun was expected to offer an end-user interface for Open Look this summer.

Applications developers won't have to modify their programs to run under Looking Glass as long as they conform to the X Window standard and use X Window primitives for the screen imaging model, Wettlaufer said. Visix will also offer a version that supports Adobe's Display PostScript.

Visix demonstrated an alpha version of Looking Glass, running on a DECstation 3100, at the recent Xhibition conference in San Jose, California. A beta version was scheduled to start shipping to test sites in July, with final software scheduled for late this month. Looking Glass will sell for $595. If Looking Glass indeed runs on all X Window-based systems and requires no modifications to the host's applications, it could be a way to get a slick, graphical user interface without waiting for applications tooled to run under Motif or Open Look.

First Wave of 4-megabit Memory Chips Arriving, But at What Cost to Users?

The first wave of denser dynamic memory chips is here. IBM, proving that it pays to make your own chips, announced in late July a memory upgrade for PS/2 Model 70s and 80s that uses the new 4-megabit DRAMs. Most other major chip makers are either offering samples of their 4-megabit DRAMs or gearing up for full-tilt production. Hitachi America says it already has the 4-megabit chips in volume. Toshiba, which fabricated its first 4-megabit memories last November, expects to be making them at the rate of 1 million per month by next March. IBM has three facilities in various stages of 4-megabit DRAM production. Fujitsu, Motorola, NEC, Mitsubishi, Oki Electric, Sanyo, Sharp, and U.S. Memories, the new co-op/company formed to produce memory chips in the U.S., all expect to be cranking out the denser memories within the next year or so.

Bigger and faster memory chips are coming, but it's not yet clear what price patterns the new DRAMs will follow in the next year. Except for IBM with its new memory upgrade—$1795 for the 2-megabyte card, $3495 for the 4-megabyte card—none of the companies are yet talking specific

continued

NANOBYTES

After months of rumors to the contrary, the U.S. Department of Transportation announced officially that it will **not impose a ban** that would keep passengers from taking **laptop computers** and other electronic equipment aboard commercial aircraft. Although DOT officials have considered such a ban, a spokesperson for the department said that there would be no significant changes regarding the use or transport of electronic equipment on domestic flights. The Federal Aviation Administration, however, is directing much tighter screening of such equipment on overseas flights by U.S. airlines, particularly in the Middle East and Europe, an FAA spokesperson told Microbytes. The screening will be the tightest on flights coming into the U.S. Earlier this year, an FAA official said a ban on laptops and other devices "is an option we must consider." Traveling computer users were in general aghast at the very idea.

Toshiba Computer Systems (Irvine, CA) **cut prices** on nine of its laptop computers. The cuts ranged from $200 on the low-end models to more than $2000 on the upper-edge 80386-based models. The T1200H, for example, has dropped from $3499 to $2799; the T5200 went down from $9499 to $7699. The company also lowered the price of its 2-megabyte memory module for the T5200 series, from $1399 to $999. Toshiba claims that it has 22 percent of the U.S. market for portable computers.

Top three lessons Lotus CEO **Jim Manzi** said he learned during the saga of 1-2-3 release 3.0: One: "Don't announce new products prematurely." Two: "Keep customers informed" if you don't announce products publicly. Three: 'It's a whole new world out there from a [software] development standpoint."

NANOBYTES

Future display: Sharp Microelectronics (Mahwah, NJ) has developed a new film supertwist (FST) display that incorporates an organic retardation film and a single layer of supertwisted liquid crystal into a thinner, lighter display than is possible with conventional double supertwist approaches, the company says. The FST technology is also better at transmitting light, Sharp says, and can be used in reflective or transmissive LCD panels. "We expect our new film-compensated supertwist technology to become the standard display on equipment whose space requirements are extremely limited," said Steve Sedaker, display products marketing manager for Sharp.

Digital Research (Monterey, CA) reports that it has licensed 2 million copies of its **DR DOS** operating system. DR DOS can run all MS-DOS applications but offers extensions such as hard disk partitions of up to 512 megabytes, password protection for all files and subdirectories, and a help system built behind each utility. DR DOS, which DRI sells to computer manufacturers, can be squeezed into and executed from ROM. The latest computer makers to adopt the ROMable operating system are both from Taipei, Taiwan: Autocomputer, Ltd. for its VIP series, and Sun Moon Star Co. for its SMS line.

The **Computer and Business Equipment Manufacturers Association** (Washington, DC) wants the federal government to **thwart computer viruses**. In a letter to the Senate Subcommittee on Technology and the Law, CBEMA said Congress should aim antivirus statutes at the "criminal behavior" itself rather than at the equipment or techniques used to perpetrate a virus; train law enforcement officials in the ways of computer crime; establish a partnership with companies in the computer industry to develop safeguards; and, above all, make research into viruses a top priority, with the National Institute of Standards and Technology leading the offensive.

prices. Toshiba says 4-megabit DRAMs will achieve "price-per-bit parity" with 1-megabit chips sometime in mid-1990. What Toshiba means by *parity* is that 4-megabit parts will cost "between five and six times the 1-megabit DRAM price." (As a point of reference, 1-megabit chips now cost less than three times what 256K-bit chips do on the retail market.) Toshiba bases its projection on its experience with 1-megabit DRAM chips.

In dollars, many current guesstimators say that the 4-megabit chips will cost about $100 each in big volumes. Some observers are forecasting that the prices will then drop until the memory/price curve is more in line with the current situation. At today's prices, $100 per chip will make the 4-megabit DRAMs considerably more expensive than 1-megabit DRAMs (which are currently selling for about $17 each), even when you consider that it takes four of the less roomy chips to make up one of the 4-megabit devices. If such prices sustain, it would also mean that memory costs would add at least $1000 to the price of a 4-megabyte 80386-based microcomputer to run OS/2 or Unix. If you want a machine equipped with 8 megabytes of RAM, which is sort of what Microsoft had in mind when it first started sketching out OS/2 (in the days when memory was cheaper), you might have to pay $3000 or more for the memory.

Although the 4-megabit chips will eventually be fairly common, there is still a great deal of life left in 1-megabit chips, which continue to drop in price and rise in speed. The technology of 1-megabit chips got a boost this summer, when IBM reported that it has produced what could be the fastest DRAM to ever come off an assembly line. IBM said that the new chip has an access time of only 22 nanoseconds, meaning that it can fetch a bit of information in 22 billionths of a second.

OOP Tools Designed to Make Interface Building Like Writing a Letter with a Word Processor

Delta Logic (Monterey, CA) has designed a set of new object-oriented development tools that could someday show up in the ROM of hand-held computers. The Entryway development software will provide tools for creating user interfaces compatible with IBM's Systems Application Architecture (SAA). Delta Logic, started by former programmers at Digital Research, is a division of Poqet Computer, which is supposed to start shipping its new hand-held microcomputer this year.

The basic concept behind Entryway is to "move the application development process more toward the process of building a letter in a word processor," according to John Hiles, the founder of Delta Logic and now a vice president at Poqet. Entryway operates very much like a word processor, except that it has a set of tools for defining on the screen user-interface objects, such as buttons, forms, and menus. With Entryway, you can construct the text of the application and the objects in the same way that you would write a plain text document. Text can become "live" by attaching an object to a word or phrase, so that when the user clicks on the expression, some action is performed (e.g., opening a database or presenting a data entry field).

The Entryway system is designed for integrating microcomputers into larger office applications without requiring a professional programmer. Basically, if you can write macros in WordPerfect or Lotus 1-2-3, you can probably learn Entryway quite easily. It provides an intuitive way to build interfaces and "front ends" for less technical users.

The core of the Entryway system is a script language of more than 200 statements that are similar to the syntax of the macro language of WordPerfect 5.0. In addition to the script language, Entryway has 12 built-in objects, including a calendar and a timer, a table and index system, a script recorder, and tools for generating forms and menus. Entryway also supports the concept of hypertext, allowing words on the screen to be associated with other text documents (e.g., a programmer could develop context-sensitive help screens wherein the user clicks on the keyword, which then opens the appropriate help screen). The system also comes with a set of debugging tools and facilities for connecting to network drivers so that Entryway interfaces can be used with distributed

continued

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- 8 industry standard expansion slots.**
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- Security keylock.
- AMI bios.
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- MS-DOS and MS-OS/2 compatible.

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NOTE: *Up to 8 MB in SL case. ** 5 expansion slots in SL case.

CSR 286/14 Hard Disk Drives	Monitors / Adapters Monochrome	VGA Mono	VGA Color
20 MB 40 MS ST/506	$1,699	$2,099	$2,399
40 MB 40 MS ST/506	$1,899	$2,299	$2,599
40 MB 22 MS ST/506	$1,999	$2,399	$2,699
90 MB 18 MS ESDI	$2,599	$2,899	$3,299
150 MB 18 MS ESDI	$3,099	$3,299	$3,699

CSR 286/20 SL
CSR 286/20

- 80286 Intel based microprocessor running at 20 MHz.
- 1 MB RAM expandable to 16 MB (8 MB on the system board).*
- Page mode interleave memory architecture.
- High speed VGA controller.
- Track buffered high speed dual diskette/hard disk controller.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Enhanced 101 tactile "click" keyboard with copy holder and dust cover.
- Socket for Intel 80287 or Weitek math coprocessor.
- 1 parallel, 1 serial port and a Microsoft compatible bus mouse port.
- 8 industry standard expansion slots.**
- 3 speed selectable 8 MHz, 16 MHz or 20 MHz speed.
- Power reset switch.
- Security keylock.
- AMI bios.
- Real time clock with battery backup.
- MS-DOS and MS-OS/2 compatible.

Popular Options
2 MB to 16 MB of high speed memory.
20 MHz math coprocessor.
Slim line case with one 5.25" and two 3.5" drive bays accessible.

NOTE: *Up to 8 MB in SL case. ** 5 expansion slots in SL case.

CSR 286/20 Hard Disk Drives	Monitors / Adapters VGA Mono	VGA Color
3.5" 1.44 MB Diskette Drive	$1,999	$2,299
40 MB 22 MS ST/506	$2,599	$2,799
68 MB 22 MS	$2,799	$2,999
90 MB 18 MS ESDI	$3,499	$3,799

CSR 386/20

- Intel 80386 Microprocessor running at 20 MHz.
- 1 MB RAM expandable to 16 MB on the system board.
- Page mode interleave memory architecture.
- Socket for 20 MHz Intel or Weitek math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Track buffered high speed diskette/hard disk controller.
- Enhanced 101 tactile "click" keyboard with copy holder and dust cover.
- High speed 16 bit VGA controller.
- 1 parallel, 1 serial port and a Microsoft compatible bus mouse port.
- 200 watt power supply.
- 8 industry standard expansion slots.
- Power reset switch.
- Security keylock.
- AMI bios.
- Real time clock with battery backup.
- MS-DOS and MS-OS/2 compatible.

Popular Options
2 MB to 16 MB expansion memory options.
25 MHz Intel coprocessor chip.
Internal or external tape backup.

CSR 386/20 Hard Disk Drives	Monitors / Adapters VGA Mono 1MB RAM	VGA Mono 4MB RAM	VGA Color 1MB RAM	VGA Color 4MB RAM
40 MB 22 MS ST/506	$3,099	$4,099	$3,399	$4,399
68 MB 22 MS	$3,199	$4,199	$3,499	$4,499
90 MB 18 MS ESDI	$3,699	$4,699	$4,099	$5,099
150 MB 18 MS ESDI	$4,199	$5,199	$4,499	$5,499
322 MB 18 MS ESDI	$4,799	$5,799	$5,099	$6,099

CSR 386/25c

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- Socket for 25 MHz Intel or Weitek math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Track buffered high speed diskette/hard disk controller.
- Enhanced 101 tactile "click" keyboard with copy holder and dust cover.
- High speed 16 bit VGA controller.
- 1 parallel, 1 serial port and a Microsoft compatible bus mouse port.
- 200 watt power supply.
- 8 industry standard expansion slots.
- Power reset switch.
- Security keylock.
- Award bios.
- Real time clock with battery backup.
- MS-DOS and MS-OS/2 compatible.

Popular Options
2 MB to 16 MB expansion memory options.
25 MHz Intel coprocessor chip.
Internal or external tape backup.

CSR 386/25c Hard Disk Drives	Monitors / Adapters VGA Mono 1MB RAM	VGA Mono 4MB RAM	VGA Color 1MB RAM	VGA Color 4MB RAM
90 MB 18 MS ESDI	$4,799	$5,799	$5,199	$6,199
150 MB 18 MS ESDI	$5,299	$6,299	$5,699	$6,699
322 MB 18 MS ESDI	$5,699	$6,699	$6,099	$7,099

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applications on a network.

The Entryway software costs $795 for a full development system and $250 for a run-time version that you supply with a completed end-user application.

Poqet plans to provide Entryway in ROM on its hand-held computers, with the intention of building interfaces between Poqet portables and home-office networks or database servers, Hiles said. Part of the company's strategy is to build software tools into the ROM of its portable computers, which could thus increase the performance and decrease the storage requirements of these small computing machines.

Can COBOL Be the Catalyst for OS/2?

Could COBOL help make OS/2 a big hit? That might sound a bit unlikely, but remember that there are probably more applications written in COBOL than in any other language. And now MicroFocus, an English company that carved its niche with a mainframe-compatible COBOL that runs on microcomputers under MS-DOS or OS/2, has designed a version of its COBOL/2 compiler that will include extensions for developing Presentation Manager (PM) applications in COBOL; those applications will comply with IBM's Systems Application Architecture. The PM extensions will let COBOL programmers embed the commands necessary to call the OS/2 Resource Compiler routines from the Presentation Manager Toolkit (e.g., routines for defining icons, and maximizing and minimizing windows).

With its PM extensions, MicroFocus claims to be the first firm to offer a programming language other than C that can write applications under OS/2 using the PM graphical user interface. This means that mainframe COBOL programmers will be able to write PM applications running on microcomputers, providing a graphical interface to mainframe COBOL applications. Micro/Focus COBOL/2 can also call C and assembly language routines. According to one of the developers of COBOL/2, Raymond Obin, "COBOL can do everything you can do in C and assembler."

MicroFocus COBOL/2 comes with a programmer's toolkit that will allow use of dynamic segment swapping and dynamic linking, techniques that Borland recently claimed as breakthroughs with its VROOMM technology (see the August Microbytes, page 17). The COBOL/2 implementation of dynamic segment swapping allows applications that are 50 percent larger than available memory to execute with "negligible degradation," Obin said. The toolkit also allows COBOL applications to use extended memory when running under DOS.

The base COBOL/2 compiler is $900. The toolkit, which also includes an editor and run-time utilities, costs an additional $900. A complete workbench with an advanced source-level debugger, menu system routines, and mainframe programming tools costs an additional $1800. Current COBOL/2 users will receive the upgrade free as part of their maintenance agreement.

OSF Seeking Shrink-Wrapped Unix Software

The key to the success of Unix and the Open Software Foundation's Motif graphical user interface will be determined by the number of shrink-wrapped software programs that will run on all versions of Unix, said OSF president and CEO David Tory. In an interview with Microbytes Daily after his keynote speech at Xhibition '89 recently, Tory was deliberately vague about when we can expect programs running under Motif. He said that "many developers are working on applications as we speak," but he declined to give any numbers or an estimate as to when these products will be on the market. OSF, headquartered in Cambridge, MA, has so far issued 73 licenses for Motif, but company officials refuse to speculate on how many of those licenses will translate into Motif-compliant software packages.

Two current OSF Requests for Technology are crucial to the success of Motif and to the success of Unix in the 1990s, Tory said. One RFT is for

continued

NANOBYTES

Intel's Programmable Memory Operation (Folsom, CA) has developed a **4-megabit EPROM**, incorporating 4 million memory cells in a chip measuring just three-eighths of an inch on each side. Since developing the first EPROM in 1971, Intel has increased density of the chips by 2000 times, a company official said.

Rochester Institute of Technology (Rochester, NY) has established a center for the study of **electronic visual design**, geared toward graphics and industrial designers who use digital systems to do such things as animation, developing videodisks and interactive media, and other areas of endeavor.

The newest **still-video camera** from **Sony** (Park Ridge, NJ) uses two charge-coupled devices to handle information about an image's appearance. Sony says the new ProMavica MVC-5000 is the first camera of its kind to have one chip for chrominance data (color hues and levels of color saturation) and another one for luminance (related to contrast and definition). Images scanned by the electronic camera are saved in analog form on 2-inch floppy disks. Before you can manipulate the images digitally, you have to send them to a special Sony workstation. Prices for the ProMavica start at $6495, which doesn't include a lens.

Tiara Computer Systems (Mountain View, CA) says its new LAN analyzer and diagnostics package, currently called "Network Inspector," will provide "60 percent of the functionality of the Sniffer [from Network General] for a fraction of the cost." The Network Inspector is expected to be available soon for around $1000. It will have sophisticated functions such as cable break detection, single- and multinode addressing tests, and dynamic performance measurement (such as network loading measurement) with graphics. More unusual features include jabbering node detection and a software implementation of a time domain reflectometer, used to locate cable breaks, a Tiara official said.

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We kept all the features that have made SummaSketch the industry standard – features that have led to more Summa-Sketch tablets being used today than any other brand.

The industry standard.

You said you wanted a complete plug and play package, not a basic tablet with a list of optional extras. So we're giving you the works – both in PC and Macintosh® SE and II versions. A 12" by 12" or 18" by 12" active area tablet; your choice of a four-button cursor and two-button stylus or 16-button cursor; utilities diskette and more. The PC version includes interface cables for the IBM® PC, PS/2, AT and compatibles, while the Macintosh version has a unique Apple® Desktop Bus interface device to connect the tablet to the computer.

A complete plug and play package.

When asked about the one key benefit you look for in deciding on an input device, your answer was productivity. And SummaSketch II delivers.

Unlike a mouse, our stylus gives you a more natural "pen-to-paper" feel for free-hand drawing. Our 4- and 16-button cursors can be programmed to move you quickly through the most sophisticated software. For the PC market, we offer a free tablet template (US and Canada only) that puts hundreds of software commands in view . . . and at your finger tips. No need to memorize commands or scroll through two or three screen menus to use the functions you want.

Push-button productivity.

IBM Compatible inquiries circle 276; MAC inquiries circle 277, and dealer inquiries circle 278 on Reader Service Card.

No tablet offers more software compatibility than SummaSketch. Our tablets work with over 250 PC programs and all Macintosh SE and II software written under the Apple Software Developers guidelines.

Since we are the standard, most competitive tablets offer software compatibility by emulating Summagraphics tablets (just look it up in their manuals). In fact, in a recent article comparing IBM PC version tablets, all nine competitive tablet manufacturers emulated Summagraphics in order to provide software compatibility.

But that's not all. Our PC version utility diskette also includes diagnostic test and reset software, an Autodesk® Device Interface™ driver, Universal Mouse Emulator™ and a Microsoft® Windows driver.

The most software compatibility.

When it comes to digitizing, the one deciding factor every tablet buyer wants (and every tablet manufacturer touts) is accuracy. SummaSketch II tablets have an accuracy measurement of ± 0.015 inches. This figure is based on the average accuracy found over the entire SummaSketch II surface – not just a "sweet spot" found in the center of the tablet. And both the 4- and 16-button cursors come with an easy-to-view cross-hair sight for precise tracing.

SummaSketch II tablets also come with high proximity so you can trace from documents up to ½" thick. And selectable resolution of up to 1,016 lines per inch (or twice the degree of resolution needed for most graphics applications).

High accuracy and control.

Add up all the benefits, then add in convenience features such as a power/proximity light, on-off switch, wedge shape design for easy use, lightweight construction for portability – and it's easy to see why SummaSketch has been, and will continue to be, the best selling tablet in the world.

Whatever the application – CAD/CAM/CAE, business or design graphics, animation, cartography, cost estimating and more – SummaSketch is the overwhelming choice of today's computer professionals. Simply stated, you can't go wrong or be "second-guessed" when you choose SummaSketch, which is why more people make that buying decision than any other.

The choice of professionals.

The deciding question – price. Would you pay more to get a tablet that has everything in the box, that gives you the most software compatibility, a choice of cursors and includes added productivity tools?

That's the one decision you don't have to make, because SummaSketch II tablets come with everything you need, all at an affordable price. And that makes our new SummaSketch II tablets the easiest buying decision you have to make.

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NANOBYTES

A Bay Area company is readying a new **sound and music board** for IBM PCs and compatibles that will provide stereo sound, voice synthesis, voice digitization, and even a MIDI port, all for less than $200. **Brown-Wagh Publishing** (Los Gatos, CA) already makes a $100 board called the Game Blaster that can output stereo sound and is supported by popular games from Sierra On-Line and others. The new Killer Kard will output stereo music and digitized sounds such as animal calls, voices, and special effects. It will also digitize sounds or speech input through a microphone, using direct memory access for speed and a proprietary compression algorithm to conserve RAM. The card has a host of interfaces, including a speaker connection (with a built-in amplifier powerful enough to drive room speakers), a microphone jack with amplifier, an analog joystick connector, and a MIDI interface for keyboards or instruments. The Killer Kard should be available in October.

A new adapter from **Ten X Technology** (Austin, TX) is designed to let most WORM drives connect to computers through a SCSI port. The Ten X OCU adapter makes the WORM drive appear to be a normal read/write device; this makes the WORM drive much easier to install and use.

Thomson-CSF, the gigantic Paris-based producer of military electronics equipment, said it will "standardize" its defense products on Motorola's **88000** RISC processor. Motorola also granted Thomson the rights to manufacture a militarized version of the 88100 CPU, the 88200 memory management unit, and future components in the 88000 series. Motorola says that more than 50 companies are designing products based on the 88000. One of the latest computer designers to announce a computer built upon Motorola's RISC chip was **Bolt Beranek and Newman**'s Advanced Computers subsidiary, which has developed a machine using more than five hundred 88000 processors.

an Architecture Neutral Distribution Format, which would allow software developers to write a single version of their Unix program that, theoretically, would run on most of the 200-plus existing versions of Unix. The other RFT is for a method of standardizing distributed processing—an interface between application programs and network protocols, device drivers, and kernel code.

A few technical details of Motif have yet to be ironed out, Tory said, including a final decision on which imaging model to use; the imaging model handles the way in which fonts and graphics are put on the screen. Motif currently uses a component of MIT's X Window, but it's not clear what the finished Motif will use. Tory called Display PostScript "excellent technology" but admitted that Adobe's refusal to hand over its source code to OSF has made Display PostScript somewhat less appealing.

An official of AT&T-backed Unix International, which is developing its own Unix user interface called Open Look, said recently that AT&T would support development of a common application programmer interface for both Open Look and Motif. Such an API would theoretically make it easier for developers to write applications that would work in both environments. The OSF can't get behind this idea, however. Donal O'Shea, OSF vice president of operations, dismissed the proposed API as an attempt to "confuse the issue." He said Motif "clearly is the winner in this race." When asked why developers should write programs for OSF/1, the OSF's forthcoming version of Unix, when AT&T's System V is a composite of earlier versions, Tory said that OSF will be providing a "nonproprietary solution."

Motif consists of components from several leading companies in the computer industry. DEC provides the library of graphical tools and presentation description language; Hewlett-Packard provides the window manager; and Microsoft, which is not an OSF member, gives it all the "look and feel" of Presentation Manager.

OSF officially offered Motif to "the industry at large" in July and planned to release the "fine-tuned" version 1.0 in late August, a company official said. Cost of a binary license now ranges from $40 down to $10, depending on the number of copies.

Group to Start Testing 88000-Based Software

The 88open Consortium has established a technical center (in San Jose, CA) devoted to developing binary compatibility standards for the Motorola 88000 RISC processor. The basic set of compatibility tests will be ready this month, said 88open official Roger Cady.

The 88open Consortium began operating last November; original sponsors include Sanyo/Icon, Motorola, Data General, NCR, Opus Systems, and Dolphin Server (a subsidiary of Norsk Data). As part of its "software initiative," the collective is hoping to attract developers to write programs for the 88000 RISC platform. Ryan McFarland, Quadratron Systems, Accler8 Technology, Statware, UniPress, and Olympus Software are among the companies that have said that they will develop 88000-compatible applications.

To back up its promises of binary compatibility, 88open recently demonstrated a series of public domain Unix applications running on four different 88000 platforms: Data General's Aviion, Opus Systems' Opus 8000 board for the PC AT, a Motorola VME-based 88000 system, and the Sanyo/Icon 88000 machine. Each system was equipped with a QIC-format tape drive, and it was possible to swap the applications between the systems. The 88open compatibility standard defines a data format for floppy disks and QIC tape.

Notably, the demonstration involved only simple text-based applications and no graphics programs. While 88open's plan for "plug and play" software applications looks promising, the big question is whether all the vendors can agree on graphics standards. The same problem applies to OSF's goal for shrink-wrapped software. While both 88open and OSF have specified X11 as the windowing standard, it is unclear what imaging model will be standard (the imaging model defines the text fonts, icons, and other graphical images that appear within the window). For example, DEC, which is a major OSF player, is

continued

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using Display PostScript as its imaging model. Other OSF members are currently either undecided on an imaging model or using the limited font set that comes with X Window.

Until a standard imaging model exists, it will be impossible to simply run applications out of the box on a variety of systems. Application developers will have to write separate versions of programs for separate imaging models. That's exactly what Frame Technology has done with its FrameMaker desktop publishing program. The company has written separate versions for Display PostScript systems, Sun's X11/NeWS system, and the X Window-based imaging model from MIT. An engineer at Frame said that most of the porting time between systems involves converting the imaging model.

User Group to Vendors: Try a Little Friendliness

Some companies are better than others at working with the very people who provide them with their revenue—the users. According to members of the Intergalactic Users Group, those companies are Apple Computer, Acius, Borland International, Intel, and Microsoft. At the second Intergalactic Users Group Officers Conference in New York City recently, representatives from nearly 100 of the country's most active computer users groups awarded certificates of appreciation to those five companies for their efforts in working with users groups.

As for other companies in the computer industry, too many of them still need to be educated about the value of users groups, said Jerry Schneider, executive director of the Association of PC Users Groups. "They have this stereotype that we are a bunch of teenagers making copies of software," he said.

Schneider said that one study noted that more than 60 percent of future computer hardware and software sales will be to individuals and companies with fewer than 50 employees, rather than to the Fortune 500 firms that many computer companies seemingly envision as their customers. "Users groups provide the way to reach that 60 percent of future customers," Schneider said.

Microsoft Joins SQL Tool with Excel

Microsoft is now offering a Windows-based Structured Query Language query tool as a component of the DOS version of the Excel spreadsheet program. The Q+E (for Query and Edit) system works only with dBASE database files(DBF files).

Q+E, developed by Pioneer Software (Raleigh, NC), appears as a series of additional menu choices in Excel's Data menu selection. Adding Q+E to Excel involves a simple setup procedure when you install the spreadsheet program. Q+E is also a stand-alone product that runs under Microsoft Windows and can exchange data with any Windows application.

The Q+E facility allows you to graphically query and perform relational operations on DBF-type files and bring the data into an Excel spreadsheet. For example, you could open multiple files in multiple windows and simply click on the columns needed in a relational join. Using Microsoft's Dynamic Data Exchange feature in Windows, links between Excel and the database accessed by Q+E are maintained, so the Excel spreadsheet is updated if you make changes to the database.

Programmers can also use Q+E to embed SQL query commands into Excel spreadsheet cells.

NANOBYTES

Roland (Los Angeles), famous for its electronic music instruments, has a new device that one company representative said is "really a 3-D plotter." Actually, the CAMM-3 is a **computer-controlled miniature machining tool**. You can use AutoCAD to design something in three dimensions, then attach the CAMM-3 to your computer's parallel or serial port, and clamp a block of plastic, wax, wood, aluminum, or brass in place, and the CAMM-3 will carve out your design. At $14,500 it's a little more expensive than the average PC plotter, though.

Autodesk (Sausalito, CA) has given "technology demonstrations" of a work-in-progress at the Autodesk Research Lab. "Cyberspace" uses a head-mounted display with separate LCD screens for each eye, a head-tracking device that changes the display with head movement, and a Dataglove for reaching into the display. It's not a product yet, but Autodesk insists that this is where CAD is going. The company also announced new versions of AutoCAD: One uses the Phar Lap 386 DOS extender and is supposed to be available by the end of the year and cost $3000; another is AutoCAD OS/2, which will run under Presentation Manager and is slated to be available in the fall.

GUIs are the equivalent of "hanging **a big rock** over the head of character-based DOS," said Bobby Orbach of 47th Street Computers, one of the nation's largest dealers, at a recent panel discussion. He called DOS extenders "life extenders," and said that from a dealer point of view, "Macintosh and DOS are the only stable operating systems."

It was a comparison that almost every citizen in New England could understand. Lotus CEO Jim Manzi told company shareholders that during the long, fabled time between 1-2-3 release 3.0's announcement and actual shipping dates, the company had become "the moral equivalent of the **Boston Red Sox**."

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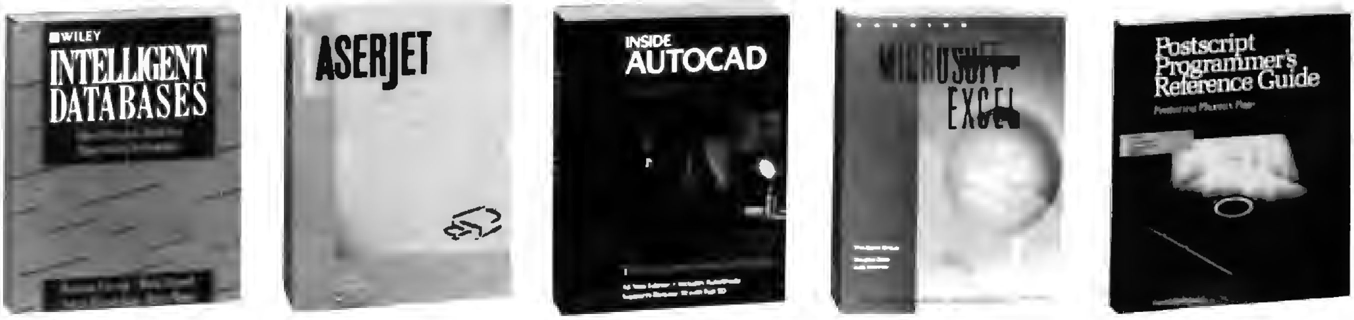

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LETTERS

and Ask BYTE

Suggestion Box: Mac OS

"The Mac Interface: Showing Its Age" by Don Crabb (Macintosh Special Edition, June) made some very good points, particularly that the lack of genuine multitasking on the Macintosh should be an embarrassment to Apple Computer.

While I believe that some of Crabb's suggested "improvements" would be frivolous rather than functional, multitasking and a command-line interface for those who want to use it should be high on Apple's list of priorities. On the other hand, I'm not going to hold my breath waiting for these capabilities.

I use a Mac II at my office, but when I decided to buy a new machine to use at home, I selected the Amiga 2000 precisely because it offered both of those utilitarian features. Perhaps Crabb should try an Amiga.

On the matter of Apple's "look and feel" legal claims, I must take issue with the views expressed in Crabb's article. The Macintosh user interface did not originate at Apple Computer, and Apple should not be permitted to make any claims against other "similar" products based on that supposition. Xerox was the originator of the windowed mouse-and-icon environment. No doubt the original designers of that system are amused by the pretensions of Apple's lawyers.

It is a serious defect of our legal system that it permits patent and copyright claims to be awarded based on the "earliest filing date" rather than the actual date of creation. I hope Apple's spurious claim will be struck down eventually by some sensible judge who believes in the spirit of the law rather than merely the words on the page.

Gary Lee Phillips
Chicago, IL

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Ackerman Function Revisited

Alf P. Steinbach (Letters, April) elegantly solved Christopher Greaves's challenge to show the value of Ackerman(5,5). Unfortunately, Steinbach's generalization about operations is wrong. He showed that the Ackerman function is a variation on $x \text{ op}_m y$, where op_1 is addition, op_2 is multiplication, op_3 is exponentiation, and op_4 is the next step above exponents. In other words,

$x \text{ op}_3 y = (((x\,x)\,x)\,x)\ldots x]$ y repetitions of x

and

$x \text{ op}_4 y = (((x^x)^x)^2)]$ y repetitions of x.

Some interesting observations arise for operations above addition (for m an integer, $m > 1$):

$$x \text{ op}_m 1 = x$$
$$1 \text{ op}_m x = 1$$
$$2 \text{ op}_m 2 = 4$$
$$x \text{ op}_m 2 = x \text{ op}_{m-1} x$$

I take exception to the general equation

$$x \text{ op}_m y = x \text{ op}_{m-1} (x \text{ op}_m (y-1)),$$

which has the effect of collecting parentheses of an expansion to the right. This is true for op_2 and op_3, because the expansions are commutative. Close inspection of the concepts of "operation" and "number" leads to the conclusion that these expansions of parentheses (i.e., order of operation) must collect to the left. This leads to a different general equation for higher operations ($m > 1$):

$$x \text{ op}_m y = [x \text{ op}_m (y-1)] \text{op}_{m-1} x.$$

Jeremy Broner
Palo Alto, CA

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Optimizing Compilers

The past few years have seen a lot of activity in the development of optimizing compilers. Unfortunately, most of these compilers are doing the wrong optimizations.

Compilers should optimize those things over which the programmer has no control, not trivialities that can easily be expressed in the source language. Examples of such useless optimization include common subexpression elimination, loop invariant removal, and loop unrolling. There is no point in developing a program to recognize situations that could benefit from these techniques because they are all common sense—any programmer other than a complete novice should automatically write code that cannot be optimized by such basic mechanical analysis.

There are many useful optimizations that should be performed that cannot easily be accomplished by simple local source code rearrangement. These include in-line expansion of functions called only once and reorganization of program routines so that functions that often call each other are closer together, so shorter call instructions can be used.

Optimization shouldn't compensate for sloppy programming. Optimizing compilers should try to generate the best possible code for a program *the way it was written* and not try to analyze whether the program could have been written more efficiently. There's no sense in developing huge, complex programs to do what can already be done simply.

James Hague
Richardson, TX

Amiga Graphics Set Right

I am writing in regard to "Variations on a Screen" by Phillip Robinson (Graphics Supplement, April).

I was offended that the IBM PC and Mac screen shots were both of professional applications, while the Amiga screen shown was that of a game. There are many professional applications on the Amiga for desktop publishing, two-dimensional and three-dimensional rendering and animation, word processing, spreadsheets, video titling, synthesizer programming and control, terminal emulation, image processing, and so forth. Why not show the interfaces of one of these if you couldn't use Amiga artwork?

By the way, why didn't you mention what system produced the ray trace on the cover of the supplement? Could it have been an Amiga?

I also take issue with the statement that "Because these chips [the Amiga's custom graphics, data movement, and audio processors] can handle video information while the main CPU is working on other tasks, the Amiga has a degree of 'multitasking'—the ability to handle more than one job at a time." The custom chips give the Amiga a degree of *parallel multiprocessing*. Multitasking is an attribute of an operating system, not of hardware. Of course, the Amiga's operating system has more than a "degree" of multitasking, with both large- and small-grain multitasking, priorities, interrupts, message passing, and shared program libraries.

Robinson's categorization of the possible Amiga display resolutions is incorrect. The resolutions mentioned are the nonoverscanned resolutions; for each of 320 by 200 pixels, 320 by 400 pixels, 640 by 200 pixels, and 640 by 400 pixels,

continued

there are corresponding overscan resolutions, nominally 352 by 262 pixels, 352 by 524 pixels, 704 by 262 pixels, and 704 by 524 pixels. These overscan resolutions are another good reason to use the Amiga in video work, because overscan is required to properly fill a video screen. Note that the Hold and Modify (HAM) mode can be used in any low-resolution mode. Note also that all these resolutions can be displayed simultaneously, through the use of multiple, slidable intuition screens.

The statement that video RAM is separate from system RAM is not correct—at least not if Robinson is speaking of what is known on most systems as a frame buffer, the area of RAM reserved for the displayed images. In the case of the Amiga, the bit maps for graphics must be located in the lower 512K bytes (1 megabyte in newer machines) of system memory, as must audio waveforms, disk I/O buffers, and any other data to be accessed by the custom chips. There is no limitation on what else can be kept in this lower area of memory—programs, data stacks, and so forth are perfectly acceptable. In fact, while it cannot multitask more than a couple of large Amiga applications (or five to eight smaller ones), a 512K-byte Amiga is perfectly capable of running programs and displaying graphics simultaneously.

The statement that the custom chip can manipulate five bit planes is misleading. The Amiga hardware reference manual does not mention such a limitation. In fact, HAM-mode images use six bit planes, and they're easily manipulated using a blitter and the Copper.

The statement that the next release of Denise will incorporate a 64-color screen mode is misleading. Except for the earlier Amiga 1000s, almost all Amigas can already use extra halfbrite mode. Another statement, that the Amiga's smaller market share has led to a smaller library of programs, is also misleading. Both the Mac and the IBM PC have been around for more years than Amiga. Remember, more than 1 million Amigas have been shipped. This is a number to reckon with, and it will continue to grow.

Also, despite Robinson's statements to the contrary, the Amiga comes with more standard simultaneously displayable colors than the Mac II (4096 as opposed to 256). And for less than a third of the price of a Mac II, that doesn't seem a bad buy. But even if the Amiga had fewer colors, it seems contradictory to say in one sentence that "The Amiga has also fallen behind the Mac II in the sheer number of colors that can be displayed on the screen—and so is less competitive as a design and industrial or business graphics tool," and then in the very next sentence to say, "The Amiga's real strength is shown in pure graphics tasks such as games, animation, and video work." After all, what requires more realistic rendering capability—CAD and business graphics, or video painting and animation? It should be obvious that Robinson is indulging in some wishful thinking in this case.

Mark Cashman
Windsor, CT

Software Despotism

Like Ezra Shapiro ("Software Despotism: Truth and Fiction," May), I have felt the pressure to conform to computer software that I didn't like simply because the boss wanted everyone to standardize. Of course, the software of choice is what the boss wanted to use, not what any of

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the rest of us liked.

I work in a U.S. government laboratory, and most of our computer work is word processing, which we do periodically. For some years now, my personal favorite has been Microsoft Word, especially because of its excellent editing control via the mouse. But my supervisor demands that we all write with WordPerfect, whether we know how to use it or not. I'm not smart enough to remember both sets of commands at the same time, so I decided to switch to WordPerfect to make it easier on myself.

It really hurt a few weeks ago when I tried to go back to Microsoft Word and found that I couldn't remember the codes anymore. By then, I'd learned about exporting foreign file formats, but I figured, why bother? To add insult to injury, we are now doing collaborative work with another laboratory that uses Microsoft Word exclusively. After final editing is complete, I convert the finished files into Microsoft Word for the other laboratory.

Michael D. Kawalek
Corvallis, OR

ASK BYTE

Failing Memory

In November of 1988 I upgraded from an Atari 800 to a 10-/12-MHz AT with 512K bytes of memory. I bought the machine from American Semiconductor of Tampa, Florida. The clock wouldn't hold the time and date, so I returned the system and received in exchange an 8-/12-MHz baby AT board with only 1 megabyte of memory available on the motherboard. (The original machine could accept up to 4 megabytes on the motherboard.)

After *four* more motherboard replacements—due to various failures—the company told me that I had to take back the baby AT board, like it or not. The person I contacted also told me that it's cheaper and better to get a memory card.

I have read that memory on the motherboard is faster. Also, I can't afford to lose an expansion slot.

I would appreciate your opinion on this situation.

Tony D. Kyritsis
Ft. Lauderdale, FL

Motherboard memory is generally *faster. If the memory chips have low enough access times, the CPU can access them at up to the CPU clock rate, rather than the (usually slower) bus speed. Card-based memory could be as fast, or faster, if the motherboard memory requires a few wait states or the bus speed is cranked beyond the standard 8 MHz.*

If the machine inserts wait states, don't expect 12-MHz performance. If the bus runs faster than 8 MHz, expect compatibility problems with I/O cards built for the standard AT bus.

Perhaps most important, you have the right to get what you ordered. If your original order explicitly requested the machine with a 4-megabyte memory capacity, a vendor can't force you to accept another product.—S. A.

Protection, Please

I have a compact-size Seagate ST-225 hard disk drive on my AT clone. I would like to install a write-protect switch or at least devise foolproof write protection in software. Is there any way to do this?

Louis Robichaud
Montreal, Quebec, Canada

The hard disk drive you refer to is connected to the standard AT disk controller through two cables. One is a 34-pin control bus that normally has connectors for two drives. The other is a smaller cable that passes raw data to or from the disk controller. The 34-pin cable handles all the command and status communications between the disk and the controller; it's the cable I'll focus on.

Pin 6 is a signal called −WRITE GATE, which goes from the controller to the drive and tells the drive when to enable writing. Normally high, the signal goes low whenever the controller wants to write data to the drive. Pin 12 is −WRITE FAULT, which goes low only when the drive cannot perform the write operation and needs to inform that controller that a catastrophic failure has occurred. One way to write-protect a drive is to prevent the −WRITE GATE from getting through to the disk and simultaneously fool the controller into thinking that the write operation has failed.

You'll want to find a spare disk cable, a double-pole, double-throw toggle switch, and a good hobby knife. Identify lines 6 and 12 in the larger 34-pin cable. Carefully split along the sides of the two lines about an inch or so somewhere between the controller side and the first drive connector. Having isolated the two lines, cut them in half, separating the drive side from the controller side. Connect the switch as shown in figure 1. If you choose to mount the switch on the back of your microcomputer, use some longer wire as necessary, but keep the cable lengths to a minimum.

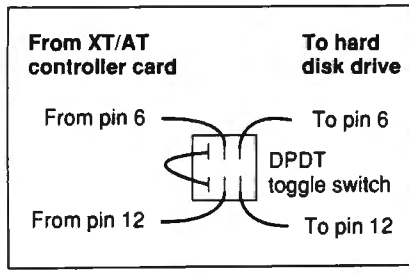

Figure 1: *Switch-wiring diagram for write-protecting a hard disk drive.*

Turn off the computer and exchange your modified cable for the one in the machine. Try copying files with the switch in each position. The write-protected mode will cause a "general failure" message during writes because of feedback from the −WRITE GATE to the −WRITE FAULT.—H. E.

Breaking the 32-megabyte Barrier

I have an 80286 PC clone with a 40-megabyte hard disk drive, 640K bytes of RAM, cache memory, and VDisk. What would be a good interim solution for breaking the 640K-byte RAM and 32-megabyte disk barriers until OS/3 (or whatever they'll call the 80386 version of OS/2) is available? When OS/3 shows up, I'll probably buy an 80386 machine.

Kenneth L. Dunn
Olmsted Falls, OH

I've heard this question numerous times (see "Breaking the Barrier" in the May Ask BYTE), and the answer always depends on what you're doing with your microcomputer.

If you need DOS, the surest way to break the 32-megabyte disk barrier is with DOS 4.0 (see "PC-DOS: Pulling Out the Stops," June BYTE). But if you're not tied to DOS, you can solve both memory and disk restrictions by installing Unix on your machine. The Santa Cruz Operation (400 Encinal St., P.O. Box 1900, Santa Cruz, CA 95061, (800) 626-8649) markets an 80286 Xenix. Going with Unix would allow you to upgrade to an 80386 without switching to a new operating system.—R. G.

More Fax

In the past two years, optical character recognition (OCR) boards have gone down in price and up in efficiency. But one thing that hasn't changed much is the price of the necessary scanner.

Most fax machines have a fine mode,

continued

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which has good enough resolution for OCR. It seems to me that a fax interface could be incorporated on the OCR board. The board would give the fax machine the signal to begin transmitting, make the A/D conversion, and calculate the scan rate and linear conversion to use the fax signal. I see quite a market for such a board. What are the problems?

Robert R. Stevens
Phuket, Thailand

I believe you're describing the fax-machine-on-a-board technology, which has progressed rapidly in the past year. Products of this type can now be had for about $400 or so. It would be a simple matter to have the fax call up the microcomputer with the fax board and transmit the digitized document to the microcomputer. What's missing then is the software to feed the received fax to the OCR board. A few hundred dollars will get you the necessary file-conversion software and drivers. Contact the manufacturer of the OCR board you'd like to use.

With scanners now down to $1000, it might be easier just to buy an inexpensive scanner. If you've just spent thousands on a good OCR board, you'll have to spend $400 or more for a fax card and a few hundred more on software.

Another approach to your problem is to turn to the class of fax machines that incorporate storage and serial connections for computers. They were made specifically to work in the way that you've described. You connect the output of the fax machine directly to your computer. When you feed in the document, the fax acts like a scanner, sending the digitized document to the microcomputer. Fax management software can send this to an OCR board or software product, convert it to a graphic for desktop publishing, and so on. Fax machines with this capability are available from Canon and other manufacturers. There is commercially available software that does all the necessary routing and conversions. FaxMate from Bright Ideas (87A Ocean St., South Portland, ME 04106, (207) 767-6031) performs all these functions, as well as using the fax as a modem and a printer.

—H. E.

Model 100 Goes to School

Some years ago I purchased a Tandy 100 laptop. Now I want to use it as an electronic notebook for college. How do I dump my files from it to my IBM clone (a 12-MHz 80286 machine)?

Arthur L. Peasall
APO, NY

continued

You have fine taste in computers—the Model 100's light weight and good battery life make it an excellent choice for taking notes (I own a Model 100 myself).

The Model 100 has a standard RS-232C serial port that supports all the expected speeds up to 19.2 kilobits per second. To connect it to an AT clone, you'll need a cable that looks like what I've shown in figure 2.

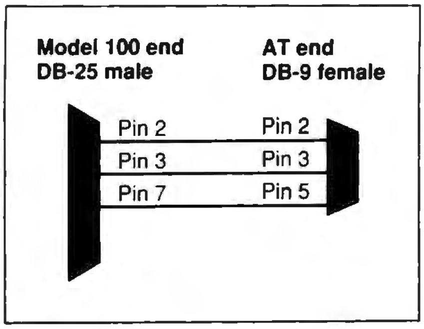

Figure 2: *Diagram for a PC AT-to-Model 100 cable.*

Find some telecommunications software for your AT that can handle ASCII file transfers with XON/XOFF handshaking. Almost anything will do. Connect the cable and set the AT to full-duplex, 2400 bps, no parity, 8 data bits, and 1 stop bit. From the Model 100 main menu, move the cursor to TELCOM and press Return. Press F3 for STAT(us). For 2400 bps, the status setting is 68N1E. Press F4 for TERM. Type a few characters on the Model 100; you should see them appear on the AT. Test the setup on the AT, too.

When you're ready to transfer a file from the Model 100 to the AT, start the software on the AT side "receiving" or "downloading" an ASCII file. On the Model 100, press F3 (Up). Enter the filename and press Return. After the file is transferred, stop the AT's receive operation. The file you receive on the AT will still be formatted for the Model 100. Paragraphs are represented as one long line with a carriage return at the end. Depending on your word processor, you may need software to convert the carriage return character to a carriage return/linefeed pair.

To send a file to the Model 100, set the AT to "send" or "upload" a file. If possible, make sure that the AT strips off linefeed characters. Press F2 (Down) on the Model 100 to start the transfer. Enter a filename and press Return, and then start the receiving process on the AT. You may want to try other transmission speeds; check your Model 100's documentation for changing the data transfer rates.

A less-technical means of saving files on the AT is a product called Disk+ from Personal Computer Support Group (4540 Beltway Dr., Dallas, TX 75244, (214) 404-4008). Disk+ is a ROM chip that fits in the Model 100 and a disk that you load on your AT. You connect the cabling between the computers and run both software packages. You simply position the cursor over the file you want to transfer, and Disk+ automatically sets the data transfer rates and transfers the file. You'll still need to do some simple file conversions to use the file in your AT's word processor. Personal Computer Support Group will even sell you the cable if you don't want to make it yourself.

By the way, if the keyboard noise bothers your fellow classmates, gently pry off the keytops and place small orthodontic rubber bands around the keyswitch posts. This cuts down on the noise.—H. E.

continued

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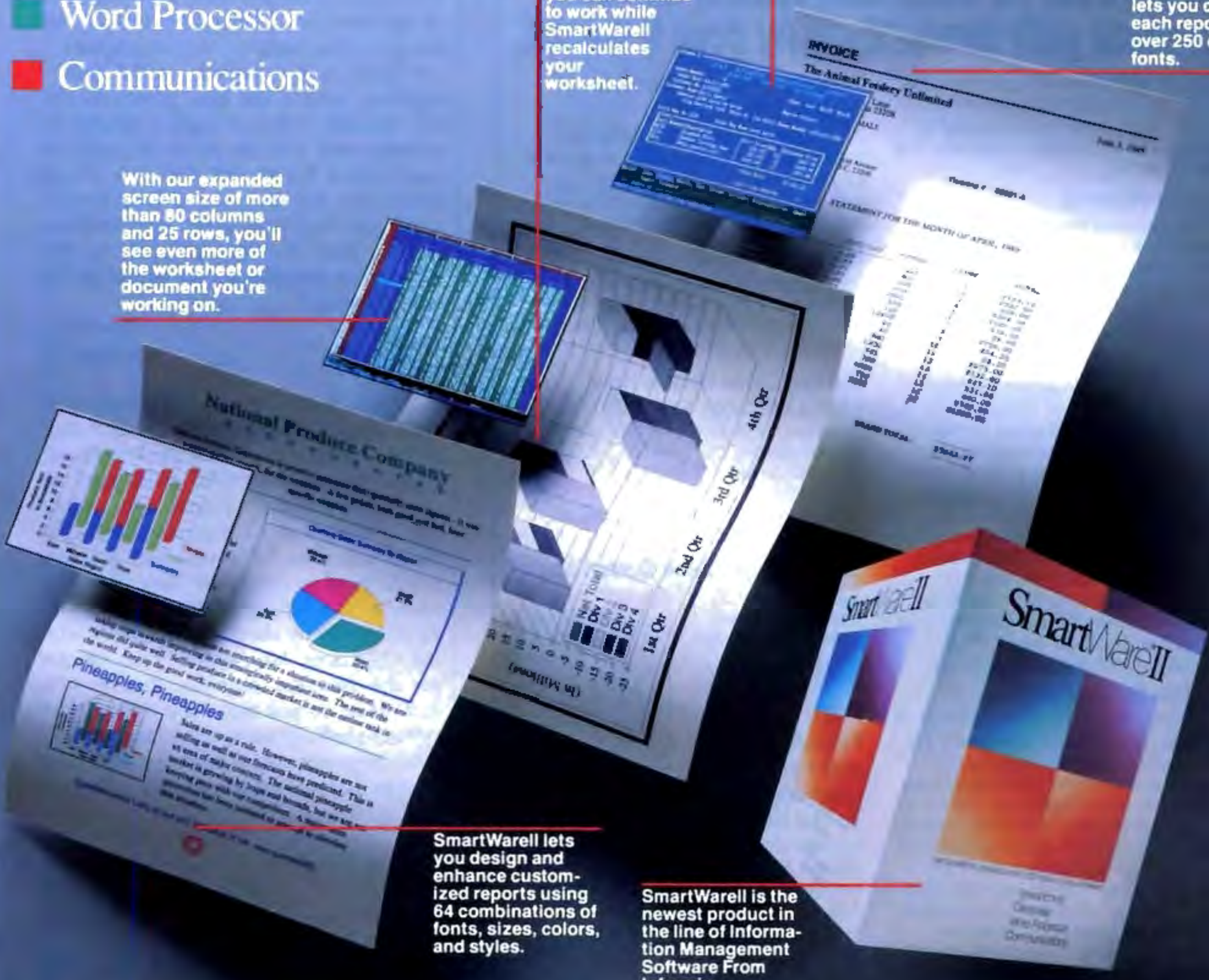

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What's in a Word?

I am interested in the structure of .EXE program files. By reading explanations about the .EXE header layout in various books on DOS, I have come to understand all but one item, the *word checksum* at byte offsets 12–13 hexadecimal. I have experimented with it by plugging in a variety of arbitrary values in a couple of .EXE-format programs, but the programs have always loaded and run with no problems.

How is this value calculated, and how is it used when the program is loaded and running?

Ronald Rowley
Laurel, MD

The item you describe is the one's complement checksum of all the words in the .EXE file. This item is calculated by LINK (as LINK is creating the .EXE file), such that if you add together all the words of the .EXE file, the result (ignoring carries) is hexadecimal FFFF. The idea was that when you went to execute an .EXE file, DOS would calculate the file's checksum and refuse to run the program if the result was anything other than FFFF (indicating a possible corrupt file). To date, I haven't found a version of MS-DOS that pays heed to the checksum. It appears that you haven't, either.—R. G.

Multiple Monitors

I have an XT clone, a monochrome monitor, and a TV monitor. I also have an IBM monochrome card, a color graphics card, and a Hercules-compatible graphics card. Right now, I have the monochrome card and the color graphics card in the machine. I can output text on the monochrome monitor, but not graphics.

I'd like to do graphics on the monochrome monitor and play games on the TV monitor. I plan to replace the monochrome card with the Hercules graphics card, but a friend said that this would break my motherboard (two graphics cards can't be placed in the same motherboard). Can I output graphics to the monochrome card and play games on the color monitor?

Daniel Fu
Austin, TX

It is possible to combine Hercules and CGA graphics adapters in the same machine, but there are a few qualifications. First, you need an IBM CGA card or clone with composite output. This will let you connect your CGA card to the TV for the price of an RF modulator. Second, you'll need to configure your Hercules clone to run in half mode, so that it will be able to share the display segment with the CGA card. Most applications written for the Hercules graphics card require full mode, so you have trouble with off-the-shelf software. One last caution: The composite output from the CGA card may be suitable for games only.—S. A.

FIX

In a June What's New item ("HyperPad Goes DOS") and a July Short Take ("Desktop Manager with Hypertext Power") on HyperPAD from Brightbill-Roberts, we mistakenly referred to HyperPAD's scripting language as HyperScript. The actual name of the scripting language is PADtalk. HyperScript is a registered trademark for the programming language used in WingZ by Informix Software. ■

CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

Unix Multitasking

Dear Jerry,

Your latest endeavors in Unix have caught my attention. I work in MS-DOS, the Mac operating system, and Unix, and I prefer Unix more each day. I'm afraid that your statement about Unix not doing multitasking is 100 percent wrong. The real problem is that the non-network version of Q&A Write was not designed to work in a true multitasking environment. It was designed to work in a single-user environment, and when it finds another copy of itself running, it assumes that you are trying to violate your copyright.

DESQview gets around this not by actively multitasking but by using an automated fast context-switching scheme. It's probably just a simple round-robin system without dynamic load balancing or any other optimization. Since you just have a context switch and only one active process at a time, Q&A cannot tell that it has been loaded more than once.

In Unix, multiple processes know who their user is, but Q&A isn't aware that the user of one process is the user of the other process, because it doesn't bother to check. You see, Unix processes are not special cases for certain situations; they are generalized and carry enough information to allow them to identify themselves, their owner, their environment, and more.

I applaud your looking into Unix, and I think that since we now have microcomputers powerful enough to support Unix properly, we will see more powerful applications. With you pointing to trouble spots in Unix, we may see a new level of refinement and performance for users. With the interprocess communication and networking abilities of Unix, we should see the visions of Mitch Kapor materialize. The types of things he wants to do may be impossible on an MS-DOS, CP/M, or Macintosh operating-system machine.

Tony Dean
Douglasville, GA

Clearly you know more about Unix than I do, but my point was then and is now that Unix remains a guru-friendly system that requires wizardry to get and keep it running. If you have access to a wizard, it's probably wonderful.

I keep hearing about new Unix-based systems that won't have that problem. So far, I haven't had a chance to run one.

Steve Jobs once said that no one in his right mind would use Unix as the operating system for a new computer. He has clearly changed his mind. Perhaps new versions of Unix will change mine.

—Jerry

Under-the-Desktop Keyboard

Dear Jerry,

The usual low-budget recourse to lack of work space is to get a flush door and set it across a couple of sawhorses or small bookcases (and in cases of absolute necessity, cinder blocks), but usually either the keyboard or the table is at the wrong height. Enter the keyboard drawer, but, as you once remarked, these are not made long enough (or perhaps deep enough) for a mouse beside the keyboard.

My solution to this problem (actually, I needed space for a digitizing tablet rather than a mouse, but the principle is the same) was to buy a pair of keyboard drawer slides. These are full-extension slides like those on file drawers, but they have hanging brackets to screw onto the bottom of a table. They provide a drop of about 3 inches, which gives you a keyboard height of 26 inches or more under a standard 29-inch table. All you need then is a piece of ¾-inch plywood—whatever size you want—and you're home free. My slides are made by Knape & Vogt (Model #8100). The 14-inch size (the smallest) is about right for a keyboard, and a pair costs $12.05. I hope this helps.

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."

On another subject, I have recently converted most of my computing operations from CP/M (and HDOS) to MS-DOS, and I miss some of the nice touches that I used to be able to write into the programs I used. So I'm looking for a disassembler that will let me do some customizing—particularly on dedicated application programs like AutoYACHT, which I use to fair up the lines of new designs. I have seen a program called The Sourcer reviewed with pretty favorable comments. Do you have any experience with it? Or do you know another, preferably reasonably priced, program?

Michael Porter
Chebeague Island, ME

That's a great idea. My present computer table is large enough and has a mouse platform, but the whole thing is 48 inches wide, which is larger than I like.

I'm contemplating rearranging the office—we're doing a CAD plan first, using Generic CAD (although we have AutoCAD, which is superb, I thought I'd try it with something more affordable for readers). I should have thought there would be hardware to let you do that, but somehow the idea hadn't sunk in. Thanks.

I've heard reasonable things about The Sourcer, but I have not used it. I fear I haven't disassembled a program for at least five years. Sigh. There's no better way to really learn what's going on.

—Jerry

Not Seeing Red

Dear Jerry,

I have a Zenith FTM display, model ZCM-1490, and I have experienced intermittent problems with the red gun. When I come to work in the morning and turn on my computer, there's about a 50 percent chance of no red for 15 minutes or so until the monitor warms up. I verified that the problem was in the monitor by putting a second monitor (a multisync type) on my desk and swapping the video cables (I have rewired the cable on my FTM to be the same 9-pin connector as the multisync). Lately, the red has also disappeared a few times in the afternoon. Unfortunately, intermittent problems don't tend to show up when you bring the item in for service, so I have resigned myself to occasionally lacking red until the problem worsens.

That's not the only problem I've had. When I got my first FTM, I showed it to some people in the office a couple of times. Then, after the accumulated "on" time was about 20 minutes, it got really bright and out of focus for a little while, and then it went blank. A trustworthy coworker suggested the high-voltage section as the culprit. The local Heath/Zenith dealers swapped it for free with the one they had, which is the one that is now having the red problem. I'm lucky that those first 20 minutes of demos were done on a PS/2 VGA before I rewired the cable.

Despite these problems, I am enthralled with the image quality of the FTM. I am using it with the Pepper SGT board from Number Nine Computer Corp. While this board may be a bit pricey for most people ($1995), devoted programmers may find it worthwhile. It contains two graphics coprocessors; the Intel 82786 provides hardware windowing support and "canned" graphics functions, and the TI 34010 provides programmable graphics functions. This is the only display board I know of that provides this absolutely essential combination of functions. Hardware windowing means that different regions on the screen have their own pointers to bit maps, so independent smooth scrolling of each region can be accomplished by changing pointers rather than moving huge amounts of data. Programmable graphics functions are needed because it is impossible for the chip designers to think of all the graphics algorithms that you will need.

There is not much off-the-shelf software that can really take advantage of this board, other than AutoCAD and Lotus 1-2-3 with customized drivers. I suspect that Windows and Presentation Manager currently treat the screen as one big bit map rather than allow the graphics driver to maintain separate bit maps for each window; if this is true, I hope things will evolve.

The connector on the Pepper SGT board is a DE9 (common 9-pin) type. At the time I purchased the Zenith FTM, I wanted to make an adapter but could not find a female DE15 connector (15 pins in the space of 9) to mate with its video cable. Therefore, I cut off the FTM's factory DE15 and replaced it with a DA15 (normal 15-pin) and then used an adapter cable to get down to 9 pins. However, now Radio Shack sells male and female DE15 connectors.

Kevin C. Scott
Rochester, NY

Like you, I've had problems with the FTM, but the darned thing is so glorious—glare-free, under horrible lighting conditions—that it doesn't matter. It's wonderful.

It's also the only American-made monitor on the market, to the best of my knowledge.

Thanks for the tip. I've had a horrible problem finding proper cables. Nowadays I call the folks at Candy Cable of San Diego and let them worry about making the darned things up. They do it for not a lot more than I could do it myself, and theirs are much neater.—Jerry ■

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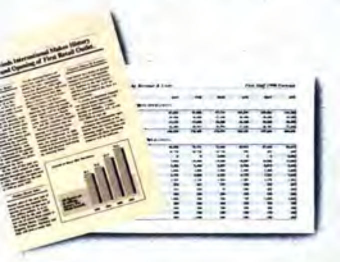

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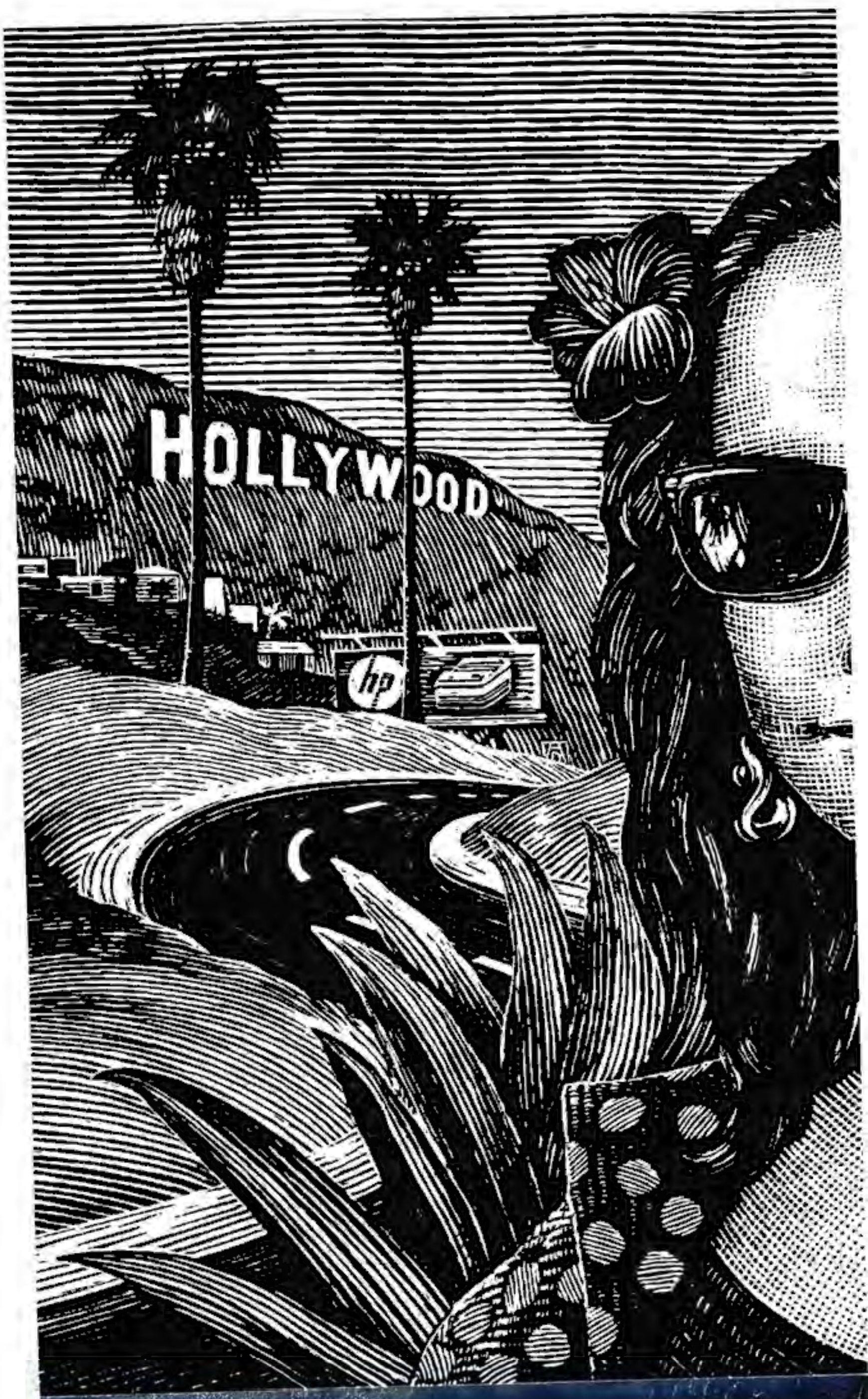

S C A N J E T

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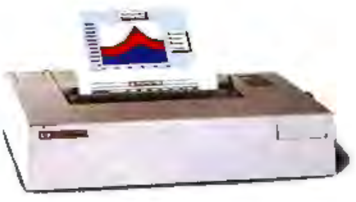

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Price: $1950; with 20-megabyte drive, $3125.
Contact: GRiD Systems Corp., 47211 Lakeview Blvd., P.O. Box 5003, Fremont, CA 94537, (415) 656-4700.
Inquiry 1115.

Dynabook Introduces Modular Notebook

A notebook-size computer called the Dynabook 286 has a modular design. There's a processor/keyboard/disk unit, a display unit, an optional battery, and an optional "docking station" for quick attachment to printers or other peripherals.

The processor unit is based around a 16-MHz Harris 80C286 (with an optional 12-MHz 80287 math coprocessor). It includes 1 megabyte of one-wait-state, 100-ns RAM (expandable to 4 megabytes) and a full-size keyboard. A 1.44-megabyte 3½-inch floppy disk drive is standard, and built-in 20-megabyte or 40-megabyte hard disk drives can be ordered.

The detachable blue-tinted display, only $\frac{7}{10}$-inch thick, uses electroluminescent backlit supertwist LCD technology and measures 11 inches diagonally.

For power, the Dynabook 286 uses either an unusual dry lead acid battery, which has the same dimensions as the computer and is only ½-inch thick, or a lightweight but bulky AC power adapter. The 2- to 4-hour battery does not need to be "deep charged"; instead, it can be topped off like a gas tank. It also weighs 5 pounds, bringing the full weight for a mobile version of the Dynabook to more than 14 pounds (not including the hard disk drive). The company says the AC adapter includes built-in surge suppression.

The 2-pound docking station snaps onto the back of the computer with two big latches. On the back are a parallel port, two serial ports, and ports for an external keyboard, mouse, VGA monitor, and AT expansion bus.
Price: $4695; with 20-megabyte hard disk drive, $5195; battery, $249; docking station, $299.
Contact: Dynabook Technologies, 6150 Stoneridge Mall Rd., Suite 225, Pleasanton, CA 94566, (415) 847-0660.
Inquiry 1116.

SEND US YOUR NEW PRODUCT RELEASE
We'd like to consider your product for publication. Send us full information, including 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.

From VCRs to Computers, Emerson Reaches Out

Emerson Radio charged into the personal computer business this month with three low-end, low-priced systems that offer something new.

For example, Emerson commissioned Microsoft for MS-DOS 3.3 in ROM. You can also order DOS on disks, but the company says it plans to upgrade all DOS-in-ROM models with talking capabilities sometime later this year. Spoken DOS, a company spokesperson said, will be possible with video-compression software technology licensed from UVC.

The company's first machine, the 8000EC, is a small-footprint 10-MHz 8088. It features a pop-up training and menu program designed to guide beginners through bundled word processor, spreadsheet, home accounting, and financial management packages. It's expandable, too, with four open 8-bit slots.

A new 16-MHz 80286 system and a 16-MHz 80386SX system feature SynOptics sound chips. For music synthesis within a range of eight octaves, models 8286EC and 8386EC feature 12 amplitude controllers, six mixers, six frequency generators, and two noise generators.

All systems include DOS, keyboards, and monitors.
Price: 8000EC, under $600; 8286EC, under $900; 8386EC, under $1000.
Contact: Emerson Computer Corp., 5500 East Slauson Ave., Commerce, CA 90040, (213) 722-9800.
Inquiry 1114.

continued

E-Machines' high-resolution NuBus monitor.

A 16-inch NuBus Monitor for Tall Applications

The TX SE/30 16-inch color monitor for the Mac SE/30 features the standard 1024-pixel width, but the display is slightly taller than normal, at 808 pixels. Resolution is 76 dpi, the refresh rate is 72 Hz, and dot pitch is 0.31 mm.

The included NuBus video controller features a 32-bit data path and a full megabyte of dedicated video memory, enough to easily display up to 256 colors. It operates at either 1 or 8 bits per pixel. Software included with the monitor lets you adjust brightness and contrast, and it also automatically dims the display to a preset level.

Outside dimensions are 19 by 19 by 21 inches, and it weighs 86 pounds.
Price: $4495.
Contact: E-Machines, Inc., 9305 Southwest Gemini Dr., Beaverton, OR 97005, (503) 646-6699.
Inquiry 1120.

Tape Backup Runs off Floppy Disk Drive Controller

The Excel 40AT and Excel II 40fi are 40-megabyte cartridge-based tape backup systems that operate off your computer's floppy disk drive controller.

Both the 40AT, for AT-based systems, and the II 40fi, for most PS/2-based systems, fit in the open half-height floppy disk drive slot and back up data onto DC 2000 minicartridges. Data backup speed is rated at up to 3.8 megabytes per minute. Both subsystems use the QIC-40 recording format.

The subsystems also feature background formatting, which lets you run applications during tape formatting, and 100-inch-per-second fast forward, seek, and rewind.
Price: 40AT, $499; II 40fi, $549.
Contact: Everex Systems, Inc., 48431 Milmont Dr., Fremont, CA 94538, (415) 498-1111.
Inquiry 1119.

Output Technology Speeds Up Dot Matrix

Output Technology's Model 2132 printer is an affordable alternative to today's laser printers, if blistering speed is of utmost importance.

High-speed draft mode is rated at 350 lines per minute, the company says, based on impact tri-matrix technology. You get three 9-wire print heads and four print modes: high-speed draft, draft, correspondence quality, and near-letter quality (two-pass printing).

The following printer emulations are included: Epson FX-286e, IBM Proprinter XL, and Printronix P6000. The buffer size is 8K or 512 bytes, user-selectable. And you can get the 2132 to print in several additional print styles, like bold and superscript.

The 2132 weighs 70 pounds and measures 27 by 11 by 20 inches. Paper handling for forms and fault detection are included. Options include twin-axial and coaxial interface cards for networking.
Price: $3995.
Contact: Output Technology Corp., East 9922 Montgomery, Spokane, WA 99206, (509) 926-3855.
Inquiry 1121.

Experience the Resolution

By increasing video amplifier bandwidth and scan frequencies, and by using a custom controller, Flanders Research has produced a 3300- by 2560-pixel monochrome monitor that's priced about the same as its 1024- by 768-pixel brethren.

Designed for high-precision CAD, desktop publishing, and other demanding applications, it's of the 300-dpi noninterlaced variety with a landscape display.

Both the 15- and the 19-inch monitors have a video amplifier bandwidth of 750 MHz and a horizontal scan frequency of 210 kHz, the company claims. That compares to standard video amplifier bandwidths on other high-resolution monitors of 100 or 150 MHz. Standard horizontal scan frequencies for VGA monitors are 31.5 kHz and are 35.5 kHz for monitors adhering to the 8514/A specifications.

The high resolution is also the result of a new CRT concept, which involves mounting a high-precision electron gun to a glass bulb, Flanders says. Hughes Aircraft also contributed a new paper-white phosphor that's optimized to produce a flicker-free display. In cooperation with Discom, Flanders developed a yoke capable of handling more than 15 A of deflection current at the horizontal scan frequency of 210 kHz.

The custom controller will emulate EGA, which also makes it compatible with Hercules, Flanders says. But there won't be initial support for VGA or 8514/A standards.

You'll need to purchase your operating system (DOS) and your graphics environment (Microsoft Windows or GEM Ventura) separately; Flanders' first video controllers fit inside the monitor.

OEMs are developing proprietary controllers for both the IBM PC and Macintosh markets, the company says. Flanders also plans to release a SCSI-based controller and DOS-based software in October.
Price: $3490; 19-inch, $4490; controller, $3000 to $3500; total 19-inch system, under $7000.
Contact: Flanders Research, Inc., 88 Bartley Sq., Suite C-6, Flanders, NJ 07836, (201) 584-0116.
Inquiry 1118.

continued

MFLOPS at RISC

The PL1250 32-bit Floating-Point Array Processor from Eighteen Eight Laboratories will give you 12.5 million floating-point operations per second, 50 percent more than the company's previous version.

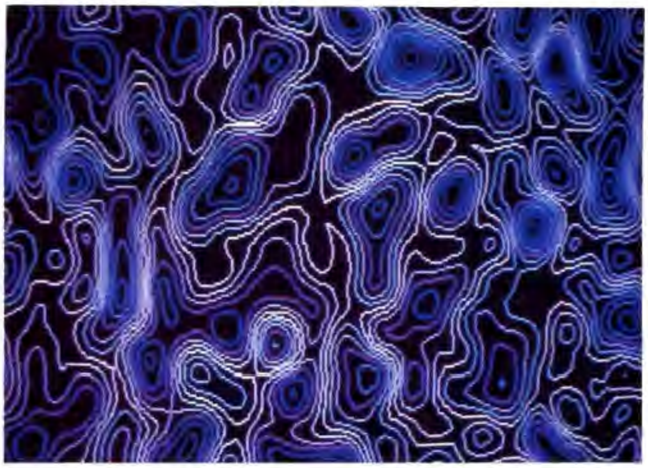
The PL1250 also comes with software that will manage up to eight PL processors in a single system, which provides a capacity of 100 MFLOPS, Eighteen Eight claims.

Key to the board's performance is a 16-bit RISC processor. It has 21 16-bit registers and completes nearly all instructions in a single 160-ns cycle time. And because DRAM memory can't support the memory-access rates required by the RISC chip, each board has 60K bytes of on-board static memory.

To best use the board's parallel-processing capabilities, Eighteen Eight includes support software in the basic package. You write a FORTRAN, C, or Pascal control program that calls fundamental library routines supplied by the PL processor.

The library comprises 473 routines that perform logical and arithmetic operations on arrays, vectors, and matrices in PL memory. Typical control programs first transfer data to PL memory, make calls to operate on the data in PL memory, and finally transfer results to the host system for display or storage.

You can run the PL1250 on XTs, ATs, and compatibles through an 8-bit bus slot.
Price: $2695.
Contact: Eighteen Eight Laboratories, 771 Gage Dr., San Diego, CA 92106, (619) 224-2158.
Inquiry 1129.



The PL1250 can provide one 100 MFLOPS for every XT.

Voice Processing Takes Two Steps

In separate developments, two companies recently introduced speaker-independent speech-recognition systems for personal computers. Voice Processing contributed an intelligent board that doesn't need to be taught and lets your AT hear better, even over noisy telephone lines. Meanwhile, Scott Instruments introduced a low-priced traditional system (i.e., it needs to be taught) that can theoretically recognize 160 different words.

Voice Processing's VPC 1000 is a board for your IBM PC AT that works with your telephone to recognize up to 13 spoken words. And unlike most voice-recognition systems, the VPC 1000 doesn't need hours of programming with live voice samples.

It works even if the words are spoken without pause over noisy telecommunications lines. Voice Processing claims that the VPC 1000 can recognize "all American English dialects by adult speakers."

The board comes with an 80386, 1 megabyte of memory, the TMS320C25 signal processor chip, and speech-recognition software. It installs in a single slot and has a standard RJ-11C connector.

It recognizes "yes," "no," and the words for the first 10 digits in our decimal system, including "oh" and "zero."
Price: $5500.
Contact: Voice Processing Corp., One Main St., Cambridge, MA 02142, (617) 494-0100.
Inquiry 1123.

The need for sophisticated voice-recognition systems in both training and telephone applications spawned Scott's SIR Model 20 voice-recognition board.

It's a full-length 16-bit card with a TMS320C25 running at 40 MHz, an application-development software package, a microphone headset, and a reference manual.

Recognition speed is rated at 95 ms if it's loaded with a 40-word vocabulary. A 64,000-word vocabulary (including samples from all the dialects it needs to recognize) can be accessed in 120 ns, according to Scott.

There is, however, quite a long and steep learning curve to use this board. The company says it will take one person about two weeks to organize voice samples from 50 people. If organized correctly and with enough different types of samples, the accuracy rate can approach 95 percent, the company says.
Price: $2495; board only, $1495.
Contact: Scott Instruments Corp., 1111 Willow Springs Dr., Denton, TX 76205, (817) 387-9514.
Inquiry 1124.

Audio F/X Creates Sound Effects

The Audio F/X is an 8-bit audio board for your XT or AT that inexpensively combines music, MIDI, and digital recording and playback.

Using special software drivers, you can create sound effects such as ocean waves, jet engines, footsteps, and almost anything imaginable, Forte claims. Or you can create music in stereo and teach the fundamentals of music theory, including pitch differentiation, note recognition, and attack, decay, sustain, and release.

You can play up to six voices simultaneously and support digital recording and playback at sampling rates greater than 40 kHz. On-board amplifiers let you cable directly to stereo speakers.

Included with the board are three software packages. Sonata is a music software editor that helps you create and edit musical scores using as many as six independent instruments.

Sound Editor is a digital editor for direct manipulation of sound waveforms. Syncom is an interpretive language that lets you experiment directly with sound effects.
Price: $299.
Contact: Forte, 72 Karenlee Dr., Rochester, NY 14618, (716) 427-8595.
Inquiry 1126.

continued

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

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Relational and Network Model Technology for Programming Flexibility. Retrieve a record fast using the relational keyed access method and all related records can be immediately available using the network model. You decide how to combine these for best application performance.

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Network Database Model	✓	
Multiple database access	✓	
Referential integrity	✓	
Automatic recovery	✓	
Record & File locking	✓	
RAM resident		✓
db_QUERY 2.1 SQL-based Query:		
Relational Query & Report Writer	✓	
db_REVISE 1.0 Database Restructure Program:		
Total database redesign/restructuring	✓	
Operating Systems*: VMS, ULTRIX, UNIX	✓	
BSD 4.2, SunOS, XENIX, MS-DOS,	✓	
Macintosh and MS Windows, OS/2 compatible	✓	
C Compilers*: Most compilers supported	✓	
C++ compatible	✓	
LANs*: 3COM, Novell, Banyan, AppleShare	✓	
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SOURCE CODE AVAILABLE:	✓	
ROYALTIES: (Absolutely not!)		✓✓

*Other environments are supported; call for complete list.

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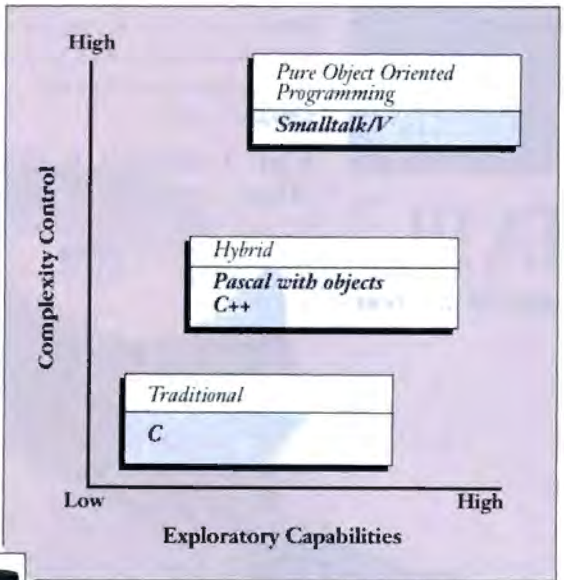
Smalltalk/V.® Designed to blow the doors off the hybrid languages of the programming world. Smalltalk/V does prototyping the same way Shelby prototyped the Cobra... using a blend of technical expertise and seat-of-the-

"Anyone can build a prototype by the by the seat of your pants." – CARROLL SHELBY

Creator of the legendary Shelby Cobra

pants savvy that's startlingly sophisticated. First you doodle, design, dream. Then you explore the possibilities and begin to assemble the prototype. You test. You tinker. You change. And you keep on changing and test-driving and refining until the prototype is just the way it was



meant to be. With no compromises... of any kind. But the most remarkable thing is this prototype is not just a prototype. It runs, it races, it performs like the real application. Because it is the real application. And you achieve this feat without once having to go through the old "crash and burn" kind of programming so common with languages born in the age of mainframes.

COMPLEXITY CONTROL FOR THE 1990s AND BEYOND.

The concept behind an object-oriented programming system is relatively simple. You build more complex objects out of simpler ones. Much as you can build complicated designs with a Lego set. With Smalltalk/V a programmer can write a piece of code and then

Cobra. Just the name of it struck fear into the hearts of race car drivers of the '60s. Le Mans. Sebring. Targa Florio. Suddenly a Texas drawl was replacing Italian accents in the winner's circle. His philosophy was simple and salty: "It doesn't matter whether you're building an outhouse or a car. You don't compromise."

THE "AM I READY FOR SMALLTALK/V" CHECKLIST

- ☐ Does a lot of your work involve prototyping/exploratory programming?
- ☐ Are many of your problems difficult to define?
- ☐ Are external factors constantly changing?
- ☐ Do you like to make changes from insights gathered along the way?
- ☐ Do you feel torn between efficiency and conceptual clarity?
- ☐ Are you developing for MultiFinder or Presentation Manager?
- ☐ Are you tired of needless crashing?
- ☐ Are team projects getting harder to manage and complete on time?
- ☐ Has your creativity been intimidated by the rigorous demands of the process?

book. But you create a legend

With Smalltalk/V your mouse becomes a hot programming tool for either your Mac or your PC. You'll find that Smalltalk/V is souped up with lots of other high performance features, too. The Class Hierarchy Browser, Inspector, Debugger, Class Browser, Method Browser and Walkback window are all standard equipment.

reuse it again and again. The "inheritance" factor lets you create, enhance and refine your applications without constantly having to re-invent the wheel. Or, as one programmer put it, "With Smalltalk/V you can write a fugue without having to build the piano."

OOPS! LOOK WHAT THE WORLD IS COMING TO.

"The software of the future, OOP promises not only to boost programmer productivity but also put powerful computing capabilities in the hands of non-techies."

—*Business Week*

"Traditional computer languages and interfaces with their structure and detail, have appealed to those of us who are left-brained (more logical and analytical). On the other hand, object-oriented languages and interfaces, with their emphasis on perception and the whole picture, invite those of us who are right-brained (more artistic and intuitive) to join the computer revolution as well."

—*Byte*

"Object-oriented programming is the key to the next great transition in personal computing."

—*NY Times*

AT THESE PRICES IT'S CERTAINLY NOT MONEY THAT'S HOLDING YOU BACK.

Smalltalk/V (DOS 512K RAM)	**$99.95**
Smalltalk/V 286 (286 or 386 1.5 MB RAM)	**199.95**
Smalltalk/V Mac (Plus, SE, II 1.5 MB RAM)	**199.95**

Smalltalk/V. A product of Digitalk Inc., 9841 Airport Blvd., Los Angeles, CA 90045. For information or to find a dealer near you call:

1-800-922-8255
1-213-645-1082
CompuServe 71361,1636

Smalltalk/V

MultiFinder is a trademark of Apple Computer. Smalltalk/V is a registered trademark of Digitalk Inc. Prices subject to change without notice.

Touché, a touch tablet with a clear glass surface, provides absolute cursor control and mouse emulation.

An UnMouse for Unhappy Mouse Users

Touché, which is being promoted as the Un-Mouse, is a small touch tablet designed to replace the mouse on Macintosh and IBM-compatible systems (through the Apple Desktop Bus and serial ports, respectively).

The new tablet uses a small, clear glass surface (3 by 4½ inches). The entire tablet is smaller than a paperback book, which lets you place it conveniently near the system keyboard, where it takes up less space than a conventional mouse pad.

Despite its small size, the Touché tablet features a fairly high resolution (1024 by 1024 pixels). With it, you can quickly move the cursor across the screen, draw lines in a graphics program, or select options from a menu. For example, if you touch the top left corner of the touch tablet, the cursor will quickly emerge in the top left corner of your screen. You press a little harder to emulate the mouse-click.

At the flip of a switch, Touché can also execute macro commands. Because the tablet surface is made of clear glass, you can slide a keyboard template under the tablet and use it as an extended keypad, with as many as 70 keys.

Touché was designed in the Macintosh environment to take advantage of MacroMaker, the mouse-movement recording function of the Macintosh operating system, MicroTouch says. In conjunction with MacroMaker, for example, you can store a series of touches from Touché that activates a sequence of mouse-clicks triggering specific computer functions. Because of its high resolution and tracing function, Touché can also use MacroMaker to instantly recall your trace of an outline of a map of the U.S., for example.

Despite the lack of a simple MacroMaker equivalent, Touché is also available in an IBM-compatible version.

Both versions include a 5-V, 6- by 6- by 1-inch power supply that mounts on the back of your monitor, six template pads for user-programmable functions in different applications, and a conductive stylus for drawing and tracing capabilities.

Touché uses the same analog capacitive technology found in MicroTouch's clear glass touchscreen monitors (which recently became available in snap-on versions for XTs, ATs, and Macintoshes). Electrodes on the sides of Touché place a linear voltage field across the screen so that the controller measures the position of a capacitive coupling from a finger or a conductive stylus.

Price: $235.

Contact: MicroTouch Systems, Inc., 55 Jonspin Rd., Wilmington, MA 01887 (508) 694-9900.

Inquiry 1130.

Arresdust Filters Your PC

With Arresdust—a three-part system that includes an intake filter, a keyboard cover, and a disk drive filter—there's no need to vacuum dust out of your PC, according to Arresdust Computer Products.

Each polyester foam filter is ³⁄₁₆-inch thick, is static-resistant, and has adhesive on one side that sticks, peels off, and sticks again and again. Arresdust recommends you change the filters every six months.

The only thing Arresdust doesn't cover is a bigger fan to pull air through the filter, and wattage to power the bigger fan.

Price: $14.95.

Contact: Arresdust Computer Products, 31 Black Horse Pike, Folsom, NJ 08094, (609) 561-4776.

Inquiry 1132.

Project Your Computer Screen Image

Kodak's Datashow 480 projects images from IBM- and Macintosh-compatible personal computers through bottom-lit overhead projectors.

The 14- by 14- by 3-inch unit sits atop the projector (where you previously placed the transparencies), and a separate cord plugs into your video port. The 10-foot cord includes a video port of its own for monitor connection, about 1 foot from the computer end of the Datashow cord. Each Datashow 480 weighs 7 pounds and ships with a 2-pound power transformer.

Whether your video card is color or black and white, the projection pad translates the CGA, EGA, VGA, MCGA, MDA, or Hercules signal into black-and-white images with eight shades of gray and resolution of up to 640 by 480 pixels.

With built-in microprocessors, the projection pad automatically recognizes and locks onto 14 different video signals.

You can also manipulate signals that aren't quite standard, whether by fault of the nearly compatible IBM clone or the nearly compatible graphics card, Kodak claims. Memory on the pad allows you to save this fine-tuning for future use, for up to three additional video signals.

Price: $1895; cable, $129.

Contact: Eastman Kodak Co., 343 State St., Rochester, NY 14650, (800) 445-6325, ext. 883.

Inquiry 1131.

continued

Fax Boards Double as Modems

The ComFax is an inexpensive add-in that combines Group II (international) and III fax functions with 9600-bps modem functions. The EconoFax is an inexpensive 4800-bps send-only fax with V.22bis modem compatibility. Both boards fit XT- and AT-compatible slots.

The ComFax uses the less expensive V.29 "facsimile modem" standard as defined by the CCITT, instead of the V.32 modem standard used most often for 9600-bps modem communication. The V.29 standard has traditionally been used in fax machines because most interaction is one-way—they're either sending or receiving. For two-way communications at the V.29 standard, interaction is slowed to between 250 and 500 ms for one keystroke to make the transfer.

CompuCom uses a "fast-train" mode inherent in the V.29 specification, which limits this interaction time to 253 ms. That's a time segment that shouldn't greatly affect BBS communications, for example, the company claims. However, matching ComFaxes on both ends of the transmission are necessary.

Both products feature support for common graphics formats in addition to CompuCom's proprietary noise and data-error reduction algorithm, called Dynamic Impedance Stabilization. The ComFax also features scanner support, mouse support, deferred send and broadcast, and automatic reentry.

Price: EconoFax, $199; ComFax, $299.

Contact: CompuCom Corp., 1275 Palamos Ave., Sunnyvale, CA 94089, (408) 732-4500.

Inquiry 1142.

CompuCom's economy fax/modem boards, EconoFax and ComFax.

First OfficeVision Component Is for PCs

The personal computer version of OfficeVision, OfficeVision/2, is IBM's first networked office automation application.

OfficeVision/2 is an OS/2 integrated desktop application that runs in a client/server environment. It looks and acts like (and talks to) similar applications that will be available from IBM for minicomputers and mainframes, all in accordance with IBM's companywide software strategy called Systems Application Architecture.

OfficeVision/2 will run only under IBM's OS/2 Extended Edition 1.2. A requestor workstation requires 7 megabytes of memory. A server workstation requires 10 megabytes.

Features include E-mail (to and from PS/2s on the same LAN, other IBM LANs, or larger IBM computers); an address book (with both private and public Rolodexes and links to other functions, such as E-mail); a correspondence processor, which is a word processor for writing letters; and a telephone function for automatic dialing.

Price: $750.

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

Inquiry 1136.

Serial AIX Communications for the Distance

The PSCC Cluster Controller is a Micro Channel add-in card that supports up to 64 users at distances of up to 2550 feet.

Device drivers are available for several multiuser operating environments, including SCO Xenix, Unix System V, IBM's AIX, Interactive 386/ix, Concurrent DOS, PC-MOS, and others.

Each Cluster Controller includes an 8-MHz NEC V50 microprocessor, 64K bytes of PROM, 256K bytes of RAM, and, most important, a synchronous modem. The modem can support up to four C16 cluster boxes, which support up to 16 users each.

Price: Cluster Controller, $1295; C16 cluster box, $1195.

Contact: Computone Products, 1100 Northmeadow Pkwy., Suite 150, Roswell, GA 30076, (404) 475-2725.

Inquiry 1143.

LANalyzer Aims for Rings

A Token Ring version of Excelan's LANalyzer Network Troubleshooter (previously available only for Ethernet networks) has many of the same features.

It's designed to monitor Token Ring network activity, troubleshoot problems, and debug protocol and application software. The Token Ring kit includes LAN-analysis software and an add-in board with an Intel 80286 CPU and 2 megabytes of RAM.

LANalyzer is also available on a portable computer, the NEC PowerMate SX, which features an 80386SX chip, a VGA graphics display, and a 25-ms, 40-megabyte hard disk drive.

With the Token Ring LANalyzer, system administrators can check rotation time to monitor performance and count ring recoveries to spot potential problems. For planning Token Ring changes and additions, LANalyzer can simultaneously send and receive, Excelan says. This allows the user to simultaneously generate a load and monitor its impact.

Buffering packets allow LANalyzer's intelligent controllers to bypass the speed limitations of the AT bus, which will be important when addressing the emerging 16-Mbps Token Ring networks, Excelan said.

Price: $9980; with PowerMate SX, $19,995.

Contact: Excelan, Inc., 2180 Fortune Dr., San Jose, CA 95131, (800) 392-3526 or (408) 434-2300.

Inquiry 1139.

continued

Introducing Close-Up/LAN the remote that lets you control all PCs on your network

Call for FREE Working Model!

Close-Up®/LAN brings you a level of control never before possible. It connects PCs on your network giving you the versatility to instantly share screens and keyboards. With one PC, or simultaneously with all PCs up and down your network. Close-Up/LAN lets people work together.

Helping people

You're sitting at your PC on the 3rd floor working on a spreadsheet budget. Suddenly, a message appears on your screen: "Bob requests help". You press a hot key, and like magic you are looking at Bob's screen. Without moving an inch you see that Bob is working on the company database. A dialog window appears and Bob explains his problem. Since your keyboard is active you instantly solve the problem, on Bob's computer.

With another hot key you decide to look in on Sue's computer screen. She's new and you need to keep an eye on her work. You see that she is working on a letter using a word-processor. You monitor her for awhile without interfering with her work. In fact, Sue doesn't even know you're there!

Hot key again and off you go on your rounds of the company. Viewing one screen after another, helping some, watching others. All from the comfort of your chair. Finished, you hot key back to your spreadsheet and carry on with your budget. Amazed, you think that support has never been this easy before.

Workgroup Conferencing

As a workgroup problem solving tool, Close-Up/LAN is unsurpassed! Close-Up/LAN lets everyone in your workgroup work as a team. Your associates can chat in a conference, all linked together on screen, no matter how distant the locations. Bring up a spreadsheet, for example, and show your sales projections for all to see. With live keyboards and an instant screen to screen connection, associates can adjust your figures (optionally at your discretion) for what-if scenarios.

On-Network Meetings? Close-Up/LAN lets you conference your people over a single network, over bridged networks, or between networks thousands of miles apart.

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No matter where your PC is located you can access resources such as high speed processors (386's), CD ROM's, plotters, Irma type connections to mainframes, and modem equipped PCs that are connected to your LAN.

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Think of it. You can give everyone on your network the power of all peripherals at a fraction of the cost.

Training & Teaching

Close-Up/LAN lets your students watch on their PCs while you solve problems on your PC. Ideal for corporate and university classrooms. You can then reverse the process. Students work at their own pace while you, at the touch of a key, hop from screen to screen, monitoring their work.

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NDP C-386	595	549
NDP FORTRAN-386	595	549
Paradox/386	895	625
VM/386	245	209

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QuickPak Professional	149	129
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Apple Branches Out to Token Ring and Ethernet

At the core of Apple Computer's "Phase 2" connectivity blitz are three products that allow communication between LocalTalk, Ethernet, and Token Ring LANs using new AppleTalk protocols and industry-standard cabling.

The TokenTalk NB (NuBus) Card is a Token Ring-compatible (IEEE 802.5) card with the Texas Instruments 4-Mbps chip set for use with IBM's wiring scheme; thus, it supports shielded and unshielded twisted-pair cabling. It includes a TokenTalk software driver to support the new AppleTalk protocols and to provide a file transfer utility that will give the Mac II access to IBM PC LAN program Server Message Block (SMB) file servers.

The EtherTalk NB card is an Ethernet-compatible (802.3) Macintosh card for plug-and-play 10-Mbps communications over thin coaxial cabling. As with most Ethernet cards, you need to purchase separate transceivers if your installation involves thick coaxial or unshielded twisted-pair cabling. An Ethernet software driver ships with this card.

The AppleTalk Internet Router, a software bridge, ties it all together into a transparent network that can be theoretically larger than is realistically possible. EtherTalk for A/UX and Mac X.25 upgrades are scheduled to ship before year's end.
Price: AppleTalk Internet Router, $399; TokenTalk NB Card, driver, and SMB, $1250; EtherTalk NB Card, $699.
Contact: Apple Computer, Inc., 20525 Mariani Ave., Cupertino, CA 95014, (408) 996-1010.
Inquiry 1135.

DCA's 10Net Goes Beyond Tempest

The first of four upgrades to take DCA's peer-to-peer Ethernet network beyond Tempest specifications allows any node to encrypt data on its individual disk subsystems. The end result, DCA says, will be the 10Net Secure LAN, a hardware-based data security and Data Encryption Standard encryption system for microcomputers.

The first phase provides "single-keyed" encryption and provides that the information is encrypted as it is written to the PC's hard disk drive and also as it is transmitted over the network. It features protection against browsing in private files, modifying and removing information and data, duplicating software, and unauthorized use of applications.
Price: $1595.
Contact: Digital Communications Associates, Inc., 7887 Washington Village Dr., Dayton, OH 45459, (513) 433-2238.
Inquiry 1137.

Network Inspector Makes Hardware Installation Easier

The Network Inspector is a LAN analyzer and diagnostics software package. It provides network operating-system drivers and aids installation with a color graphics help screen before it performs simple node diagnostics. It's compatible with Ethernet, Token Ring, and ARCnet.

It includes such things as cable break detection, single-node and multinode addressing tests, and dynamic performance measurement (such as network loading measurement) with graphics. One unusual feature is a software implementation of a time domain reflectometer.
Price: $1000.
Contact: Tiara Computer Systems, Inc., 2700 Garcia Ave., Mountain View, CA 94043, (415) 965-1700.
Inquiry 1140.

Careful, Big Brother Is Watching

Close-Up/LAN is a TSR program that carries the benefits of "workgroup computing" to all the workstations on your LAN.

It's topology-independent, Norton-Lambert claims, and will work with either NetBIOS or IPX protocols.

Close-Up/LAN lets a single-host workstation connect to and remotely control any other single workstation on the LAN. (Optional versions transcend some bridges.) There's a "chat window" for two-way communications. Basically, Close-Up/LAN lets any number of workstations simultaneously work together on individual applications.

Close-Up/LAN also has a monitoring feature that allows a manager to "watch" what any workstation on the LAN is doing, without the operator's knowledge.
Price: Two-user, $395; eight-user, $795; 16-user, $995; 32-user, $1495; 64-user, $1995.
Contact: Norton-Lambert Corp., P.O. Box 4085, Santa Barbara, CA 93140, (805) 964-6767.
Inquiry 1138.

GlobalView Lets You Configure Remote Modems

GlobalView is a PC-based network management system, similar to products found in LANs but applicable to modems and, therefore, wide-area networks. It provides much of the same functionality previously available only by leasing lines from the telephone companies.

What you see is Microsoft Windows-based network management software and an equipment rack for as many as 512 GlobalView-compatible modems. Initially, GlobalView software lets you remotely monitor and configure Universal Data Systems' V.22bis dial-up modems anywhere in the United States. Support for other modems is planned.

From your control station, you can determine if a particular modem is on-line, off-line, busy, ringing, dialing, in test mode, or under testing. You can also reconfigure remote modems for data rate and communications protocol, and you can run remote diagnostics. Of course, your results can be printed and manipulated for statistical analyses.

A user-friendly system map lets you examine your network configuration and organize it by address or by type of device. Universal Data Systems recommends an 80286 with a 20-megabyte hard disk drive, EGA graphics, and a mouse. The rack-mounted modem uses either an RS-422 or RS-232C interface.
Price: $6000.
Contact: Universal Data Systems, 5000 Bradford Dr., Huntsville, AL 35805, (205) 721-8000.
Inquiry 1141.

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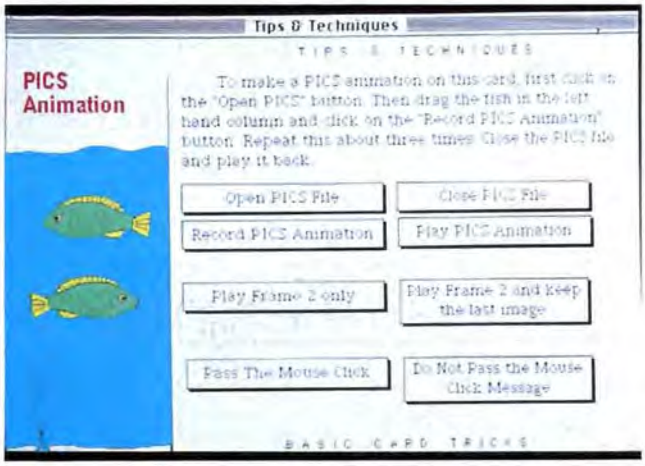

Create multimedia presentations with SuperCard by mixing animation, sound, and video.

SuperCard: HyperCard with a Kick

Silicon Beach's SuperCard lets you create custom applications that are similar to HyperCard's but conform to the Macintosh user interface. Unlike HyperCard, which limits you to one image in a window that you can't modify, SuperCard lets you create applications with resizable windows and dialog boxes, multiple documents open simultaneously, and custom menus.

Because SuperCard uses a scripting language called SuperTalk, a superset of HyperTalk, you can open HyperCard stacks, HyperTalk scripts, XCMDs, and XFCNs and convert them to SuperCard projects. Once you've created a project, you can save it as a stand-alone application that doesn't need SuperCard to run.

SuperCard fields can contain mixed fonts and sizes. The program can import and export TIFF, PICT, PICS-format animations, and MacPaint files. SuperCard also supports sound and video and 256-color Paint and Draw graphics. SuperCard requires 1 megabyte on a Mac Plus or higher to run in black and white, and 2 megabytes on a Mac II or higher to run in color.

Price: $199.

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

Inquiry 1148.

Build Your Own GUIs

The HALO Window Toolkit is based on Media Cybernetics' HALO and offers a set of windowing subroutines that help you design graphical user interfaces.

The Toolkit consists of a Window Manager and a Window Library. The Manager controls interactions between you and the windows, such as sizing, placing, and saving functions. The Library contains windowing tools, such as command bars, radio buttons, and icons.

The Toolkit has an object-oriented design, so you treat windows as objects, which enables you to copy and place them in any size or color anywhere on the screen without additional source code.

The memory manager has a look-ahead feature that automatically uses extended, expanded, or disk-cached virtual memory to maintain an image, so you don't have to keep a copy of the image to be redrawn after the interface removes a window.

Media Cybernetics reports that the HALO Window Toolkit runs under DOS and OS/2. All you need is the appropriate Microsoft C HALO (for DOS or for OS/2) to run in either environment.

Price: $595.

Contact: Media Cybernetics, Inc., 8484 Georgia Ave., Silver Spring, MD 20910, (301) 495-3305.

Inquiry 1146.

Get to the Bottom of Your C

After spending all your time putting the finishing touches on a C program, the last thing you want to do is document the code. Clear+ for C is a program that will do it for you.

Clear+ for C reads your C source code and automatically generates a system tree chart, function flowchart, formatted source listing, function cross-references, and prototype files. The tree chart represents the hierarchical relationship between all functions in the system and shows structure of up to eight levels. The flowchart shows the logical structure and control flow of the program's statements.

The program uses a WYSIWYG approach. It also offers automatic paging, allows for background printing and portrait and landscape page orientation, and offers a variety of graphics options.

Clear+ for C runs on the IBM PC with DOS 2.0 or higher, 512K bytes of RAM, and Hercules, CGA, EGA, or VGA graphics.

Price: $199.95.

Contact: Clear Software, Inc., 637 Washington St., Suite 105, Brookline, MA 02146, (617) 232-4720.

Inquiry 1145.

Object-Oriented C Programming on the Mac

Symantec developed Think C 4.0, a programming environment for the Macintosh, so that C programmers can get the benefits of object-oriented programming without having to learn a new language, such as C++ or Smalltalk.

Think C's object syntax is based on a subset of C++, and its object extensions are built on structures that any C programmer already knows.

With Think C's enhanced code resource support, you can write cdevs (control panel devices) and multisegmented code resources. The program includes an object-oriented shell that provides the basic code necessary to create a cdev, and a cdev Runner is included for debugging. The Runner provides a shell that lets you fake the system into thinking you have installed the cdev.

Think C 4.0 includes a full source-level debugger and a class library. Because the library implements the standard Mac user interface, including floating windows and tear-off menus, you don't have to waste time reinventing the wheel by re-creating common code. Symantec also rewrote the Think C libraries to conform to the ANSI standard.

Think C's in-line assembler, which lets you use assembly language within your source files, supports the instructions and addressing modes of the 68020 and 68881 coprocessor.

Price: $249.

Contact: Symantec Corp., 135 South Rd., Bedford, MA 01730 (617) 275-4800.

Inquiry 1147.

continued

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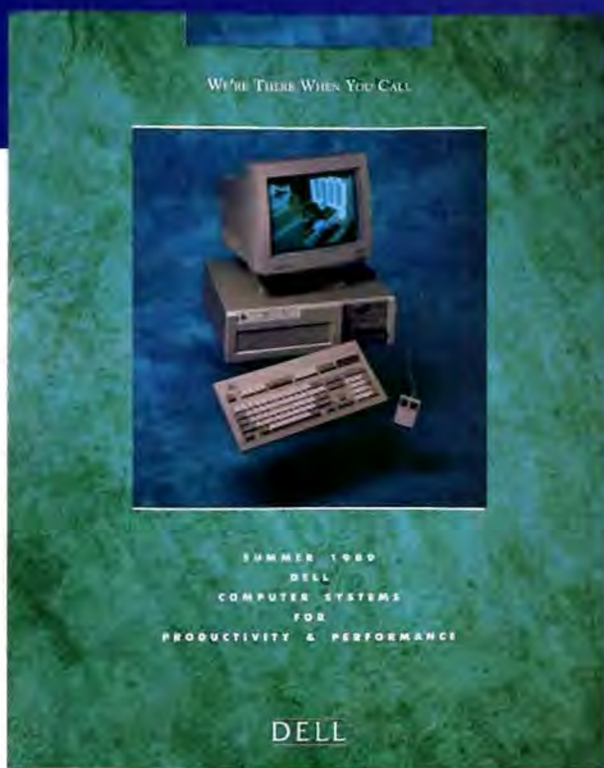

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Let her roll.
Give them a piece of your mind.
Off the wall.
See lion.
Make amends.

WealthBuilder Helps You Plan Your Future

Unlike other financial programs designed to help manage your current finances and investments, WealthBuilder can help you plan your finances through retirement. You can use the program to balance your budget, but its expert-system techniques can also suggest specific investment strategies designed to meet your present and future financial objectives.

WealthBuilder's proprietary user interface looks like Windows and acts something like hypertext. Through colorful graphics and fill-in-the-blank menus, you are guided through inputting a personal financial profile and setting financial objectives, taking into account your tolerance for risk. You can tweak the strategies through what-if scenarios.

WealthBuilder includes 600 pages of context-sensitive tutorials, a dictionary of financial terms, and a guide to mutual funds, available through screen buttons. The package can examine your current financial situation, flagging expenditures that are out of line and advising ways to cut taxes and debt.

WealthBuilder can accept data from Andrew Tobias's Managing Your Money and Intuit's Quicken. It runs on the IBM PC with 512K bytes of RAM, DOS 2.0 or higher, and a hard disk drive. The program's developers report that a Macintosh version is in the works.

Price: $249.95.
Contact: Reality Technologies, 3624 Market St., Philadelphia, PA 19104, (215) 387-6055.
Inquiry 1152.

WealthBuilder can help you with the business of life, especially in reaching financial objectives.

New Reflex Not Just Knee-Jerk Reaction

Reflex 2.0, an entry-level flat-file database management program, is Borland International's first program to support dynamic segment swapping. Borland says its programming technology, called VROOMM (for virtual real-time object-oriented memory manager) allows applications with more features and data capacity, but within 640K bytes of RAM.

Borland reports that Reflex 2.0 is a complete rewrite from the previous version (1.14). In addition to including VROOMM, which the company plans to incorporate into all its products over the next five years, Reflex 2.0 lets you view data in six different ways and print directly from within a file (previously, you had to run a separate program). It also supports databases of up to 32 megabytes. You can open five windows simultaneously, each with a different view, and enter text in memo fields of up to 8000 characters.

Reflex 2.0's capabilities include Form View, which displays one record at a time; List View, for displaying data in a spreadsheet-like grid; Graph View; Crosstab View, for comparing and summarizing data; Report and Labels View, for reports and mailing labels; and Mail Merge View, which works as a text processor. All views are hot-linked—a change you make in one is reflected in the others.

Reflex 2.0 works on the IBM PC with 512K bytes of RAM and a hard disk drive.
Price: $249.95.
Contact: Borland International, Inc., 1800 Green Hills Rd., P.O. Box 660001, Scotts Valley, CA 95066, (408) 438-8400.
Inquiry 1150.

Sales Commission Tracker

Argonaut's Sales Commission Tracker lets you track your income and sales activity, including sales order status and distributor point-of-sale transaction status. With the program, you can enter sales orders, invoices, distributor transactions, and commission data.

You can print reports that show total commissions for each order, commissions due on shipment, commissions paid to date, and the difference between commissions due and paid. You can display delinquent commission payments and the number of days late.

The program, written in FoxBASE, lets you sort reports by nine parameters. Sales Commission Tracker is a stand-alone program and requires an IBM PC with a hard disk drive, 512K bytes of RAM, and DOS 2.0 or higher. Argonaut is distributing it as a shareware program.
Price: $45.
Contact: Argonaut Systems, 15466 Los Gatos Blvd., Suite 109-314, Los Gatos, CA 95030, (408) 867-5029.
Inquiry 1149.

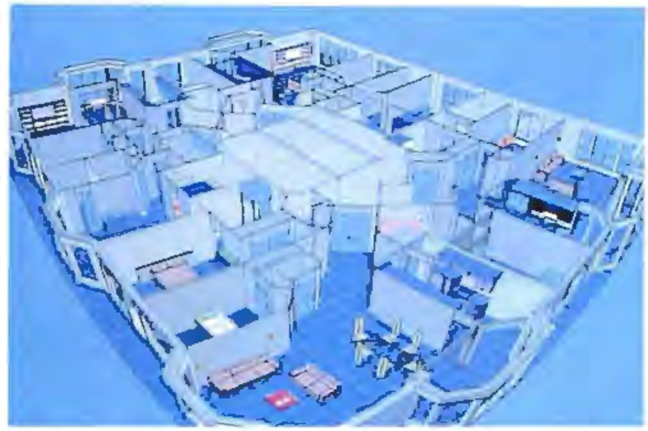
1-2-3 Release 3.0 Add-in Solves What-If in Reverse

Frontline Systems introduced what it calls the first add-in for Lotus 1-2-3 release 3.0. What-If Analyst automatically determines the what-if value on your spreadsheet. You specify a desired result value (e.g., net profit) and a what-if variable. The program then automatically determines the what-if value that yields the desired result, solving the what-if problem in reverse.

A single What-If Analyst package includes the add-in versions for Lotus 1-2-3 release 2.01, 2.2, and 3.0, and for Symphony. The program requires 35K bytes of RAM on release 2.01 and 2.2, 45K bytes on Symphony, and between 15K and 55K bytes on release 3.0.
Price: $49.95.
Contact: Frontline Systems 140 University Ave., Suite 100, Palo Alto, CA 94301 (415) 327-7297.
Inquiry 1153.

continued

SCIENCE AND ENGINEERING



With Architrion II, you can study the effects of interior lighting.

Two Architectural Programs for the Mac

Architrion II, a design, drafting, and presentation program, lets you study the effects of light and color on your projects. You can define the colors of a building and its components and specify the light source's position and intensity to simulate shading and shadowing from interior lights or the sun.

With Architrion II, you can easily coordinate planes, sections, and elevations of a building so that you include a change in the three-dimensional database in its two-dimensional drawings. According to Gimeor, you can create and modify a building in section view and position and adjust openings in elevation while making real-time updates to the database.

Architrion II works on the Mac SE or higher with a minimum of 2 megabytes and a hard disk drive. A version that takes advantage of a math coprocessor is available.
Price: $2495.
Contact: Gimeor, Inc., 420 10th St. SE, Washington, DC 20003, (202) 546-8775.
Inquiry 1155.

MacBravo! Facilities is a program for the Mac that lets facilities managers and industrial engineers plan, manage, and document the interior of plants and offices. The program uses independent overlays with references between them so that changes made in the facility are automatically updated for everyone. It also allows several people to work simultaneously using a common database.

MacBravo! Facilities includes a DBMS that lets you associate information with graphical representations of the facility. You can, for example, click on a symbol that represents a piece of machinery and get information on its initial service date, when it is scheduled next for maintenance, or how much it costs.

If you are drawing the top view of a wall, you can tell Facilities the height of the wall, and it can create a three-dimensional image from your two-dimensional drawing.

Facilities works on the Mac II or higher with 8 megabytes of memory and at least a 40-megabyte hard disk drive. It includes a library of about 1000 mechanical and architectural components.
Price: $4900; PlanPrint components, $495; IGES (Initial Graphics Exchange Standard), $495.
Contact: Schlumberger Technologies, CAD/CAM Division, 4251 Plymouth Rd., P.O. Box 986, Ann Arbor, MI 48106, (313) 995-6000.
Inquiry 1156.

continued

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Performance Comparisons using PC Labs Benchmark Series Release 4:

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

- *Fast 32MB Seagate 138R Hard Drive with auto-park, 1.2MB Floppy Drive.*
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Performance Comparisons using PC Labs Benchmark Series Release 4:

	80386 Instruction Mix	Floating Point Calculation	Conventional Memory
ZEOS 386/20 Desktop	2.87	10.40	0.39
IBM PS/2 Model 70-121	3.24	12.72	0.61
Compaq Deskpro 386/20e	2.91	10.54	0.40

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Math for the Masses

MathCAD 2.5 is based on MathSoft's live document interface, which lets you use the computer as if it were a notebook, defining variables and entering text anywhere on the screen.

MathCAD formats equations in standard math notation and automatically calculates the results. As you make changes to the original equation, MathCAD automatically recalculates. The program generates each plot as soon as you specify the variables. According to MathSoft, MathCAD is capable of handling complex arithmetic, fast Fourier transforms, integrals, derivatives, Bessel functions, matrices, simultaneous linear and nonlinear equation solving, and statistics.

Unit conversion is another given with MathCAD. You specify what units you want the answers in, and that's what the program returns, according to MathSoft.

MathCAD also produces documents of any length and width. It offers cut, paste, and copy features, along with automatic word wrap.

One enhancement in version 2.5 is the ability to graph three-dimensional surface plots and manipulate their rotation viewpoint. Also added to the new version is HPGL sketch import capability, support for PostScript, sorting ability, multiple region cut and paste, and pop-up menus.

To run MathCAD 2.5, you need an IBM PC with DOS 2.0 or higher and 512K bytes of RAM. A math coprocessor is recommended.

Price: $495.

Contact: MathSoft, Inc., One Kendall Square, Cambridge, MA 02139, (617) 577-1017.

Inquiry 1158.

Structural Analysis Under Windows

Finesse/f is the first in a series of structural analysis and design programs from Cube Systems that run under Windows. Finesse/f solves two- and three-dimensional trusses and frames. In three-dimensional mode, when viewing a complex structure such as a bridge, you get a sensation of depth better than that produced by hidden line removal.

The system is written in optimized C, performs bandwidth minimization, and uses a math coprocessor and available EMS memory to reduce analysis time. With the Data Editor, you can build a materials database and define structural geometry, loads, and other data. Other databases are available for steel, timber, general shapes, and materials in Imperial, Canadian, and German metric formats.

You can view the structure in normal 2-D and deformed 2-D mode at the same time to see the effects of an applied force. Finesse/f (the *f* stands for wire-frame cases) can handle shear corrections for deep beams and shear walls, partial and full member releases, wide support corrections, variable and nonprismatic cross-section definitions, and inclined supports.

Finesse/f requires an IBM PC AT or higher with 640K bytes of RAM and Windows 2.0 or higher.

Price: $995; four databases, $245.

Contact: Cube Systems Consulting Services, Inc., 77 Metcalfe St., Suite 310, Ottawa, Ontario, Canada K1P 5L6, (613) 236-7067.

Inquiry 1157.

continued

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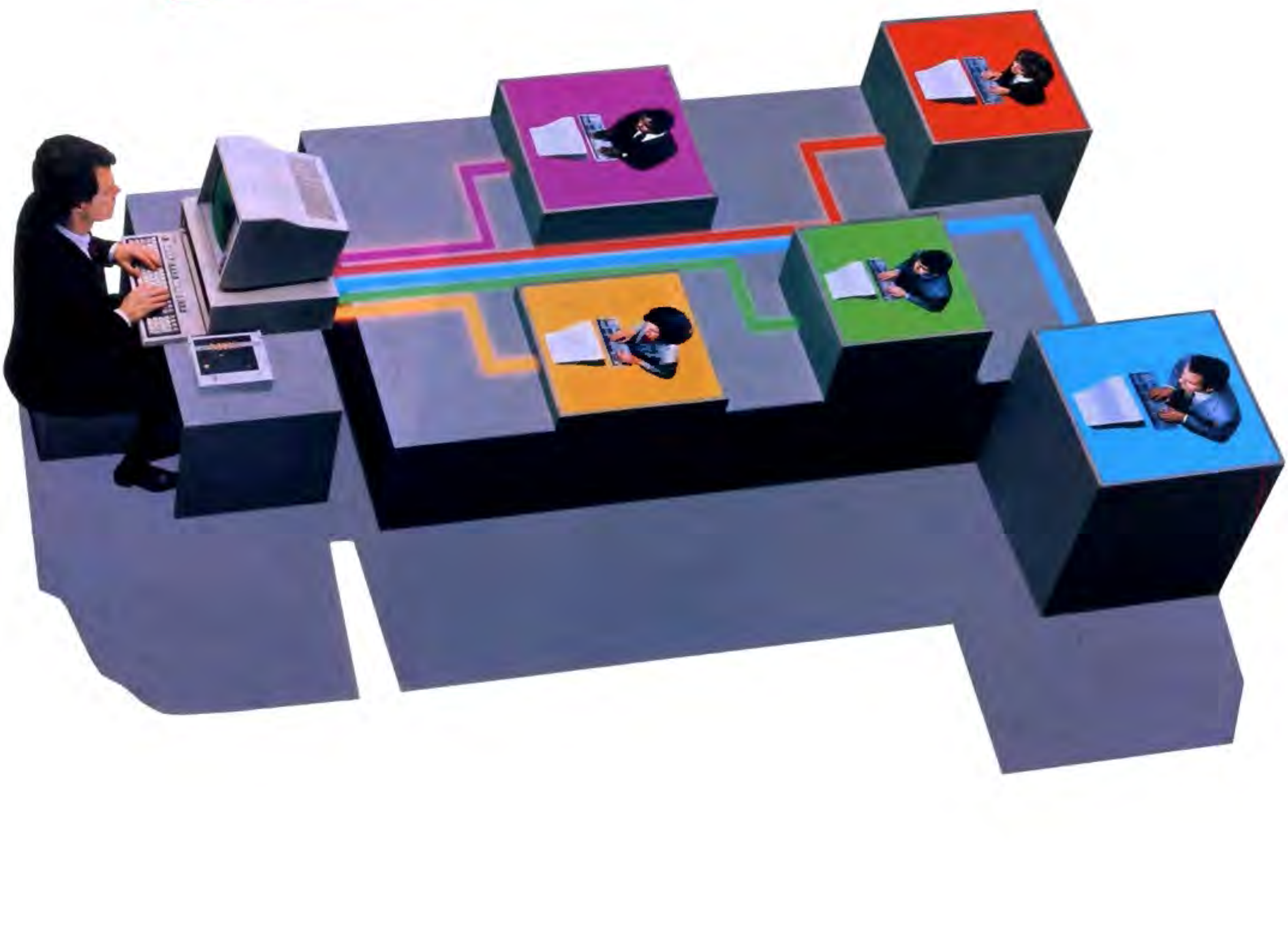

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There are now more than 100,000 users of PC-MOS worldwide, but if you haven't seen it lately, take another look. We've broadened our base of compatible applications and added multi-level security, faster disk performance and larger task sizes. Version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

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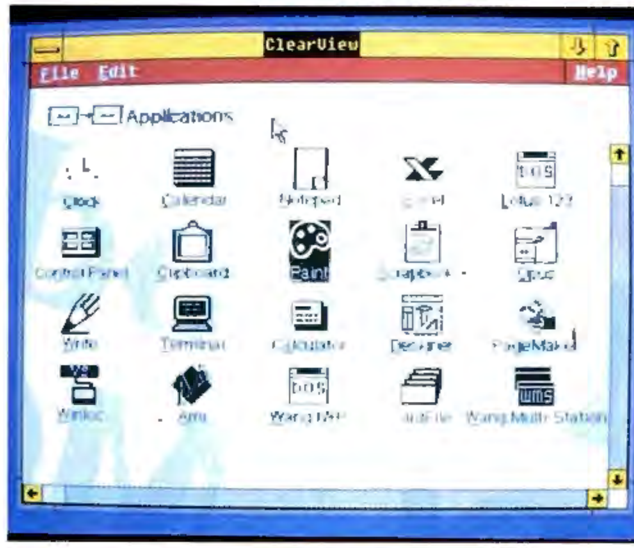
CAD AND GRAPHICS



ClearView lets you add true icons to the Windows desktop.

Customize and Enhance the Windows Desktop

Microsoft's Windows, while providing a consistent graphical user interface, isn't without its limitations. Two products, from Wang and hDC Computer, can make Windows easier to customize and manage.

Wang developed ClearView for Windows users who want to improve the graphics and functionality of the Windows desktop. ClearView's Window Organizer lets you customize the placement and size of the windows in which you run your applications so it's easier to find them. You can arrange open windows in an overlapping stack or move them into an aligned grid for viewing and access.

With ClearView, you can tell Windows which programs to load automatically and customize your desktop so a particular layout automatically appears when you activate the Windows environment.

ClearView replaces filenames with a menu system that lets you access Windows and non-Windows applications from the same menu. A List feature of ClearView automates the opening, sizing, moving, and closing of windows.

ClearView works on the IBM PC AT or higher with Microsoft Windows 2.0 or higher, 512K bytes of RAM, and a hard disk drive.

Price: $79.
Contact: Wang Laboratories, Inc., One Industrial Ave., Lowell, MA 01851, (508) 459-5000.
Inquiry 1164.

Windows Manager from hDC Computer lets you install and manage desktop utilities for Windows. The program ships with seven utilities, and hDC says that more are on the way.

You can install Windows Manager in two ways: as a tear-off menu that you place anywhere on the screen or as a pull-down menu that becomes part of the Windows menu bar.

The System Enhancer utility's Run command lets you run any application from within any Windows program. Arrange lets you organize open windows by overlapping or tiling them, and the utility can also close all open Windows applications and exit Windows from any application.

The Work Sets utility lets you create sets of programs and files that you work with

continued

and launch with one command. You can also use it to save the current state of any session when you quit.

Other utilities include Alarm Clock; Auto Save; Desktop, which lets you customize your start-up screen, customize your background, and add a screen saver; Font Viewer; and Memory Viewer, which displays a graph in pie chart form that shows how you're using conventional and expanded memory.

Windows Manager requires less than 10K bytes of RAM per utility and about 10K bytes for the manager itself. It works on the IBM PC AT or higher with Windows 2.0 or higher.
Price: $79.95.
Contact: hDC Computer Corp., 15379 Northeast 90th St., Redmond, WA 98052, (206) 885-5550.
Inquiry 1165.

Software Brings PostScript to the Fax

GammaLink's GammaScript lets you create presentation-quality faxes with any application that uses the PostScript page-description language. Using an interpreter that GammaLink licensed from QMS, the program takes your PostScript application's output and translates it into a fax format file with output comparable to that of a 200-dpi PostScript printer.

GammaScript is available in two versions: GammaScript Plus is compatible with all 35 typefaces of the Apple LaserWriter NT; a less expensive package offers 13 typefaces. The program will work with GammaLink's line of PC-to-fax boards.

GammaScript works on the IBM PC AT or higher with a PC-to-fax board, 1 megabyte of RAM, and 4 megabytes of free memory on your hard disk drive.
Price: GammaScript, $145; GammaScript Plus, $440.
Contact: GammaLink, 2452 Embarcadero Way, Palo Alto, CA 94303, (415) 856-7421.
Inquiry 1161.

A Step up from Deluxe

The PC Tools DOS utilities package upgrade offers file viewers, LAN support, and a new application launch capability.

With version 5.5, you no longer need to know exactly where information is stored on your hard disk. Find and Locate functions let you identify and select files that match your search criteria. New file viewers let you view files in dBASE, Lotus 1-2-3, ASCII, and hexadecimal formats. The application launch capability links the selected data file with its associated application, and the program automatically loads them both.

LAN support added to version 5.5 lets you load the PC Tools DOS shell, desktop manager, and hard disk backup programs onto a Novell or IBM Token Ring network server. For security, the DOS shell will display only directories that the user is allowed to read, or you can run the PC Tools programs from a write-protected directory.

PC Backup, PC Tools Deluxe's hard disk backup program, includes new reporting capabilities, new verification and formatting options, and an automated installation procedure.

PC Tools Deluxe version 5.5 runs on the IBM PC with at least 512K bytes of RAM.
Price: $129.
Contact: Central Point Software, Inc., 15220 Northwest Greenbrier Pkwy., Suite 200, Beaverton, OR 97006, (503) 690-8090.
Inquiry 1160.

WHAT'S NEW

PACIFIC

BMUG Wins Award, Starts Unix SIG

At the Second Intergalactic Users Group Meeting, held in New York City, users group officers held their first newsletter competition. The Berkeley Macintosh Users Group won top honors in the Best Columns or Columnist and Best Features categories for its newsletter, *BMUG*. Editors from *Folio:*, *Home Office Computing*, and the *MacStreet Journal* rated the newsletters. The meeting was sponsored by the New York Personal Computer Group for BBS sysops and newsletter editors and officers.

BMUG has also formed a Unix Workstation special-interest group for BMUG members involved with A/UX, microVAX, Apollo, and the NeXT machine. The SIG meets every third Tuesday at one of the BMUG offices, 2150 Kittredge, Suite 3B, between Oxford and Shattuck.

The meetings will be free and open to the public.
Contact: The Berkeley Macintosh Users Group, 1442A Walnut St., Suite 62, Berkeley, CA 94709, (415) 549-2684.

Technology Conference Nanobytes

The Second Workshop on Workstation Operating Systems takes place at the Asilomar Conference Center in Pacific Grove, California, on September 27–28.
Price: IEEE members, \$160; nonmembers, \$210.
Contact: Joseph Boykin, General Chairman, Encore Computer, 257 Cedar Hill St., Marlborough, MA 01752, (508) 460-0500.

The tenth annual Design Engineering Show and Conference/West will be held earlier than usual this year. Normally held in December, the conference will be held this year on September 26–28 at the Los Angeles Convention Center so that more engineers can attend.
Price: One session, \$115; four sessions, \$335. Show only, \$25.
Contact: Show Manager, Design West, 999 Summer St., Stamford, CT 06905, (203) 352-8372.

AmiEXPO, the conference for Amiga users and vendors, will take place in Santa Clara, California, on October 20–22. The conference will include master classes in animation, programming, video, graphics, and desktop publishing.
Price: To be announced.
Contact: AmiEXPO, 211 East 43rd St., Suite 301, New York, NY 10017, (800) 322-6442 or (212) 867-4663.

Supercomputing World, although mostly for mainframe computers, will also feature sessions on workstations. The expo will be held on October 17–20 at the Civic Auditorium in San Francisco.
Price: Full conference, \$475; one day, \$350; tutorials, \$300; exhibits only, \$20.

continued

There are two ways to build PCs

Theirs OR Ours

On the left are your typical PC/AT motherboards. On the right is Advanced Digital's SBC-386SX, a versatile, modular PC-on-a-board.

Conventional computer systems, (on the left), placed some of their electronics on the motherboard and required additional plug-in cards such as; memory boards, video graphic boards, serial/parallel boards, etc.

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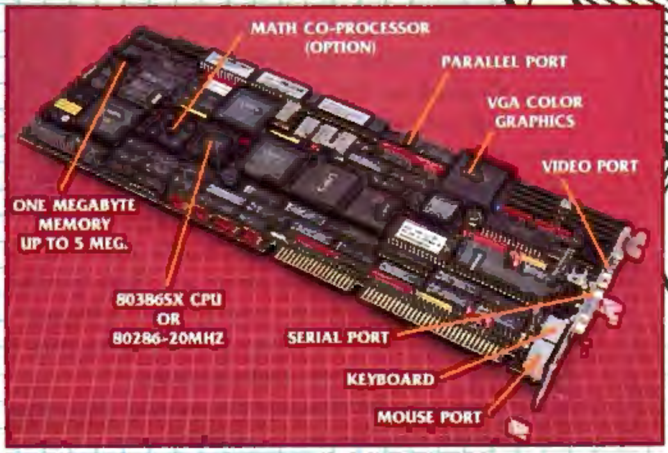

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The Choice is Yours.

Contact: MG Expositions Group, 1050 Commonwealth Ave., Boston, MA 02215, (800) 223-7126 or (617) 232-3976.

INTEREX, the international Hewlett-Packard Users Group, is holding its North American Users Conference on September 11–14 at San Francisco's Civic Auditorium and Brooks Hall Complex.
Price: INTEREX members: $650; nonmembers, $750.
Contact: INTEREX San Francisco Conference, 680 Almanor Ave., P.O. Box 3439, Sunnyvale, CA 94088, (408) 738-4848.

The Seventh Annual Pacific Northwest Software Quality Conference will be held on September 12–14 in the Red Lion/Lloyd Center in Portland, Oregon. Half-day tutorials begin September 10.
Price: $100.
Contact: Conference Management, Lawrence and Craig, Inc., 320 Southwest Stark, Room 411, Portland, OR 97204, (503) 222-2606.

A conference on the role of information systems in the global economy will be held on October 1–4 in San Francisco. Called "Information Systems Perspectives: Affecting the Global Market," the conference is sponsored by GUIDE International, an international association of IBM computer users.
Price: $1495.
Contact: GUIDE International Corp., 111 East Wacker Dr., Suite 100, Chicago, IL 60601, (312) 644-6610.

The third annual AppleFest will be held at the Brooks Hall and Civic Auditorium in San Francisco on September 22–24.
Price: Exhibits only, $10; half-day seminar, conference sessions, and exhibition, $99.
Contact: Cambridge Marketing, Inc., One Forbes Rd., Lexington, MA 02173, (800) 262-3378 or (617) 860-7100.

NCGA C[4] will be held on September 12–15 at the Santa Clara Convention Center.
Price: Full conference: NCGA members, $475; nonmembers, $525. Exposition only, $10.
Contact: National Computer Graphics Association, 2722 Merrilee Dr., Suite 200, Fairfax, VA 22031, (703) 698-9600.

Technology and Its Consequences

A conference called Technics, Culture, and Consequences will cover the impact of technology on society. According to the IEEE Los Angeles Council, the conference serves as an interface between engineers and society, allowing both segments to exchange ideas.

The conference will be held at the California State University's Los Angeles campus on October 20–21.
Price: IEEE members, $100; nonmembers, $130.
Contact: Dr. C. Toporow, Society of the Social Impact of Technology (SSIT) LA, P.O. Box 328, Canoga Park, CA 91305, (213) 813-6194.

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Toshiba MK134FA	42mb/25ms	495

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Seagate ST238	30mb/65ms	249
Miniscribe 3650	40mb/65ms	349
Seagate ST251-1	42mb/28ms	445
Seagate ST251	42mb/40ms	355
Mitsubishi MR535	42mb/22ms	525
Seagate ST277R	65mb/40ms	445
Rodime 5090*	74mb/28ms	895

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Micropolis 1325	72mb/28ms	$795
Seagate ST4096	80mb/28ms	599
Maxtor XT1140	120mb/28ms	1,625
Newbury Data 1140	120mb/25ms	1,295
Maxtor XT2190	150mb/28ms	1,895

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Teac	720k	$110
Fujitsu/Toshiba	720k	105
Teac	1.44mb	120
Fujitsu/Toshiba	1.44mb	115

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YE-Data	360k	$59
Alps IBM	360k	59
Teac FD55BR	360k	79
Teac FD55GFR	1.2mb	115

SCSI Interface • 5 1/4" Full Height

Micropolis 1373A *	85mb/28ms	$995
Newbury Data 3170S	147mb/19ms	1,595
Maxtor XT3280S	244mb/16ms	1,895
Newbury Data 3380S	320mb/19ms	2,495
Maxtor XT4380S	320mb/16ms	2,795
Maxtor XT8760S	676mb/16ms	4,250

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HP97500-85620 *	20mb	$225
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Rodime 652 *	20mb	245
Lapine LT4000 *	40mb	295
Connor CP340 *	40mb	375

SCSI Interface • 5 1/4" Half Height

Seagate ST225N *	20mb	$225
Seagate ST251N *	42mb	395

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30mb/65ms Hard Card *	295
48mb/36ms Hard Card *	395

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Newbury Data 4175E	157mb/19ms	$1,495
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Newbury Data 4380E	320mb/19ms	2,295
Maxtor XT4380E	320mb/16ms	2,495
Siemens 4410	383mb/16ms	2,495
Maxtor XT8760E	676mb/16ms	4,250

IBM PS/2 KITS

360K Floppy w/Case & Cable	$210
1.2mb Floppy w/case & Cable	250

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XT Cable Set	$15
AT Cable Set	15

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WD-FOX 360k/720k/1.2mb	$ 69
1.44 mb Controller	79
WD-1002-WX1 Tandy	99
WD-WXT-GEN	79
WD1003 MM2 AT	149
ADAPTEC 2072A XT RLL	99
XEBEC 1210 XT 10-20mb only	59
DTC5287 AT RLL	195
Perstor/Sequel 200 Series AT (8 bit)	225
Perstor/Sequel 200 Series AT (16 bit)	325
Data Master 44-800 -- 3.5", 5.25", 8" floppy	79
SCSI Controller, Future Domain TMC841 (Kit)	265
WD1007-WA2, ESDI, AT (HD & FD)	325
WD1007-WAH, ESDI, AT (HD)	315
Omti 8620, ESDI Controller	295
WD1006-SR2 1:1 Inter. HD & FD RLL	195
WD1006-MM2 1:1 Inter. HD & FD	195

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VGA

Projection Panel Now Supports Atari ST, DEC Terminals

nView Corp., which produces an LCD projection panel that lets you project your computer's screen onto an electronic transparency screen for presentations, has enhanced the panel to support the Atari ST and DEC's VT220 and VT340 terminals. Called ViewFrame II+2, the panel also incorporates double-scanning circuitry, which increases the resolution on a CGA system from 640 by 200 pixels to 640 by 400 pixels.

To display your screen on the wall (the panel also supports IBM PCs and—with an adapter kit—the Mac), you connect the appropriate video interface cable to your system's video port and the ViewFrame display panel, place the panel on an overhead projector, and turn on the power. Your computer screen then appears on the projection screen. The DEC VT340 requires you to install an nView video interface board (which is supplied). A composite input jack lets you use VT220 and the Apple II.

Price: $1995; Mac adapter kit, $149.
Contact: nView Corp., 11835 Canon Blvd., Newport News, VA 23606, (804) 873-1354.
Inquiry 989.

The ViewFrame II+2 now supports a wide variety of personal computers and terminals.

Not Just the Fax

One of the benefits of fax boards is that you don't have to wait in line to send a fax. But if you create a document in a word processor and have to translate the document into an ASCII file, you lose the impact of fonts and formatting. The Fax Group's FaxPro line of hardware/software and software-only products lets you send fax messages from your PC that retain the special formatting and graphics of your normal printed document.

According to The Fax Group, you can send a fax from any application by executing the Print command from the application program. The page prints to screen, giving a WYSIWYG display of the final faxed document. You can send the document to a fax or a printer or to both simultaneously. FaxPro lets you tag a signature, letterhead, or logo to the fax. You can also enlarge the document for viewing.

FaxPro is currently shipping in two versions: a software-only version, and with a PC-to-fax board. The Modem FaxPro program works with a Hayes-compatible modem and lets several people in a workgroup share an internal FaxPro card. You can also use FaxPro with a fax service such as MCI Mail. For heavy-volume faxing, the Internal FaxPro gives you your own WYSIWYG fax capability. A network version of the product will be available soon.

FaxPro works on the IBM PC with 512K bytes of RAM, a hard disk drive, and a graphics board.

Price: Internal FaxPro, $1295; Modem FaxPro, $298; Network FaxPro, $1795.
Contact: The Fax Group, 12526 High Bluff Dr., San Diego, CA 92130, (800) 426-7489 or (619) 456-0795.
Inquiry 982.

Math C Subroutines for CAD/CAM/CNC

With the QuickGeometry Library, a collection of math subroutines, you can perform geometric operations that formerly required you to write them yourself or use CAD/CAM interpreted macro languages. Developed by Building Block Software, the library is independent of any CAD/CAM environment, and you can use it for graphical and nongraphical programs.

Unlike other packages that support a wide range of geometry and require you to remember many routines, the library uses an object-oriented approach that lets you define one general object type, such as a curve, that can assume the form of any specific curve type, Building Block reports. Each geometric operation requires only one routine.

With the library, you can do parametric design and write CAD/CAM utilities for batch geometry processing, computer numeric control (CNC) postprocessing, mapping, medical imaging, and other engineering tasks. Routines are included for offsetting, breaking, trimming, rotating, scaling, translating, and reading and writing DXF files. Geometry types supported include lines, ellipses, arcs, nonuniform rational B-splines, and circles.

The QuickGeometry Library runs on the IBM PC with DOS 2.0 or higher.

Price: $199.
Contact: Building Block Software, P.O. Box 1373, Somerville, MA 02144, (617) 628-5217.
Inquiry 985.

Wintime

WIN YOUR TIME BY WINTIME pcTABLET

Wintime pcTablet KD series are designed for IBM personal computer family and compatibles, excellent performance in three sizes, compact and lightweight, suited for all popular CAD program and most application packages.

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Active area —

KD-1000	: 6"×9"
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Technology:
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Resolution:
100-1016 lpi (auto selectable)

Accuracy:
+/− 0.025 (.625mm)

Proximity:
UP to 0.5"

Baud rate:
Auto Baud rate (75-19,200) or 9,600

Report rate:
Up to 200 reports/second (selectable)

Certification:
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Includes: Tablet, 4-button, cursor, power supply, RS-232C cable, 9 to 25-pin adaptor cable, Mylar template overlay, Utilities diskette.

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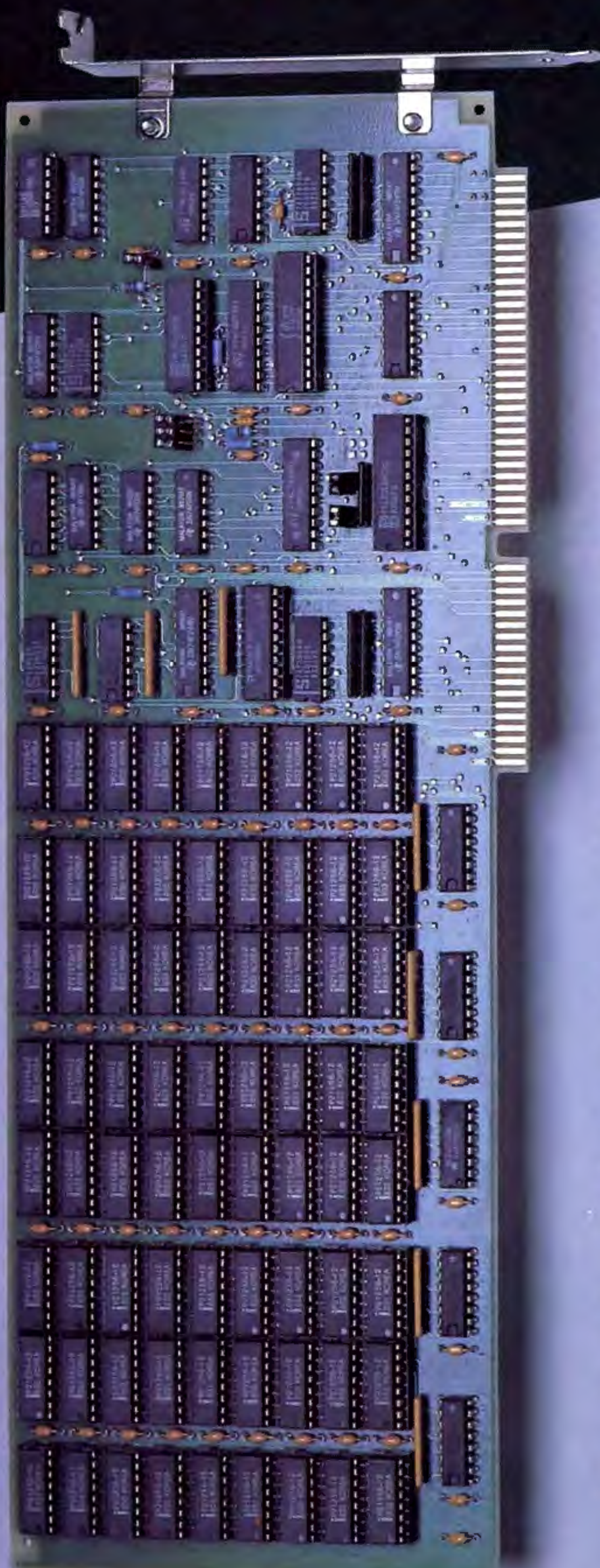

"should be very useful for DOS users who are straining the limits of the 640K barrier"
—BYTEweek June 12, 1989

DESIGN PHILOSOPHY

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

MEMORY

• Segmented Memory Mapping allows the user to fill out unused memory segments between 640K and 1024K. By "claiming" unused portions of memory in 16K increments, the user effectively increases TPA size. LAN or custom software modules, for example, can be loaded into these high memory areas thus relieving the lower 640K of TPA for other application programs.

• Split Memory Addressing allows the user to fill out conventional memory to 640K.

• Extended Memory Addressing is available for the PC/AT version.

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• Easy menu-driven auto configuration software.

• Device driver includes print spooler and RAM drive.

• Supports multitasking with the appropriate shell-resident software package.

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• 6/8/10 MHz speed with 0 wait states. 12 MHz speed with 1 wait state.

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We call this 12 Mhz Zero Wait state system our Entry level AT because of the Fabulous Price Performance Ratio with a relative AT speed rating of 15.7 Mhz. Special offer includes choice of Std AT case or Mini Tower case. Memory configuration options include 512k, 1 MB, 2 MB or 4 MB on the main board. This system includes:

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CDS 386SX Model 16/20

A low cost 16 Mhz system is a great solid entry level 80386 product. Overall cost is close to 16 Mhz & 20 Mhz 80286 systems and yet maintaining the ability to run all current and future 80386 Software. This 386SX system can run 16 Mhz or 20 Mhz as well as being fully OS/2 compatible. The system includes:

* 16 Mhz 80386SX Main Board (See col 7 on table below)
* 1 MB Memory
* 40 MB Hard disk w/ 40 ms access
* Mini tower Case / 200 W PS
* 1.2 MB Floppy Disk
* Hi-res amber monitor
* Graphics controller with printer port
* AT style keyboard

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CDS 386 Model 25

This 25 Mhz system is a great 386 value based on our solid 80386 Chips and Tech main board. This system will give you the ability to run all 80386 Software or chose our 80386SX Model 16 and save $200. (or custom configure any system from the Main board Table below.
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* 1 MB Memory
* 40 MB Hard disk w/ 40 ms access
* Mini tower Case / 200 W PS
* 1.2 MB Floppy Disk
* Hi-res amber monitor
* Graphics controller with printer port
* AT style keyboard

$ 1899

Floppy Disks:
360K 5 1/4 " Fujitsu or Chinon .... $ 68
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720K 3.5" .... $ 78
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Controllers:
XT/AT FD 2 Drive 360k,720k, 1.2M and 1.44M .... $ 44
XT H/Disk DTC MFM or RLL ... Call
AT Floppy/Hard, MFM, 2:1 ..... $ 99
AT F/Hard, MFM, DTC 1:1 ..... $149
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40MB ST 251-0 .... $ 339
40MB ST 251-1 .... $ 369
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EGA with or without p port ..... $ 149
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PC Mouse From $48
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Current System — AT Speed Comparison
XT Turbo — 4 Mhz
Bullet 286-10 — 12.6 Mhz
Bullet 286-12 — 15.4 Mhz

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Column	1 Bullet 286 286-7.2	2 Bullet 286 286-10	3 Bullet 286 286-12.5	4 VLSI AT 286-12	5 Precision AT 286-16	6 Bridge 286 286-12	7 CCI 386SX 386SX-16	8 CCI 386 386-20	9 X Golden 386 386-25
CPU	80286-8	80286-8/10	80286-10/12	80286-12	80286-16	80286-12	80386SX-16	80386-20	80386-20
Math Co-po	80287-2/3	80287	80287	80287	80287	80287	80387SX	80387	80287/80387
Cache Ram	N	N	N	N	N	N	N	N	N
Dram Type	64/256K	64/256K	64/256K	64/256/1024K	64/256/1024K	256k/1M SIMMS	256/1M SIMMS	256/1M DIP	256/1M Sip/DIP
Mem Speed	150ns	120ns	100ns	120/100 ns	100/80 ns	100ns	100 ns	100/80 ns	100/80 ns
Mem Config	512/640K/1M	512/640K/1M	512/640K/1M	512/640K/1/2/4M	512/640K/1/2/4M	512K/1M to 6M	512K to 8MB	1/2/4/6/8/10 MB	1/2/4/8/16/32MB
8 Bit Slots	8	8	8	2	2	(2) 5	2	2	1
16 Bit Slots	0	0	0	6	6	(3) 3	6	5	5
32 Bit Slots	0	0	0	0	0	0	0	1	2
BIOS	Quadtel	Quadtel	Quadtel	Award/AMI	Award/AMI	Phoenix	Phoenix	Award/Phoenix	AMI
Relative Speed	9	12.4	15.6	15.6	21.6	15.4	18.0	25.5	33.0
SI Rating	8.2	11.0	14.7	15.3	18.3	15.2	17.2	23.0	28.0
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DRAM Tester Includes SIMM/SIP Option

Fast RAMstar, a 64-, 128-, and 256-kilobit and 1-megabit DRAM tester, can test chips in the 45- to 110-ns range in 1-ns access-time resolution. Developed by the company Computer Doctors, the DRAM chip tester has an option that allows you to test 1-megabit single in-line memory modules (SIMMs) and single in-line pins (SIPs) with 8- or 9-bit configurations.

The company's 4-By adapter lets you test each bit of 4- by 64-kilobit and 4- by 256-kilobit DRAMs individually. The products are updates to Computer Doctors' original RAMstar tester, which has 16- and 18-pin zero-insertion-force sockets, autoloop testing for long testing, and access-time control from 80 to 180 ns. RAMstar's test rate is 6.25 Mbps with continuous access speed set at 80 ns, and the tester can test all bits at every address.

Price: RAMstar, $249; Fast RAMstar, $349; SIMM/SIP adapter, $189;
4-By adapter, $89; 5-volt power supply, $25.
Contact: Computer Doctors, 9204-B Baltimore Blvd., P.O. Box 470, College Park, MD 20740, (301) 474-3095.
Inquiry 1001.

Workgroup Editing and Review Software for the Mac

The old saying that the stongest drive is to edit someone else's copy holds especially true when the edit and review process involves an entire workgroup. After 12 or so passes, the document or proposal can resemble something from Custer's Last Stand.

A program called MarkUp is designed to make workgroup review less painful and laborious. With it, members of a group can use a variety of editing tools to independently edit the same document at the same time, without having the application that created it. The program uses an overlay metaphor that lets you mark up, expand, annotate, and comment on an image of the document.

After all editing is complete, a master reviewer collects the comments from the overlays and incorporates them into the final version. A pop-up palette of proofreader's marks helps you add standard editing symbols.

MarkUp works on any AFP-compatible network, or you can use a personal version of the program that includes a run-time version of MarkUp with each distributed document. The program runs on a Mac Plus or higher.

Price: $245; two-user version, $495; five-user version, $995.
Contact: Mainstay, 5311-B Derry Ave., Agoura Hills, CA 91301, (818) 991-6540.
Inquiry 1003.

New ScanLab Prevents the Washout Blues

Professional ScanLab 1.1, the 24-bit color-separation package, can make allowances for impurities in printer ink, so that your blues are blue and your yellows aren't orange. According to developer ASDG, impurities can exist in printer ink that corrupt the final printout.

For example, magenta has a slight touch of cyan. The program's utility software now accounts for that, using less cyan when mixing with magenta. The new program prevents blues that end up looking purplish, yellows that look too orange, and washed-out greens.

The package is a hardware/software combination that includes a board that fits into an Amiga expansion slot. It works with the Sharp JX-300 and JX-450 24-bit scanners and Gold Disk's Professional Page desktop publishing package. Pages can be converted to electronic color separations, saved in PostScript format, and sent to a bureau for film production for offset printing.

Professional ScanLab 1.1 requires an Amiga 2000 or 2500 with AmigaDOS 1.2 or higher and a minimum of 2 megabytes of memory.

Price: $995.
Contact: ASDG, Inc., 925 Stewart St., Madison, WI 53713, (608) 273-6585.

Ntergaid Upgrades Hypertext System for the IBM PC

Black Magic 1.4, a hypertext authoring system for the IBM PC, now generates reports, supports the extended ASCII character set (with international characters), and allows you to grab VGA and multiple images from a screen without having to name each successive file. Ntergaid added a DOS shell that lets you access other DOS programs.

When you're moving through your application, Black Magic notes what you've read and remembers it when you want to generate a report. The report is then written to a text file when you activate the link. Because Black Magic now supports international characters, you could use it to create a language instruction tutorial. The program's TSR screen grabber lets you grab VGA and multiple images, which you can incorporate into your program. If you import a CAD image, you can link specific points of that image to explanatory text. Documents can be as large as your available RAM.

Black Magic 1.4 runs on the IBM PC with 384K bytes of RAM (640K bytes is recommended), DOS 2.1 or higher, and a monochrome, EGA, CGA, or VGA graphics adapter.

Price: $89.95.
Contact: Ntergaid, Inc., 2490 Black Rock Tpk., Suite 337, Fairfield, CT 06430, (203) 368-0632.
Inquiry 994.

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

THE FACTS

Studio/1
$149.95

Requirements:
Mac Plus, SE, or II with at least 1 megabyte of RAM; it will run on a system with two 800K-byte floppy disk drives, but a hard disk drive is recommended.

Electronic Arts
1820 Gateway Dr.
San Mateo, CA 94404
(415) 571-7171
Inquiry 986.

Electronic Arts Decolorizes Studio/8

Last year, Electronic Arts brought out a color paint program for the Macintosh that is still the best in its class. The only problem with Studio/8 is the color. You can create some beautiful images with the program, but you need a Mac II with lots of memory, not to mention a color printer if you want to get the images off the screen.

Electronic Arts has now decolorized the program, added some capabilities, and released it as **Studio/1**. This monochrome paint package runs on anything from a Mac Plus on up. It's the most capable graphics program I've seen yet that will work on a system with just 1 megabyte of RAM.

Studio/1 has the same hefty toolbox as its colorful predecessor: freehand pencil, paintbrush, airbrush, text typer, filler, eraser, magnifier, selectors, a palette of 40 background/foreground patterns (including gradient fills), and tools for drawing straight lines, bent lines, rectangles, ellipses, polygons, triangles, freestyle shapes, and Bézier curves. Manipulating these shapes is easy; you can quickly rotate, distort, shrink, or stretch just about anything you can draw.

The capabilities for drawing and editing are enough to make this an excellent program. But Studio/1 also has animation facilities.

Not everyone has a need to whip up animated graphics, but the developers have designed such a nice process that this part of the program will lure even people who have gotten no closer to animation than Mighty Mouse cartoons. If you have done any work with animation, the method for creating moving pictures with this program will seem (pardon the cliché) intuitive. If this is new to you, the manual will help make it clear.

You can paint/draw each frame yourself or create key frames and have the program make the transitions from frame to frame for you. The animation control panel is straightforward; so are most of the dialog boxes, although I have some nonintuitive trouble with the setup for doing some three-dimensional effects. The rectangular control panel has buttons for moving backward and forward through the frames, for playing back the animation, and for setting the speed of the playback. One very handy feature is a simple thing: a line that tells you how much memory you have left for the rest of your animation. (I usually had about 160K bytes to start with and could comfortably fit in about 20 frames of fairly undense content.)

The Anim three-dimensional effects take some work to get used to, but they're worth the plotting if you like dissolves, zooms, and fades. By entering numbers for *x* and *y* axes, you can do some fancy visuals with this program. And with a folder of sounds, you can add sound effects (e.g., boing, warp, and bip) to the graphics. To really do much with Studio/1's animation functions, you'll need more than a megabyte of RAM, though.

The program works with most file formats, including PICT, TIFF, PICS, MacPaint, Encapsulated PostScript, and Electronic Arts' own format for compressed animation files, SIAN. I had a chance to scan some images with the program but wasn't able to check out its ability to play animations in HyperCard stacks. The package comes with a HyperCard disk for installing the Animation Driver XCMD. This is a complex program that takes time to explore. I had less than a week with beta software, so I'm sure there are other things I haven't hit upon.

Companies like Electronic Arts, Silicon Beach Software, Cricket Software, and SuperMac Technology have developed some very capable color paint programs, but Electronic Arts deserves extra points for remembering the Mac owners who don't have the luxury of equipment for color graphics—or for those people who prefer to work in black and white. After all, some of the best things in life—*The Honeymooners* and the first third of *The Wizard of Oz*, for example—are black and white. □

—D. Barker

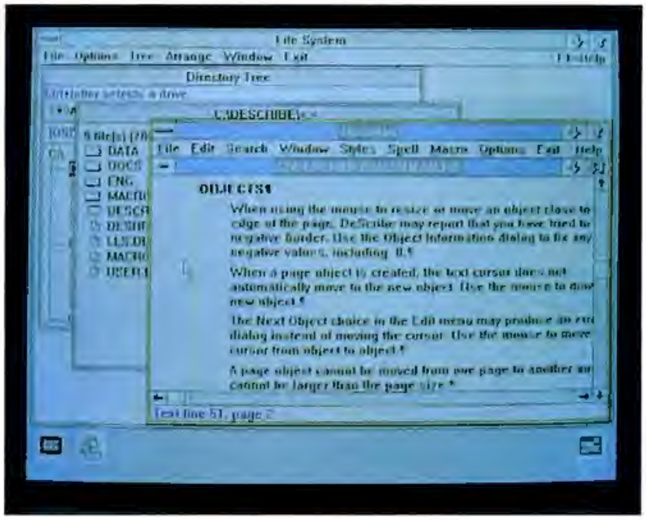
continued

Word Publishing for OS/2

If you're looking for something just a bit different in IBM PC–based word manipulation, Lennane Advanced Products, a recently formed company whose entire mission in life is producing programs for the OS/2 Presentation Manager (PM), is developing what it calls the **DeScribe Word Publisher** (DWP). The program is a real hybrid, lying somewhere between a word processor and a full-fledged desktop publishing package.

DWP is a true child of OS/2. Most of the under-development PM programs I've seen don't take full advantage of OS/2's very own graphical user interface. But it's evident that Lennane's designers are committed to PM. They started with a given (PM) and asked themselves how a word-manipulation program could take the best advantage of it. Despite some rough edges, they're well on their way.

My copy of DWP was an alpha version. Understandably, it had its bugs and shortcomings. But after only 15 minutes, I was happily producing multicolumn documents with a variety of fonts, type sizes, and styles. If you, like me, have ever spent hours attempting to get one of the leading desktop publishing programs to produce a simple multicolumn page layout, DWP is a minor revelation.



THE FACTS

DeScribe Word Publisher
$399

Requirements:
An 80286- or 80386-based IBM PC or compatible running OS/2 1.1, with at least 2 megabytes of RAM and a hard disk drive.

Lennane Advanced Products
4047 North Freeway Blvd.
Sacramento, CA 95834
(916) 646-1111
Inquiry 987.

Its user interface is remarkably intuitive. I rarely had to call up the extensive (800K-byte) help file. DWP uses those ubiquitous style sheets to customize the look of a page or even a block of text. But unlike competitors, the program's style sheets are easy to fill out. And they're not set in stone either. I found I could change the layout of a page on the fly with a couple of mouse-clicks.

But DWP's variable undo feature is absolutely unique among PC-based word processors. And it's almost worth the price of admission by itself. I've been frustrated by the so-called undo ability of most word processors. If you're lucky, you can undo just your last change and maybe a level or two back. But DWP's variable undo lets you undo any number of changes, all the way back to when you started working on the document. The last time I saw something like this was in my first word processor, which ran on a VAX.

Several high-end PC-based word processors come close to DWP. But none are anywhere near as easy to use. DWP does have one major shortcoming in its lack of graphics capabilities, which won't be available until next year. DWP was also molasses-slow on my 10-MHz AT clone. It's a bit more acceptable on a 20-MHz AT, and (as you might expect) it flies on a 33-MHz 80386. DWP isn't the be-all, end-all PM program, but it's a solid start, and it's the only program I've seen that's actually fine-tuned to PM. ▢

—Stan Miastkowski

Save and Annotate Your Mac Output

Two of the definitions in *Webster's Dictionary* for the word *utility* are, as a noun, "fitness for some purpose or worth to some end," and, as an adjective, "capable of serving as a substitute in various roles or positions." Solutions International's **SuperGlueII** is one of those versatile Macintosh utilities that assumes both roles.

Its fitness of purpose comes from providing the Mac with a "print to disk" capability. That is, it captures an application's printer output and redirects it to a disk file. Since printing operations are graphics-based on the Mac, the file becomes a copy of the document, down to the different fonts, embedded charts, and diagrams. SuperGlueII then serves as a substitute in that you can "print" your PageMaker newsletter and then send this file for evaluation to a graphics designer who doesn't have PageMaker.

SuperGlueII consists of two main files, ImageSaverII and SuperViewer, plus several support files. The ImageSaverII file masquerades as a Chooser-selectable printer driver, redirecting the application's printer I/O to a file. The SuperViewer file is the other half of the equation: It's the application you use to examine these files. Since there's no licensing fee for distributing SuperViewer, you're free to send a copy of it along with your output files.

You can adjust ImageSaverII to emulate either an ImageWriter or a LaserWriter from the Page Setup dialog box for those applications that can deal with only these printers rather than ImageSaverII's generic printer (the default). When you're ready to print, you can select what format the output is to be saved in (Image, BackFAX cover page, PICT, Scrapbook, or text only) and optionally preview the output.

The SuperViewer application lets you look at and perform some slick operations on these captured files. You can extract portions of text or extract parts of captured images

continued

THE FACTS

SuperGlueII
$119.95

Requirements:
Mac Plus, SE, SE/30, or II running System 6.0.2 or higher with 1 megabyte of RAM.

Solutions International
30 Commerce St.
Williston, VT 05495
(802) 658-5506
Inquiry 988.

using either the built-in Marquee or Lasso tools. Where SuperViewer really shines is in its GlueNotes feature: You can annotate a document, both text or graphics, with the electronic equivalent of Post-it notes. This is similar to the Notes feature in MacDraw 1.1, but the advantage here is that you can annotate anything that can be printed, and the notes can hold text or an image (but not both). SuperViewer can print these files, including their notes.

The printed output of files containing notes is handled elegantly. First, there's a thumbnail (miniature) view of the document, with each note's position marked on the image and assigned a number. Following this thumbnail view are, by number, the notes themselves. It's an effective way to keep what might be large amounts of disparate information organized.

I used a late beta version of SuperGlueII on a Mac II equipped with 5 megabytes of RAM and 32-Bit QuickDraw, and running System 6.0.3. ImageSaverII worked well with word processors (FullWrite Professional 1.0, MindWrite 2.1, and MacWrite 5.0) and graphics applications (MacDraw 1.1, PixelPaint 2.0, and SuperPaint 2.0). The Preview window worked well, even with PixelPaint, where it displayed a full-color view of an image before I committed the output to a file.

However, applications that emit special PostScript commands can cause problems or give you what looks like an empty file, but actually contains PostScript code. Offenders in this area are Adobe Illustrator, Aldus FreeHand, and early versions of PageMaker. Some of these problems should go away with the improved printing drivers in System 7.0, but until then, check out the application carefully before attempting to save output to your Macintosh's hard disk. GlueNotes worked fine, but I wish that you could open all the notes at once, rather than just one at a time as you must do with the current implementation.

Despite these minor quirks, SuperGlueII's ingenious capture mechanism worked without a hitch, even with color graphics, and GlueNotes lets you comment on a document in a simple, intuitive way. If your work has you shipping information electronically across the country in a medley of formats and wishing there was an easier way, SuperGlueII is a must buy. □

—Tom Thompson

Text Marries Graphics under Windows

With **Amí Professional**, Samna adds a boatload of features and improvements to the original Amí, the company's inexpensive ($199) program that combines word processing and basic desktop publishing under the Windows graphical user interface (GUI). Amí Professional lets you do fairly sophisticated graphing and drawing, use macro commands, and import TIFF, XLC, PIC, EPS, and PCX graphics files. At press time, Samna was working on supporting CGM files.

The new version also supports Dynamic Data Exchange, a protocol developed by Microsoft for message passing between applications. Using DDE, changes made to a spreadsheet would automatically update a related graph in Amí Professional. The program can also import data from non-DDE programs like Lotus 1-2-3.

But first things first: If word processing is your primary application, beauteous graphs and such aren't worth much if the program you're working with can't efficiently manage text. This program lets you work in two modes: draft, for high-speed text entry, and layout, which gives

continued

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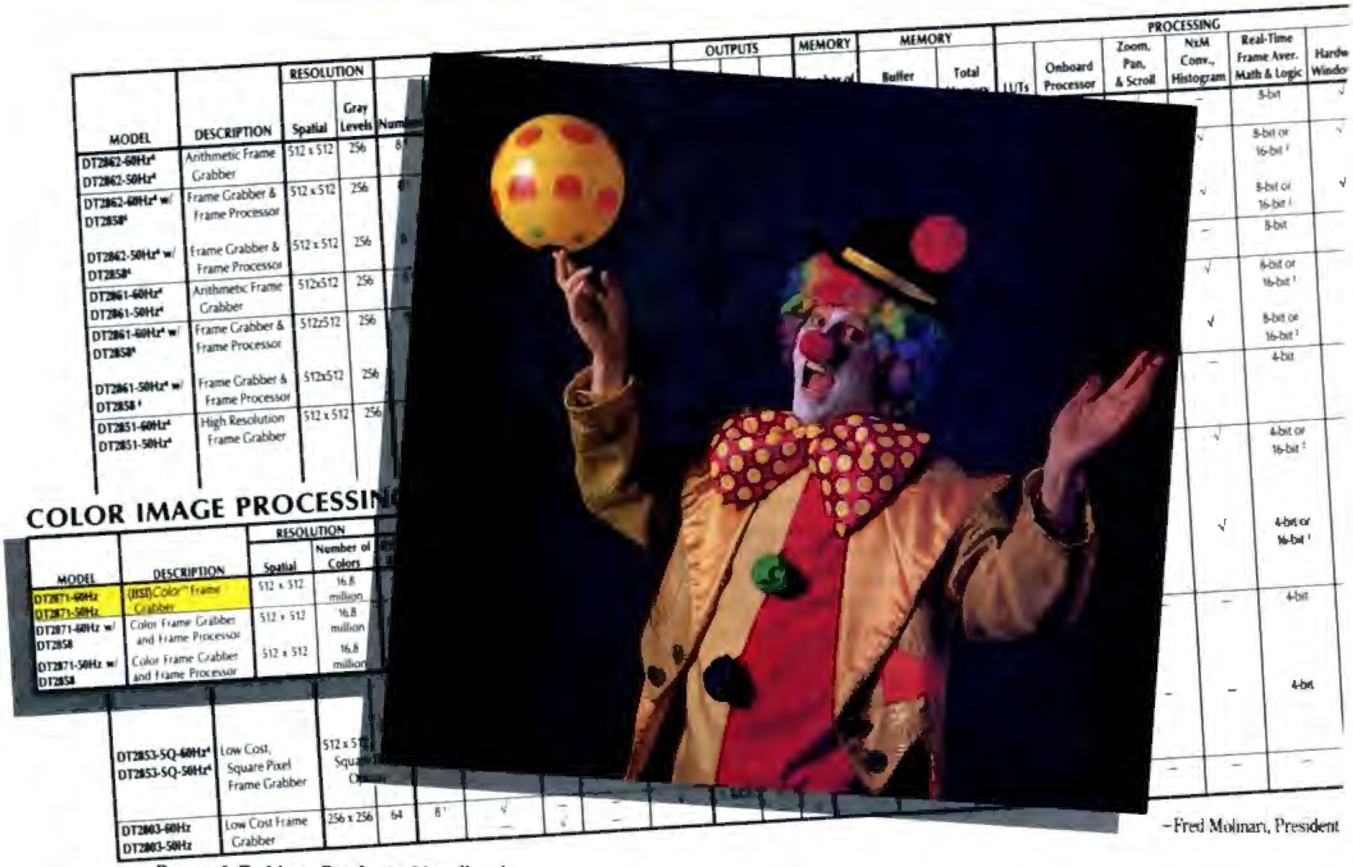

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you a preview of the finished product as you type.

With Amí Professional, you can create a document with footnotes, a table of contents, and an index. Amí doesn't treat footnotes and your index as outcasts. They are included with the main copy, which allows you to edit them on the same page as the rest of your text. When generating the table of contents, all I had to do was tell the program the styles for titles and headings; Amí Professional collects them into a table of contents and adds the correct page number. When I double-clicked on an item in the table of contents, the program took me directly to the page. A similar approach is used for indexing.

Amí Professional lets you use DDE in two ways: You can link Amí with another Windows application where both applications are active on your screen, or you can use a file-importing function that updates the linked files when you load them.

Other features include complex headers and footers, mail merge with conditional statements, and a tables facility that lets you create and maintain tabular formats and bring in data from spreadsheets. The program lets you add hidden notes, which is handy when several people want to review a document and make comments to it. What I liked about Amí Professional's implementation of annotated notes is that if you anchor a note to a word and someone accidentally deletes that word, the note will remain intact, preventing accidental deletions of comments.

One common complaint against full-blown desktop publishing packages is the slow reaction when substantially editing a document in WYSIWYG mode. Sometimes, you have to get back in your word processor, make your edits, and repour the document into your desktop publishing program. Amí Professional also is not a speed demon. However, while draft mode is best for text editing, you won't be twiddling your thumbs too often while editing in layout mode. The beta version I looked at was faster than the original Amí, but at press time, Samna was still tweaking the program's speed capabilities.

As for Amí Professional's page layout and drawing capabilities, the program is not (and is not meant to be) quite in the same league as full-featured desktop or drawing packages. But what it does, it does nicely, and the GUI made it easy. The program can do basic drawing (e.g., ellipses, lines, circles, and round-cornered boxes). I created a bar chart from text data I'd already entered by using the mouse and simply selecting the type of chart I wanted.

Amí Professional can wrap text around graphics frames, support multicolumn and variable-width column layout, and anchor defined text or graphics to the main body of text. You can also use the program to edit gray-scale images for qualities like contrast and brightness.

If you're looking for a program that can do desktop publishing and word processing for under $500, I recommend that you look closely at Amí Professional. It bundles power with simplicity. □

—David L. Andrews

continued

THE FACTS

Amí Professional
$495

Requirements:
IBM PC with 640K bytes of RAM and Windows 2.01 or higher (a run-time version is included); a Microsoft Mouse is recommended.

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Atlanta, GA 30342
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(404) 851-0007
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Send a POSTcard to Your PC

Award Software's aptly named **POSTcard** is an add-in card that monitors your IBM PC during the POST (power-on self test) sequence that's run from the ROM BIOS every time you turn on your system. POSTcard has both a dual-digit LED display and a setup of 10 individual LEDs that tell you (in hexadecimal and binary, respectively) what tests are being performed. If your system locks up, it tells you exactly where the problem lies.

POSTcard's power lies in its ability to test a system without the need for an operating system, a monitor, or a disk drive. It's particularly useful for apparently dead and otherwise-undiagnosable systems. I borrowed an "unfixable" AT motherboard from a local computer store, plugged in POSTcard (into an 8-bit expansion slot), and within minutes found that its problem was a defective direct-memory-access controller chip.

Beyond the POST, POSTcard also automatically performs extensive diagnostics on major system components, including memory, disk drives, and communication ports. Its unique ability to continually loop through the same tests is particularly valuable for isolating those annoying intermittent problems. My AT was occasionally locking up for no apparent reason, and diagnostic software told me nothing was wrong. But after nearly a full weekend of nonstop looping, POSTcard found a sticking memory chip.

POSTcard isn't designed for novices. You'll need a solid knowledge of PC hardware and your BIOS. Even with its well-written manual, I spent well over an hour puzzling over setting the card's two banks of DIP switches. Add its price tag, and it's clear that POSTcard isn't the type of add-in that's designed for everyone. But if you repair computers for a living or are responsible for a building full of corporate PCs, POSTcard can save scads of time and money—not to mention your sanity. ■

—Stan Miastkowski

THE FACTS

POSTcard
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Not Quite as Simple as 1-2-3

The new high-end release 3.0 of Lotus 1-2-3 finally arrived, endowed with a huge assortment of long-awaited features—but the features come at a price

Few software packages have ever been more anticipated than Lotus 1-2-3 release 3.0, the new three-dimensional spreadsheet application from Lotus Development. Now that release 3.0 is here, the news is decidedly mixed. The product adds dozens of new features and capabilities, and it addresses weaknesses that have plagued 1-2-3 for years. But release 3.0 is so big that it needs at least 1 megabyte of memory and an 80286 or higher CPU just to operate, and it's so slow that it runs at almost half the speed of release 2.01 on the same hardware.

Lotus originally announced release 3 back in 1987 as the next upgrade for 1-2-3 users. But early this year, the company abandoned its effort to bring out a single upgrade to 1-2-3 and instead divided the product into two versions, one for high-end PCs and the other for low-end PCs. Release 3.0 is the high-end product, a wholly rewritten 1-2-3 that runs under both DOS (with a built-in extended-memory manager) and OS/2 (in character mode, without Presentation Manager). For low-end users who are seeking an upgrade path, this fall Lotus will release a less-ambitious 2-D version of 1-2-3 called release 2.2.

It's obvious with both of these new releases that Lotus has listened to its customers. Both are chockablock with the sort of new features that the user community has been clamoring for, ranging from the minor (e.g., 1-2-3 now warns you if you try to exit without saving your file) to the major, such as an undo function and a keystroke recorder for building macros.

Ironically, the new richness of features comes at the expense of simplicity, and Lotus's famous user interface, already showing signs of aging in the brave new world of Mac-like user interfaces, is stretched to its limit. This is the biggest drawback to 1-2-3 in today's market: Lotus has given users dozens of new features and functions, but the product just can't offer the user-configurability and graphical power available in newer packages like WingZ.

The Third Axis

The major improvements in release 3.0 are 3-D ability, background recalculation and printing, and improved graphics. By far the most significant is the addition of a third dimension. "Depth" is created by allowing spreadsheet files to consist of multiple pages, or "sheets," all of which are resident in memory at the same time. For the sake of simplicity, all these sheets can be referenced by a single filename, and operations familiar to 2-D denizens, such as range naming, copying, formatting, and summing, all work identically in 3-D. The only difference is that in front of the normal A1 cell address is a sheet designation (i.e., A:A1) that is used to reference any cell in sheet A. Each sheet can be large (up to 8192 rows long and 256 columns wide), and each file can have 256 sheets.

3-D spreadsheets are a useful way to organize large files, such as consolidated financial statements or regional sales reports, where a similar structure is repeated from one page to the next. Thinking in 3-D takes a little getting used to, but Lotus's implementation is straightforward. Moving between sheets is easy, and release 3.0 gives you a Perspective function that allows you to view up to three sheets of a spreadsheet file simultaneously (see the photo).

The major drawback to the Perspective function is that the configuration of the three windows is fixed: The three are arranged horizontally, each is the same size and shape, and the sheets they show must be contiguous (e.g., you can display sheets B, C, and D, but not B, D, and G). You can partially get around this problem by hiding sheets the same way you can hide rows or columns, but that's inconvenient. I don't understand why the user can't, as in Lucid 3-D, determine the size, shape, location, and contents of each window separately.

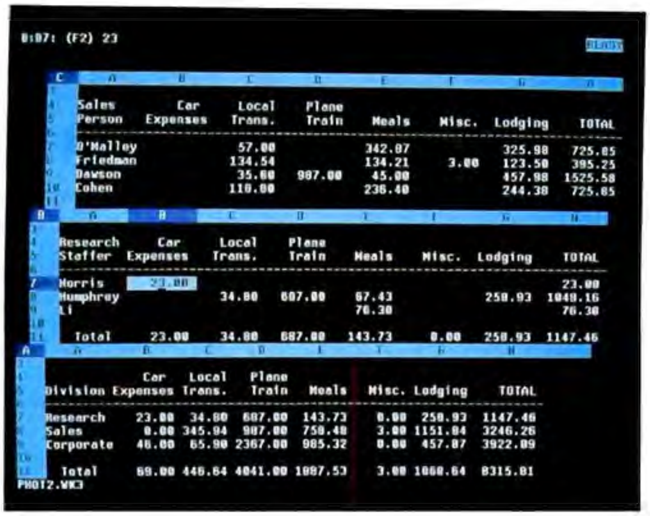
In addition to supporting worksheets with multiple pages, release 3.0 also permits you to load multiple worksheets into memory simultaneously and to establish hot links between them. Links between cells can also be made to "inactive" files—that is, files on the disk. These links are updated whenever the affected files are loaded into memory and recalculated. There's a big difference in performance between active and inactive links: If the linked file is in memory, updates are almost instantaneous, whereas from disk it takes much longer.

Saving Time with Foreground/Background

To save recalculating time, release 3.0 introduces two important enhancements: optimal and background recalculation. Optimal recalculation means that only those cells whose values have been, or will be, affected by a change get recalculated. With background recalculation, other activities can continue in the foreground while the spreadsheet recalculates. This is particularly important for power users whose massive recalculations sometimes tie up the computer for several hours at a time.

Naturally, activity in the foreground does slow down background recalculations: One test that took 16 seconds to recalculate with no foreground activity took 22 seconds when I moved the cursor constantly during the recalculation. The background capability also applies only if all the spreadsheets in a linked group are memory-resident; if disk access is required to update cells across inactive linked files, the computer is locked up until the recalculation is finished.

One benefit of backgound recalculation is that it hides how much slower release 3.0 is than release 2.01. As long as you don't have to sit around waiting for the computer, you are not as likely to be annoyed by how slowly it is working. (Some of this slowness may be due to the overhead involved with background recalculation.) Unfortunately, with very large spreadsheets you'll still want to disable automatic recalculation when doing data entry, and if you're running what-if analyses (where knowing the answer is the rate-limiting factor), background recalculations won't help you get results faster.



With the Perspective function, you can view three pages or sheets of a spreadsheet file at once. You can also easily jump between them, zoom in on one, or create formulas that involve cells on multiple sheets.

Graphics Galore, Printing Aplenty

A virtual cottage industry has sprung up over the years to enhance the graphics capabilities of 1-2-3, and now Lotus has incorporated some of those features into the package itself. The most important improvement is that you can now view a graph and a spreadsheet on the screen simultaneously in two vertical windows with "live" updating. Also, an automatic graph generator lets you create a "best-guess" graph with a single keystroke, and it is easier to specify data ranges. In addition, release 3.0 includes six new graph types, new scaling options (including two y-axes), and a set of advanced options for controlling colors, hatch patterns, fonts, and text size.

Another nice change is that you no longer have to exit 1-2-3 and enter the separate PrintGraph module to output graphs. Also, you can store graphs in either .PIC or .CGM formats, and you can print both graphics and spreadsheets in background mode, which saves a lot of time. (Printing graphs is still slow, but at least you're not waiting for the computer.) Other print enhancements are long overdue: You can set print attributes and specify landscape mode from within 1-2-3, cancel and suspend print jobs, save your print settings for future sessions, and even print the worksheet frame.

Release 3.0 also includes a number of small but useful enhancements in the Range section. There is a new data format, Automatic, that allows you to enter data in its native format—dates as dates, percents as percents, and dollars as dollars. Lotus 1-2-3 will understand it and automatically format the range appropriately. A new search-and-replace function lets you locate strings in labels or formulas, and you can now use a range name in a formula before defining the range.

For macros, which are the richest and most flexible part of 1-2-3, Lotus has added a macro keyboard recorder, 10 new macro commands, and the ability to specify unlimited macro names. Macros developed in earlier versions of 1-2-3 are fully compatible. Other general improvements include 14 new @ functions, nine new function keys, 10 pointer-movement commands, four new file-name extensions (including .BAK for automatic backups) and an easy-to-use install routine.

Auditing has been improved through the addition of a Map command that shows a pictorial representation of the spreadsheet with cells indicated as numbers, labels, and formulas, but, unfortunately, not links. Finally, at long last 1-2-3 includes an undo command, but in 3.0 it's a one-shot deal: Once you undo, you can't change your mind. (By contrast, the undo in 2.2 is a toggle.)

Performance

I extensively tested release 3.0 in both its beta and final versions and compared it to my trusty old copy of release 2.01. For hardware, I used both a high-end Compaq 33-MHz 80386 computer (with an 80387 math coprocessor and 4 megabytes of memory) and a much more modest 6-MHz 80286 with 2 megabytes of memory and no coprocessor. On the 80386, release 3.0 was approximately 41 percent slower than 2.01. (The complete suite of tests ran in 26.97 seconds under 2.01 and in 45.42 seconds under 3.0.) On the 80286, the situation was even worse. Release 3.0 was approximately 47 percent slower (409.94 seconds versus 215.04 seconds for 2.01).

My conclusion is that release 3.0 is best suited to 80386 environments with large amounts of memory. Release 3.0 did better relative to 2.01 on the 80386 computer than on the 80286 machine, but it was still far slower. On a fast high-end system, that slowness will be less apparent.

As a point of comparison, release 3.0 was also considerably slower than our beta version of the forthcoming release 2.2. We'll have more coverage of release 2.2 when it becomes available, but from our early look it appears that 2.2 is an improvement for users of low-end machines in both features and performance, while 3.0 trades off performance for new capabilities.

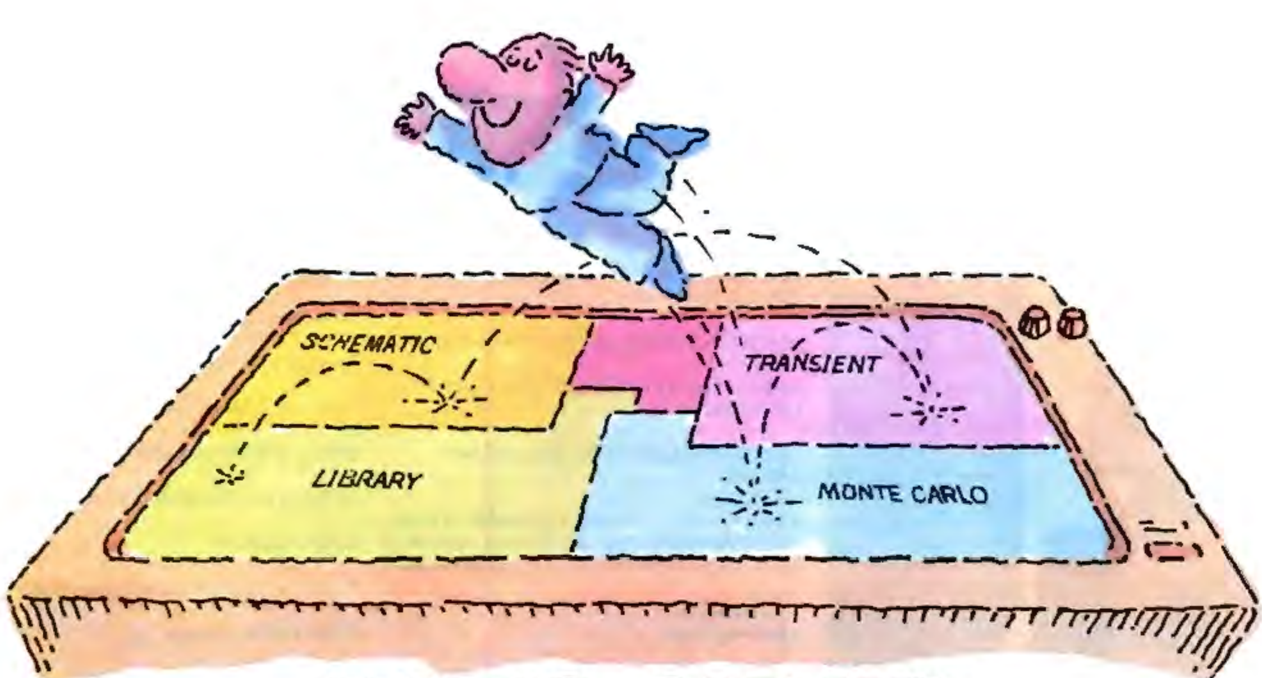
Worth the Wait?

This article has just scratched the surface of the capabilities of Lotus 1-2-3 release 3.0. BYTE will soon follow up with a full review, where we will be able to give a more detailed and thorough evaluation of the product. For the time being, however, some points are immediately apparent.

Release 3.0 is a big step up from the older versions of 1-2-3 in both features and functions. But these improvements seem to come with a price in performance. If you have a very fast computer, release 3.0 will allow you to create new worlds of complex spreadsheets. However, if you have a slower system (e.g., an AT-class system), you may want to sit back and wait for the new release 2.2 or check out the many 2-D and 3-D alternatives to 1-2-3 now available on the market, such as Excel, Quattro, Lucid, or Twin.

Was release 3 worth the wait? On high-end systems and certain applications that lend themselves easily to 3-D, yes. But other users may just want to continue waiting. ■

Andrew Reinhardt is an associate news editor for BYTE. He can be reached on BIX as "areinhardt."



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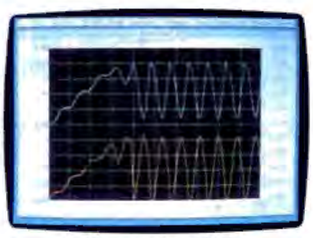
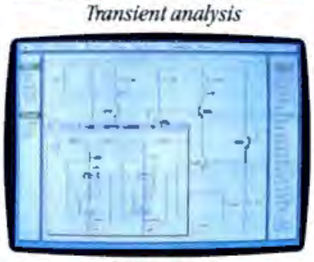


Transient analysis



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FIRST IMPRESSIONS ■ Paul Lavin and Michael E. Nadeau

The 486s Are Here!

Apricot's VX FT Server is the first announced PC to use the new Intel 80486 CPU

While IBM and Compaq have been loudly engaged in a one-upmanship battle over who leads the market, Britain's Apricot has quietly introduced the first PC based on Intel's 80486 CPU. Unlike IBM's recently announced 80486 Power Platform upgrade for the PS/2 Model 70, the Apricot VX FT Server, based on the Micro Channel architecture (MCA), is an entirely new system with an external RAM cache. This cache memory provides a significant performance advantage over IBM's product.

Apricot has built an impressive machine. The prototype VX FT Server with a 25-MHz 80486 CPU is faster overall than any other 25-MHz PC and most 33-MHz PCs that BYTE has benchmarked. However, it is not cheap; prices range from $18,000 to $40,000. Designed as a high-performance file server, it could nonetheless prove economical for large network or multiuser installations.

Apricot configures the VX FT Server in two versions: the Series 400 for network duties, and the Series 800 for multiuser Unix systems. They differ in RAM allotment and intelligent I/O ports (see table 1). Both versions provide multiple layers of data security. In Europe, an 80386 version is available in both series.

The Series 400 will be shipped with MS-DOS 4.01, although you can get the more powerful OS/2 Extended Edition as an option. The VX FT Server supports Novell NetWare, 3+Open, Microsoft LAN Manager, Torus Tapestry, and Apricot's own VXNet. SCO Unix System 3.2 is the chosen flavor for the Series 800. The 80486 machines will be available this month.

The model we tested was a Series 400/30 running MS-DOS 3.3. It had a 347-megabyte Maxtor SCSI hard disk drive, a 1.44-megabyte 3½-inch floppy disk drive, 12 megabytes of RAM, and, of course, an 80486 CPU.

The Box

Typical of Apricot PCs designed by Bob Cross, the VX FT Server is an unconventional yet attractive box. It's also big, measuring 2 feet tall by 2 feet deep by 16 inches wide and weighing (in a typical configuration) 165 pounds. Two retractable handles at the top of the unit provide purchase for four strong hands. The VX FT Server stands on skids. Apricot thought that using casters would increase the chance of damage, even though the system would be easier to move. Gigabyte file servers should be bolted to the floor; the skids were a compromise.

A distinctive feature of the box's external design is a backlit LCD panel (handy during a power failure) above a row of buttons. Under software control, the buttons provide access status information about the VX FT Server and control the sliding door that conceals the drive bays below it. The monitor panel functions are under system security control.

There are removable panels on either side of the box that provide access to the

continued

inner workings of the VX FT Server. A physical case lock is backed up by an alarm that sounds if you remove the side panels without first establishing your access privileges.

The grill at the bottom of the system unit conceals an air filter and the fan for cooling the power module. Another fan in the rear panel takes heat from the motherboard and expansion bay. With all the noisily moving air, the VX FT Server is easier to live with in the corner of the room than under your desk.

The Power of the 80486

The VX FT Server's 6.7 CPU index bests IBM's 80486 Power Platform upgrade, which tested at 5.3, as well as all but two of the 33-MHz 80386 machines we've tested (for these results, see the upcoming *Inside the IBM PCs*, Fall 1989). Its 21.8 FPU index is unmatched; IBM's Power Platform scored a 21.4. The Apricot's disk index is a so-so 2.3, but its video index is a near-record 5.2 (see table 2).

But the real payoff is in the application area. Although we were unable to run all the BYTE application benchmarks, those we did run challenged or beat those of the fastest 80386-based PCs. The only exception was the VX FT Server's subpar database index of 2.6. The database tests are disk-intensive. Apricot uses a SCSI hard disk drive rather than a faster ESDI unit for two reasons: The SCSI drive provides a greater throughput rate, and it lets you chain multiple drives off the same controller. If faster access times are needed, adding a hardware disk cache and a faster drive from a third party should be no problem.

The VX FT Server could not run all portions of the BYTE scientific/engineering tests, although the times for the tests it did complete suggest that it is significantly faster in this area than any other PC we've seen. An Apricot spokesperson said that some software would not run properly on the prototype 80486 CPUs from Intel and suggested that this could have been the cause of our benchmark problems.

The Qi to the VX FT Server

The VX FT Server is based on the MCA motherboard used in Apricot's Qi (pronounced "key") PC. The Qi has been sold primarily in Europe, although it and the VX FT Server are available in North America through Apricot's Canadian distributor.

The company has integrated a number of I/O features on the Qi motherboard, including serial and parallel ports, a mouse port, Ethernet (both thick and thin wire), an analog VGA connector, and a bisynchronous communications port, which you can use as two additional serial ports (see photo 1). A second serial port is dedicated to the front LCD control panel. Additionally, Apricot has built security into the hardware by using a spare 8042 keyboard processor with its own CMOS RAM and real-time clock.

Chips & Technologies provides the MCA chip set that was developed with Apricot input. The BIOS is by Phoenix Technologies.

The motherboard, measuring 15 by 14 inches, fits comfortably into the system unit (see photo 2). It is the same one used in the other 80386 Qi models, but with an 80486 mounted on a daughtercard. (Unlike the IBM PS/2 designs, the 80386 CPU in the Apricot sits on the motherboard, not on a daughtercard.)

The daughtercard holds the 80486, the 82385, static RAM (SRAM), and associated programmable array logic (PAL)

Table 1: *The VX FT Server model designations and respective base configurations.*

Model	Cache memory (K bytes)	Standard RAM (megabytes)	Hard disk drive size (megabytes)	Serial channels	Maximum number of users
400/10	64	4	157	N/A	N/A
400/30	128	4	347	N/A	N/A
400/60	128	4	647	N/A	N/A
400/90	128	4	1047	N/A	N/A
800/10	64	8	157	32	64
800/30	128	8	347	32	96
800/60	128	16	647	64	128
800/90	128	16	1047	64	128

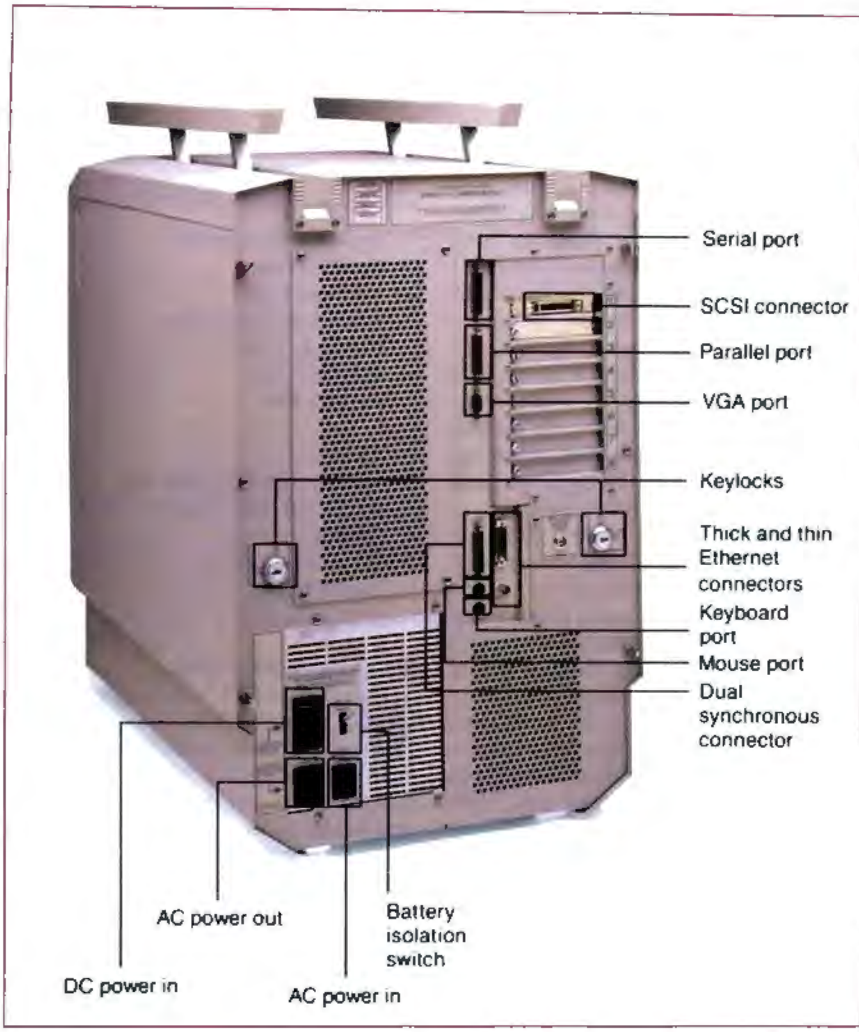
Note: N/A = Not available

Table 2: *Indexes based on BYTE benchmark results. The VX FT Server is faster than the IBM Power Platform 486 and most of the 33-MHz 80386 PCs. (Indexes for the fastest 33-MHz PCs are not shown; only preliminary tests were run.) All tests were run on beta or prototype machines; times for shipping units might vary.*

	CPU	FPU	Disk I/O	Video	Word processing	Spreadsheet	Database	Scientific/ Engineering	Compilers
Apricot VX FT Server	6.7	21.8	2.3	5.2	5.5	4.6	2.6	N/A	5.0
IBM Power Platform 486	5.3	21.4	1.8	4.3	N/A	N/A	N/A	N/A	N/A
ALR 33/386	6.6	11.1	2.3	1.6	N/A	N/A	N/A	N/A	N/A
Zenith Z-386/33	4.8	N/A	3.1	3.0	N/A	N/A	N/A	N/A	N/A

Note: Indexes show relative performance. For all indexes, an 8-MHz IBM PC AT = 1. N/A = Not available.
For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

Photo 1: *The back of the VX FT Server sports numerous I/O ports and other outlets. The rugged handles on the top of the unit make carrying the system relatively easy for two or more people.*



chips. It plugs into both the 80386 and 82385 sockets in the original Qi mothercard. Eventually, a revised 80486 motherboard will replace the daughterboard arrangement, but probably not until a 33-MHz version of the 80486 becomes available.

A bank of single in-line memory modules provides main system memory. The motherboard can accommodate up to 16 megabytes of RAM using Apricot-sourced double-decker SIMMs. Using the more readily obtainable 80-nanosecond parts, the motherboard holds 8 megabytes.

While the 80386 benefits from the 82385 cache controller and a 64K-byte bank of 35-ns SRAM, the 80486 itself has 8K bytes of four-way set-associative cache memory on-board. Apricot has added an external 128K-byte cache using 25-ns SRAM orchestrated by a 25-MHz 82385 and some custom PAL work. This arrangement has been christened Hypercache. The low-end versions of both series use a 64K-byte cache.

According to Apricot, Intel expected PC manufacturers to use the 80486 without any external caching, at least until both an "82485" and a 33-MHz version of the 80486 were in production. Rather than suffer the inevitable wait states or use faster, less-economical system memory, Apricot devised its own 82385 solution.

Apricot claims a 95 percent to 96 percent hit rate with its two-way set-associative cache system, depending on the code being run. The company thinks that the

continued

Photo 2: *With only SCSI and run-length-limited disk drive controllers in two of the eight MCA slots, the inside of the VX FT Server looks empty. Note the large daughtercard on which the 80486 CPU sits. Apricot plans to integrate the CPU on the motherboard sometime in the future.*

external cache is vital for multiuser performance; it unloads a good chunk of bus traffic and enables the 80486's burst mode. The BYTE benchmarks bear this out. IBM's 80486 Power Platform uses no external cache and suffers the consequences. For example, the VX FT Server was about 1.6 times faster than the IBM product on the string-move portion of the BYTE CPU tests. On the matrix, Sieve, and sort portions, there was virtually a tie. The string-move tests make extensive use of cache memory.

The 80486 has full floating-point capabilities built in. The 80486's computational abilities are alleged to exceed those of a Weitek 3167 math coprocessor while maintaining compatibility with 80287/80387 code. The BYTE FPU index supports that performance claim.

Courtesy of a plug-in bus extension, the VX FT Server has eight MCA expansion slots: four 32-bit and four 16-bit. The Chips & Technologies 452 VGA controller, a high-performance video extension, is available on one of the 16-bit slots, although it was not installed in our demonstration unit. In addition to the eight physical slots, two phantom slots let you configure the Ethernet and bisynchronous port options.

Making Your Data Secure

Given that the VX FT Server will hold a lot of valuable data, Apricot has gone to some length to provide more security than most PC-based file servers offer.

Two built-in 12-amp/hour solid electrolyte lead-acid batteries provide backup power. A lightly loaded VX FT Server could conceivably run for 1.5 to 2 hours on the batteries, but a fully configured machine, including a monitor, would get about 15 minutes—plenty of time for an orderly software-controlled shutdown. A switch on the back of the unit lets you disconnect the battery.

Temperature monitors are linked with sensors that detect electrical failure in the cooling fan. An alarm sounds if the machine runs too hot, and an automatic software-controlled shutdown occurs.

The keyed lock at the back of the system unit is only the first portion of the VX FT Server's access control. The company offers a $450 security package called the Qi Environment. It includes a microprocessor-controlled infrared remote device and a master reference disk that guards access to all or part of the VX FT Server's services. You point the infrared card at the sensor on top of the unit, click, and then enter a code for access. Unauthorized attempts to access components or data sound an alarm that is specific to the offense.

The computer's security scheme is flexible enough for you to shut off the Ethernet link in the evening or on weekends but still allow system access for backup at preselected times. You can also enable or disable disk drives or any of the eight expansion slots. The security is menu-driven, and its configuration is stored on the master reference disk. If you lose or damage this master disk without having made a backup, you have to contact Apricot for a replacement. You can leave the security system inactive.

Mass Storage

As befits a well-designed file server, the VX FT Server has mass storage capacity to spare. The system box has space for six full-height devices, one of which must be fitted to provide mounting for two half-height drives. Three drives are inserted from the front, and three from the rear. Between the two stacks of drives is a plug-in partition holding two 4-inch-diameter cooling fans.

The standard VX FT Server has one 1.44-megabyte 3½-inch floppy disk drive and one of four hard disk drive options. The Series 400/10 and Series 800/10 have a 157-megabyte SCSI Maxtor drive. The other 80486-based models, the 30, 60, and 90 in each series, also use SCSI Maxtor drives run off an AHA 1640 Adaptec controller fitted into the MCA backplane. The drive capacities are 347, 647, and 1047 megabytes, respectively. Average access times are in the sub-16-millisecond range.

Apricot lacks a slick hardware-based mirroring system like that found in the DPT SmartCache controller, but the company has implemented one in software. This poor man's version of disk mirroring may be marginally slower in writes to disk, but it doesn't require the development of a special, low-volume controller card. Although the SCSI controller can nominally have up to seven devices daisy-chained to it, Apricot suggests fitting a controller for each drive to get maximum performance.

With the potential for up to 5 gigabytes' worth of hard disk drives humming away inside the box, Apricot has not skimped on the power supply. It's a 465-watt monster with built-in surge protection.

The three tape backup options range from the ridiculous (in the server context) to the sublime. An 80-megabyte DC2000 tape streamer that runs off the floppy disk drive controller is at the leanest end of the tape options. A somewhat more useful 150-megabyte SCSI tape drive from Irwin Magnetics sits in the middle of the range. For the VX FT Server user with 1 or 2 gigabytes in the box, Apricot supplies a 1.2-gigabyte DAT/DDS (full-height) digital audio tape drive from Hewlett-Packard. No price has been set as of this writing for the DAT/DDS drive.

Microcomputer or Minicomputer?

With the 80486 VX FT Server prices starting at $18,000, Apricot is competing with both PC-based workstations and low-end minicomputers. Considering its performance, its security features, and the number of users it can serve, the VX FT Server should be a cost-efficient alternative to those systems.

It's not perfect. The prototype unit we tested overheated easily and would not run some of our benchmark software. We expect that these problems will disappear in units with production CPUs, however.

Although the SCSI drives provide easy mass storage expandability—an important feature to consider for a growing network—some users will want hard disk drives with faster access times. Apricot should think about offering a hardware cache controller and faster ESDI drives as options.

The 80486 has popped up sooner than expected, and with it a new standard in the price/performance ratio. It is too soon to announce the death of the minicomputer again, but the power that the 80486 provides, as Apricot has demonstrated, will be giving many midsize-computer makers nightmares. The good news is all for the users. ■

Paul Lavin is a writer and consultant living in the U.K. Michael E. Nadeau is a BYTE associate managing editor. You can reach them on BIX as "plavin" and "miken," respectively.

COMPANY INFORMATION

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THE WORLD ON CD-ROMS

Jerry looks at current CD-ROMs, WORM drives, and UPSes

I am supposed to be hard at work on *Wrath of God*, a sort of sequel to *Lucifer's Hammer*, but it's hard to concentrate while they're shooting students on the Avenue of Eternal Peace in Beijing. A civilized army will fight and die to prevent the massacre of its nation's citizens. I keep hoping the Chinese People's Liberation Army will remember that. I also keep hearing a line from Robinson Jeffers, "Long live freedom, and damn the ideologies."

ERRMON

You may recall that a few months ago I had, or thought I had, hard disk drive problems, particularly on the Zenith Z-386; but after exhaustive disk media analysis, I wasn't able to find anything wrong. After I wrote that column, BYTE's editor in chief Fred Langa sent me a small program that actually solved the problem. (He sent it over BIX; the "attach" command in BIXmail is a very convenient way to send any kind of file, including binary files in ARC format.)

It's a freeware program written by Robert J. Newton, called ERRMON. This is a small TSR program that sits there waiting for DOS to detect a drive error; when an error is detected, ERRMON tries to figure out what it was and then posts a message on the screen. This message is generally considerably more helpful than the ones DOS puts up. Besides, it works inside other programs. In particular, it works inside Coretest; and Coretest was the only program that thought I had a problem with the Z-386 hard disk drive. Coretest, you may recall, kept reporting a READ ERROR on that disk, although no other program could find a thing.

ERRMON saw what the trouble was immediately. While Coretest was reporting a READ ERROR, ERRMON printed out its strange error message number, which, being interpreted by referring to the table in the ERRMON.DOC file, translates to: "Direct-memory-access boundary crossed. This indicates a software problem. DMA cannot operate across 64K-byte segment boundaries."

Presumably, there is some odd interaction between Coretest, DOS, and the Z-386 BIOS, which is why this happens only when you run Coretest on that particular machine. I expect I could find out more if I took the trouble, but the fact is I'm just relieved to know there's no real difficulty with the Zenith hard disk drive—and there never had been. My files are safe.

ERRMON is available on BIX and other BBSes, and it's copyrighted freeware, meaning you can use it and give it away, but you can't sell it.

Just after I wrote that, I got a note from Doug McFadyen ("dougm" on BIX), who reports that if you upgrade to the 2.5A version of the Z-386 ROMs, Coretest no longer reports a problem. I'll try that and let you know.

Golden Bow Strikes Again

John Carr has been using the AT&T PC 6300 Plus, an older IBM PC AT compatible, to enter the introductory essays for the next volume of my anthology series on the future of conflict (*There Will Be War*, Tor Books). We've had that machine quite a while. First it was my main text system; then Mrs. Pournelle inherited it and named it Attila the Honey. She kept it until we got her an 80386. Now John uses it for general office work.

A couple of days ago he had a problem: the AT&T PC 6300 Plus was taking several retries to save files. John is a science fiction editor; he knows nothing about computers, and problems are definitely not his department.

It took me about 2 minutes to discover there was a flaky sector somewhere on Attila's hard disk. We did a quick backup of John's work onto a floppy disk and invoked Golden Bow's Vmarkbad, a program that comes with their Vopt disk optimizer program. As the name implies, Vmarkbad finds and marks bad sectors on a hard disk, examining the disk at about 2 megabytes a minute. It found eight or nine bad sectors, making me wonder if Attila hasn't suffered some unreported traumatic injury.

Unlike SpinRite and some other "disk repair" programs, when Vmarkbad finds a bad sector in a currently active file, it reports the filename. In our case, there were bad sectors in seven files. Three of those were .BAK files, and one more was in a file we'd just copied onto a floppy disk. The other three were Q&A auxiliary files, including the one that handles text saves. It was no trick to get the original Q&A disks and recopy those files.

Then we used Norton Commander to go through all the directories and eliminate needless files, something John just won't do. There were a bunch of tutorial files, .BAK files by the score, and just a lot of general garbage. After that cleanup, I used Vopt to compact the disk, ran Vmarkbad again, and just for luck ran Norton Disk Doctor. No new bad sectors found, and Attila hums along as if nothing had ever happened. There's a dance or two in that old boy yet.

I received my version of Vopt and Vmarkbad in January 1988. There may or may not be updates. I have a number of programs that are supposed to do the same job as the Golden Bow tools, but I've never seen any good reason to change; Vopt and its auxiliary programs are a lot more than good enough.

A Study in CD-ROM

At the West Coast Computer Faire, I was given two copies of the entire Sherlock

continued

Holmes canon, one on floppy disks, the other on a CD-ROM. The CD-ROM version is called Sherlock Holmes on Disk! and also has *The Medical Casebook of Dr. Arthur Conan Doyle* by Alvin E. Rodin and Jack D. Key; linoleum block prints by Dr. George Wells; medical poetry by Dr. George Bascom; and all kinds of indexing and retrieval software. The publisher is CMC ReSearch.

There are no documents, but none are needed. Simply log onto the CD-ROM and type DP; the rest is pretty automatic. After a few questions about your system configuration, you're at the main command screen. This has pull-down menus that work about as you'd expect them to, including menu items for text searches. Once I was clear on how that worked, the first thing I did was use word search to look for any story with the words: dog .AND. curious .AND. nighttime. (The program uses .AND., .OR., .NOT., and so forth as commands for Boolean searches.) It took about 10 seconds for it to tell me there was only one match, "Silver Blaze," which is the story involving the curious incident of the dog in the nighttime: "'The dog did nothing in the nighttime.' 'That was the curious incident,' remarked Sherlock Holmes."

Pressing Return put that story on the screen. It puts the text in black letters on a soft white background, quite easy to read, and next thing I knew I'd read it all instead of working on the column. Then I looked up Persian .AND. slipper, expecting that there would be a dozen matches, but in fact there were only three: "The Adventure of the Empty House," "The Musgrave Ritual," and "The Naval Treaty." That slipper is so famous I was sure there was some mistake and tried again, this time using "persian," but I got the same result; the search isn't case-sensitive.

There are nine matches on Moriarty but only seven on Moriarty .AND. Professor. I haven't had a chance to look at the differences.

I'm sad to say I have not seen the linoleum block illustrations that are supposed to be on the disk. When I try to access any of the graphics (including the chart in "The Naval Treaty"), the CD-ROM drive light blinks, and something obviously is read from it, but then the screen goes blank; all I can do from there is escape back to the story. The program documents say you must have a 640- by 480-pixel VGA board and monitor capable of 256 colors, but that's a generic description of VGA. The program itself offers you a menu of two VGA boards, the Orchid Designer VGA and the STB VGA Extra/EM. I've tried invoking the program under each option, but neither lets my Video Seven V-RAM VGA show the pictures.

I've often thought CD-ROM was an ideal medium for presenting not only the Sherlock Homes canon, but just about every word written about England's greatest detective, including all the issues of *The Journal of the Baker Street Irregulars*. It could also have maps of London in Victorian times, illustrations from contemporary newspapers, and all that sort of thing, possibly linked by hypertext.

Most of the CD-ROMs I have are disappointing given the potential of the medium.

Sherlock Holmes on Disk! doesn't have all that, but it is fun; it's another of those programs that you probably wouldn't buy a CD-ROM drive for, but if you already have the drive, it's a neat thing to have around. It's amazing what you can find out about the Holmes stories with the proper Boolean searches.

Geography Lesson

I have a whole bunch of CD-ROMs I collected at the Microsoft CD-ROM conference last spring. Most are a bit like Sherlock Holmes on Disk!: not bad, but disappointing given the potential of the medium. An example is the World Atlas by Electromap. This gives a pretty good high school-level atlas, which starts with two views of the world, physical and political; if you use a mouse or arrow keys to go to a region of interest and press Return, up comes a more detailed map of that area. You can then go down one further level to maps of individual countries.

Alas, that's as far down as it goes, and at the country level there isn't a lot of detail. For example, the U.S. map has perhaps 40 cities and half a dozen rivers. The USSR map has even less information.

The geographical maps aren't the real point, though. There are numerous statistical maps, each accompanied by pull-down menus of information on economics, population, languages, population density and growth rate, infant mortality, life expectancy, and a whole bunch of other stuff from the *World Almanac*, all given for each country and listed both alphabetically and by parameter order.

If you're interested in inflation rates, you bring up that map and then go to the menus. If you want to find the country with the smallest inflation rate (Equatorial Guinea with a rate of −18 percent) or the largest (Nicaragua, 1800 percent; next is Vietnam with 700 percent), it's easy, and if you want to look up a specific country (say, Liberia, 3.6 percent), it's simple enough. Ditto for population growth (Hungary, −0.2 percent, Brunei +8.6 percent annual) and a raft of other stuff. You can spend a couple of hours playing about with this with no trouble at all.

Access is reasonably fast, but it seems slow compared to a hard disk drive. Of course, I have a *very* fast hard disk drive. In any event, it's quicker to find specific information on this CD-ROM than it would be to go look it up in your atlas or almanac.

Once again, you wouldn't buy a CD-ROM drive for this, but if you've got students in the house, it would be worth letting them browse through this.

I do wish there were more detail. Electromap says they're doing a U.S. atlas that will have both political and topographic maps of each state, plus a great many more statistical maps.

A second atlas-type CD-ROM comes from the CIA. The World Factbook is available from Quanta Press. This has a directory of maps, one outline for each country or territory, at 300-dot-per-inch resolution in TIFF format suitable for desktop publishing. The World Factbook consists of 248 data cards much like the 5- by 8-inch paper index cards you used to make up in the library (although there's a bit more information on many countries than you could conveniently put on even two or three cards). There's form of government, religion, population, currency, literacy rate, economic trends, recent history, diplomatic problems, and a whole raft of other stuff—more details than you got on the World Atlas disk, but not as well organized.

The cards are indexed on 22,987 keywords, and you can do Boolean searches with or without wild cards. Searching on the word *atheist* gives you four countries, Albania, Hungary, USSR, and China. You can then examine cards for each or all of those. Searching on *OPEC* yields 16 cards, one of them

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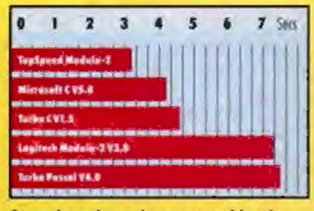

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Austria, which isn't an OPEC member (OPEC is mentioned in another context). This is another of those disks well worth having if you have a CD-ROM drive.

Programmer's Library

If you're a professional programmer, the Microsoft Programmer's Library is valuable enough to make it worth buying a CD-ROM drive just to have it. The disk contains the reference manuals to QuickBASIC 4.0, C, FORTRAN, Assembler, Pascal, Windows 2.0, and OS/2 Programmer and User Reference. All these can be popped up inside the compiler environment or in an external editor like BRIEF. The newest versions have the reference manuals to Windows/386 and QuickPascal.

I'm not spending a lot of time on this because there's no need to: if you do much programming and your time is worth anything at all, get a CD-ROM drive and Microsoft Programmer's Library. You won't regret it.

Highly recommended.

The Coming Scene

Microsoft has done an admirable job of pushing CD-ROM, so much so that the number of installed CD-ROM drives out there has gone from zip to perhaps 100,000 in the last three years; and a good half of those, perhaps more, are due to Microsoft products.

continued

Meanwhile, the number of CD-ROMs available continues to grow. Some, like McGraw-Hill's wonderful Encyclopedia of Science and Technology, haven't been done all that well; that is, the information in that Encyclopedia is more than worth it (except it's a time trap: you start browsing through that thing and the next you know it's dawn), but the CD-ROM software isn't as good as it could be. It also wants some pretty specialized graphics board equipment. Now that VGA is getting common, we can hope that McGraw-Hill will revamp the Encyclopedia.

There are the various NASA CD-ROMs with planetary data. Grolier's has much improved their access software for the original Grolier's Encyclopedia on CD-ROM. We see new CD-ROMs here every day.

Moreover, we can expect a lot more CD-ROM drives in the future: not only will Microsoft continue with excellent products like Microsoft Bookshelf and Programmer's Library, but IBM will, in about 18 months, have a low-cost home computer with a built-in CD-ROM drive. Microsoft is writing the code for it even as you read this, and IBM expects to sell a *lot* of those machines at $1995 or thereabouts. The machine will also have a MIDI interface.

IBM will then very aggressively go after both the home and educational markets. One supposes Apple will have some sort of response, since they certainly wouldn't want to abandon the educational field to Big Blue without a hard fight.

Whatever the outcome of that, it should be beneficial to users. Right now CD-ROM is about where small computers were before the IBM PC. CD-ROM is a wonderful way to organize and distribute information; you'll see a lot more of it as time goes on. The potential is nearly unlimited.

WORMs and DESQview

In my judgment, the 8086, 8088, 80186, and 80286 chips will disappear in the next few years. Their place will be taken by chips that can execute the 80386 instruction set. Probably one of those replacement chips will be the 80386SX, although I don't think there's any real reason to prefer the SX to a real 80386. Even more important will be the 80486; there are definite indications that you can build a fully operational system with the 80486 *cheaper* than you could build the same system with an 80386 and 80387.

This is going to have a large effect on both the bus and operating-system wars. Most volume buyers won't care much about the details; all 80386 systems, regardless of bus and operating system, are a great deal faster and more powerful than most businesses think their "standard" user—a secretary or junior executive—will need. The decision factors will be total workstation cost, hardware and software, including both applications and operating-system software. There's also training and support, which aren't trivial, especially when changing systems. The bottom line is, what can Bertram and Susie accomplish, and what's it going to cost?

Which is to say that while OS/2 with Presentation Manager can be pretty nifty (I've just got OS/2 PM running on a fast 80386 system, and I confess I like what I'm seeing), the fact is that right now, at least, you can get a lot more done with MS-DOS 3.3 and DESQview.

We have, for instance, tuned our Big Cheetah 80386 so that we can have a number of 530K-byte windows open all at once, and every one of those windows has a mouse, various keyboard fix programs, and the Maximum Storage WORM (write once, read many times) drive built in. Every bit of the 530K bytes is available to application programs.

All this is accomplished with carefully arranged CONFIG.SYS and AUTOEXEC.BAT files. (Listings of these files are available on BIX in the CHAOS.MANOR conference.) We use a SHELL command to increase the program environment to 512 bytes to support a larger PATH statement. And we use LOADHI.SYS and the LOADHI program (they come with Quarterdeck's QEMM) to load various TSR programs into the area between 640K bytes and 1 megabyte. In this particular case, we do more than that: we also load some 15 buffers up there. The result is that we can have pretty big DESQview windows, and inside each of those windows the software thinks the WORM drive is just one more disk drive.

CD-ROM

All this was very well, but there's something missing. There's no CD-ROM driver. In order to use the CD-ROM, I used to have files called CONFIG.CDR and AUTOEXEC.CDR. A batch file would make them the current CONFIG.SYS and AUTOEXEC.BAT, and then I'd reboot. Those files omitted the WORM drivers. Thus, I could have a CD-ROM in every window or a WORM in every window.

I could even have both, but if I loaded both CD-ROM and WORM drivers, even using LOADHI.SYS, I'd end up with a maximum window of about 480K bytes; and while this isn't tiny, it's not quite large enough, either. I have programs that want a full 512K bytes before they'll run properly. I don't need both WORM and CD-ROM in every window; indeed, I don't really need both in any single window.

DESQview has no problem with the kind of TSR program that's loaded with a command file. The problem comes with drivers that must be loaded with CONFIG.SYS. They have to go in on boot-up; there's no way to put them inside a DESQview window. Both the WORM and CD-ROM drivers have to be loaded with CONFIG.SYS, and if you load both, you use too much system memory.

The obvious solution, I thought, was either to get Quarterdeck to change DESQview so that it *can* bring .SYS drivers into DESQview windows, or to get Maximum Storage to change its drivers so they can be loaded with a command. Alas, so far neither of these has happened.

I continued to brood, and suddenly I was struck with inspiration.

The purpose of buffers is to speed disk operations by giving the disk drive controller a place to stash stuff prior to putting it where it belongs. My Big Cheetah uses a Distributed Processing Technology hard disk drive controller. This controller has 500K bytes of on-board memory. Why, then, would it want or need file buffers? Maybe I could eliminate the buffers.

That wasn't hard to do: just remove the LOADHI buffers statement in AUTOEXEC.BAT and reboot. I tried that. If there was any effect on disk operations, I sure couldn't detect it; time for a real test.

The sure test of whether your system needs more buffers is to make up a subdirectory with a *lot* of filenames in it. The test is to get a directory: if you need more buffers, the directory information will scroll smoothly at first; then, as the buffers are filled, it will get jerky until you start getting one or two filenames put to screen, and then there is a noticeable hesitation as the machine goes to disk.

I went to one of the unused logical areas on Cheetah's Priam 330-megabyte hard disk drive and transferred every short file on the system to it. I ended up with something like 450 filenames. Then I looked at the directory. No hesitation. OK, next try a *big* file transfer. Again no loss of speed. Clearly, Big Cheetah with the DPT controller doesn't need any stinking buffers.

Alas, while that gave LOADHI some extra room, it still wasn't enough to let me have WORM, CD-ROM, and windows bigger than 512K bytes. Time for more thought.

Of course, the solution was obvious. Access to CD-ROM drives requires two actions. First, you have to load the CD-ROM driver with CONFIG.SYS. Then you have to execute the MSCDEX.EXE program, which loads Microsoft DOS extensions that allow DOS to recognize disk drives larger than 33 megabytes. All I had to do, then, was use LOADHI to install the Amdek Laserdek driver with CONFIG.SYS and, when I wanted to access the CD-ROM drive, open a window and execute the MSCDEX.EXE command *inside the window*.

That worked fine. I can now open a window; do MSCDEX.EXE; load SideKick; go to the CD-ROM drive and set it up to use its software complete with memory-resident software; load Procomm; and log onto BIX with, say, both SideKick and Grolier's Encyclopedia available in the communications window. I can also download files directly from BIX into the WORM drive. Meanwhile, I can have a 525K-byte program going in other windows that can't access the CD-ROM.

Of course, not everyone has or needs both CD-ROMs and WORM drives; but it's nice to know you can have both and still use DESQview.

WORMs and UPSes

I'm going to make this a flat statement that you can accept or not as you choose.

If you're seriously in the software development business, either your company is large enough that you've got all your expensive people's systems networked and a systems manager sees to it that daily backups are made, or you need at least one WORM drive for every expensive programmer you employ, including yourself. True, there are a lot of arguments for tape backup systems; but my experience has been that they don't tend to be used routinely. If there's someone whose job is to see that backups are made, they probably will be made; but leaving that task to individual programmers—or writers, or financial analysts, or CAD engineers—is risky.

WORMS are different: since they look to the user like just another disk drive, it's very easy to save stuff to WORM, and just as easy to recover lost data from a WORM; and unlike most other backup systems, WORM drives save every version. When we were working on Mrs. Pournelle's Reading Program, I had several opportunities to bless that feature.

The other thing that you can't afford not to have is an uninterruptible power supply, which is commonly called an UPS. Indeed, given that you can buy a

continued

decent UPS for a few hundred bucks, you can make the case that not having one, even on a system with a WORM drive, is plain stupid.

I now have several UPS systems. Two of them are Clary systems: there's the big one we had when the Great Power Spike hit (see my August column) and a smaller desktop model. The big one will run more equipment, including the laser printer, but be warned, it really is big—a couple of cubic feet—and heavy. It also has a fan that, while reasonably quiet, does add a bit to the background noise. The smaller model does just fine taking care of your computer, and the Clary people tell me it has the same surge-protection capability as the large unit.

My other UPS is a TSi UPS-3160P. This is a handsome little unit that will sit nicely under a computer or its monitor; it can also stand on the floor, which is where I have mine. It has three conditioned power outlets, labeled Computer, Monitor, and Printer, each with its own switch. There are also two non-UPS outlets, also switched. The TSi has been running Big Cheetah and his monitor and, instead of a printer, an outlet box that powers the Maximum Storage WORM, the Amdek CD-ROM drive, and the USRobotics modem. There have been no problems in over a month.

I've no great competence in evaluating an UPS. I have tested both the Clary and the TSi, subjecting them to such cruel and unusual punishment as yanking the power cords and hooking them to a Variac variable transformer on which I steadily reduce the input voltage to simulate a brownout. Both cut in well before I got worried about what low voltage would do to my computer.

Most UPS systems will work; but some deliver a much better quality of power than others. Your computer power supply probably won't care about that, but your printer will, and so can other auxiliary equipment. There's more to learn about UPS systems than I thought. (See "Curing the Brownout Blues," April BYTE.)

Pournelle's Law: If you don't know what you're doing, deal with people who do. I'm pretty sure there are a lot of companies that make good UPSes; one thing I'm quite sure of, both the Clary and TSi people know what they're doing. They both independently tell me the same story regarding power quality and the dangers and advantages of different ways to do power conditioning.

Get yourself some good advice on what *kind* of UPS to get; but take it from me, if your work is worth anything at all, get an UPS. It's darned cheap insurance.

Bringing Up OS/2

Recent visitors to Chaos Manor include Pierluigi Zappacosta, president of Logitech, and Logitech programming engineer Mansour Safai. They wanted to demonstrate the new Logitech Modula-2 Compiler and the Logitech Debugger on OS/2 PM. The only problem was I didn't have OS/2 up and running on anything here. They offered to install it.

Although you can set up your system so that you've a choice between DOS or OS/2 on start-up, I wasn't quite ready to change operating systems on my main machine. On the other hand, I wanted to have PM handy, not off in a back room. That left two candidate machines, the Zenith Z-386 and the new Northgate 386. The Zenith has a Maximum Storage WORM drive installed already. That made it easy to back up the Zenith files.

continued

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And just at the moment, the Zenith has the 19-inch Electrohome monitor running off a Video Seven 16-bit VGA board. I thought PM would look pretty good on that.

Alas, OS/2 PM won't install on the Zenith. It doesn't like the Zenith's disk drive controller. Microsoft says that OS/2 is "very picky" about disk drives. They're also working on the code to make it less so; OS/2 won't install on something like half the systems it's tried on, which cuts down the market potential something fierce.

LapLink 3

It was time, then, to back up the Northgate 386. That was simple enough because, being a recent arrival, it didn't yet have many files. I'd just received a new version of Traveling Software's LapLink 3; this one came with a six-headed cable and a new option to send files through the parallel port. We hooked the Northgate to the Zenith, printer port to printer port, put LapLink on the Zenith, and turned on the system.

LapLink trundled for a moment, noticed that the remote computer wasn't running LapLink, and offered to send itself to the Northgate. This is a new feature of LapLink: you don't need a copy on both machines. Just follow instructions. We did that, and in about a minute we had the two machines linked. I initialized a new WORM disk cartridge, put LapLink in turbo mode, and told it to send all the files from the Northgate to the Zenith's Maximum Storage WORM drive. The result was startling: LapLink 3 in turbo parallel mode sends files about as fast as the WORM drive can write them. The whole process was completed in about a minute or so.

The new LapLink is awesome. Highly recommended.

Logitech and PM

The good news is that OS/2 went on the Northgate 386 without a hitch. We did have to repartition the hard disk; the Northgate comes with 5 megabytes on the C partition and 75 megabytes on the D, but OS/2 wants more C disk space. Once that was done, though, OS/2 went up smoothly enough.

Then Mansour put up Logitech Modula-2 and the new Modula Debugger and did a quick demonstration. It works.

Logitech Modula-2 is one of the first highly structured programming languages (other than C) available for OS/2 PM. This could be important for both the language and the operating system. More next month.

MultiScope

Meanwhile, MultiScope, Logitech's newest debugger, works so well I can hardly believe it. There's a version for DOS as well, and it simply blows everything else out of the water.

Like Borland's (excellent) debugger, MultiScope can be run remotely from another machine. Like Microsoft's CodeView, it works with a whole bunch of different languages. It also has features you won't find in any other debugger I ever heard of. You'll be seeing a lot more on MultiScope, all good.

FRACTINT

The shareware of the month is actually freeware: FRACTINT, which you can find on BIX and a number of other places. On BIX, look for FRACTINT.ARC. The .ARC file extension denotes software that uses a shareware file compression and archiving utility that you can also find on BIX and elsewhere. I've been using it to compress Empire war game moves so they can be uploaded to BIX.

FRACTINT was formerly FRACT386, but now there's an 80286 version as well. It's an integer program, but very fast, about the fastest fractal program I'm aware of. There are all the standard features, including the Mandelbrot set. It runs under DESQview, and as my son Alex says, the program is a sponge for any time and CPU cycles you have left over from something else. You can find out more from the program's inventor, Bert Tyler ("btyler" on BIX), who says he doesn't want money but he does ap-

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preciate acknowledgment. If you're at all interested in fractals, find a BBS that has this. You won't regret it.

Some Corrections

I generally send an early draft of my column to the people I'm talking about. Because Penny and Giles is an English company, their reply to my remarks about their TrackerMouse trackball/mouse substitute didn't get back here in time to be incorporated into the July column. What they said didn't make sense to me anyway: they insisted that their gadget worked fine with Microsoft Windows, and I continued to insist that it sure didn't work with my machine. Meanwhile, the Microsoft Windows people said the same thing, that the Penny and Giles TrackerMouse worked fine with Windows; which was all very well, but it sure didn't work with the version of Windows running on my Northgate 386. Finally, I got a call from the Microsoft Windows technical-support people.

One solution: you have to tell Windows you're using a Mouse Systems mouse. Then the Penny and Giles TrackerMouse will work fine. Indeed, according to Microsoft, when dealing with a foreign mouse, the first thing you ought to try is telling Windows you have a Mouse Systems mouse, because that will usually work.

I also discovered that the original Northgate 386 I got had a bad serial port. It affected the TrackerMouse when running with Windows, but it had little effect when running some games such as Empire. The TrackerMouse indeed works fine with Windows, and you don't need to use the Mouse Systems (highly generic) option.

About the time you read this, there will be another trackball system designed much better than the Penny and Giles TrackerMouse, or indeed anything else I've seen. More on that next month. Anyway, whatever strange mouse or mouse substitute you've got, if you have trouble installing Windows, try saying you have a Mouse Systems mouse. That may save you having to reload Windows yet again.

Winding Down

There are several books this month. First, I'm often asked how one gets to be a writer. The answer to that is simple: you write. For more details, *Techniques of the Selling Writer* (University of Oklahoma Press) is the single best work I'm aware of. *Film Scriptwriting: A Practical Manual* (Focal Press, 80 Montvale Ave., Stoneham, MA 02180) is the best introduction to that subject I've ever seen. Both are by a good friend, Dwight Swain, sometime professor at the University of Oklahoma and longtime selling writer.

Cosmic Catastrophies (Plenum, 233 Spring St., New York, NY 10013) by astronomers Clark Chapman and David Morrison is a highly readable but serious discussion of catastrophes in earth's history: dinosaur extinction, greenhouse effect, nuclear winter—all presented without sensationalism. This is well worth reading.

The program of the month is, of course, Mrs. Pournelle's Reading Program. I don't normally pay much attention to advertising—I consider my responsibility is to the readers—but I have to say I'm impressed with the number of inquiries we've got from the BYTE product information cards. One of these days I expect we'll turn the program over to a regular publisher. Meanwhile, Roberta is shipping copies all over the world, to schools and home study groups and even a Roman university.

The game of the month is Broderbund's SimCity. The monochrome Mac version is fun; the color version for the Amiga is even more so, especially if you have a MicroWay FlickerFixer board and a really good color monitor. Do note I call it a game: while it's jolly fun to play city planner, the real world is much more complex than this game implies. SimCity is highly sensitive to the prejudices of its designers, including their extreme preference for rail over road transport. Still, it's fun to outwit them.

Alex is in the other room installing OS/2 application programs. So far we have SideKick and Paradox, as well as the Logitech Modula-2 and MultiScope. He's been working with it for half an hour and it hasn't crashed yet; given the Murphy field he carries around with him, that's pretty encouraging.

Now back to *Wrath of God*. It's very quiet in Beijing. They create a desolation and call it peace. ■

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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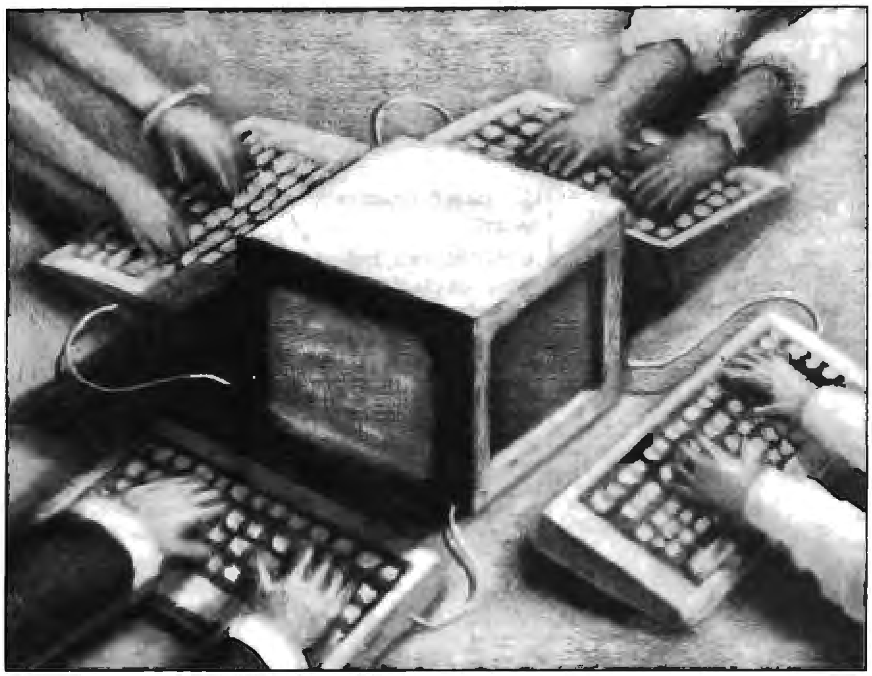
UNIX ON PERSONAL COMPUTERS: WHY AND HOW

Installing Unix on a personal computer isn't always easy, but it's well worth the effort



There are many reasons why you might want to run Unix on your personal computer, but making your life simpler wouldn't be one of them. It's true that learning Unix isn't done overnight. Just the idea of installing it frightens many people unnecessarily.

There are advantages, though, to having a small but well-managed Unix system:

- No more worrying about spooler programs, manually switching printers, or waiting for a print job to finish.
- If someone else wants to use the computer, he or she can log in at a terminal. You won't have to stop what you're doing.
- Background communications? Of course. You can dial up another machine manually or put the UUCP (for Unix-to-Unix copy) system to use for unattended E-mail and file transfer.
- The ability to run DOS programs (once a major stumbling block for Unix acceptance) is becoming less of an issue with the emergence of DOS running in 8086-compatibility mode on 80386-based machines, or DOS emulators on other platforms. You won't have to give up much if you're coming from the MS-DOS world.
- You'll finally appreciate how incredibly primitive the whole concept of loading TSR programs really is. For the most part, you can also forget any concerns about available memory. The "swap partition" on your hard disk will take care of things for you invisibly.
- Perhaps best of all, you will be able to work the way you want. Did you just start up a long batch job and now need the computer for something else? Switch to another window or screen and do as you like. No kludge programs that sit on top of your operating system here: This is the way it was designed to be. For example, in the middle of writing this paragraph under The Santa Cruz Operation's (SCO) Xenix, I wanted to make a note to myself, so I switched to "virtual screen 2" by pressing Alt-F2, mailed myself a message, and switched back to the editor on "virtual screen 3" with Alt-F3. It took less time than typing the last sentence, and I was able to do it before the thought slipped my mind. No mousing around, either.

Not All Good News

There are disadvantages to Unix, too. Using your operating system becomes more complicated. You can't just turn the machine on and off whenever the mood strikes. It takes a minute or three to boot up. If you're not the only user on the system, shutting it down without warning can be hazardous to your health, depending on how heavy the nearest manuals are and how good your officemate's aim is. But you generally don't have to go into a long, involved ritual for shutting down, either. (On Xenix, at least, you just run the `haltsys` program, and it comes down safely and instantly.)

Another drawback is that you'll have to do more administrative work with the system. On DOS, this generally refers to things like editing the AUTOEXEC.BAT and CONFIG.SYS files, so you get the default behavior you want from your system. On Unix or Xenix, you might end up editing the `/etc/profile` and `.profile` files (to customize default behavior), changing the `/etc/inittab` file (to tell the system which ports are active), perhaps reconfiguring the kernel (to add

continued

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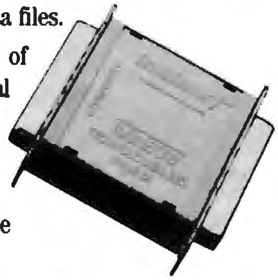
#1 In A Series.

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.

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special device drivers), modifying the line printer spooler system (to get spooled printer output), adding systems to UUCP (for electronic communications), and specifying backup schedules (to ensure that you won't forget to run backups).

Very little mandatory work is necessary, in most cases, to just get the system running on a minimal DOS-equivalent level. It's only when you want to start taking advantage of all the things Unix can do that you have to start reading manuals.

First-time users should skip the swap space calculations and use defaults.

What about those backups? Backups on Unix are no more critical or difficult than on any other operating system, which means that if you fail to run them consistently, you will get yourself into trouble one day.

Then there's the issue of money. Unix costs quite a bit more than DOS. There are lots of manuals and disks, not to mention a certain amount of learning (which is an expense, even if it's just taking the time to read the manuals). And although there are versions (or look-alikes) of Unix around that will technically run on machines as small as an 8086, that's not realistic. You can't really run Unix with less than 2 megabytes of RAM and 40 megabytes of hard disk space. This means you'll be spending more money on hardware, too.

Be Honest with Yourself

So the choice really has to do with what you use your machine for. For instance, are you using your computer for personal development, recreation, and intellectual stimulation? If so, and if you're the kind of person who has to have the newest, most exotic hardware and software, you can dazzle your friends by buying Unix. Otherwise, it might not be such a wise investment.

But suppose you're a home- or office-based programmer who needs to develop programs for several markets. Or maybe you're the "power user" in a small but growing office or department, with other people who need access to the same data. Or you're just a lone user who has to work with machines from DOS to mainframes, perhaps on multiple databases. In these cases, Unix starts making sense, both logistically and financially.

Setting Up Xenix

Say you've decided to at least think about it. What is physically involved in turning a running DOS system into a Unix system? I'll use the example of an 80386-based IBM PC AT clone and SCO Xenix. I chose this setup partly because that's what I run on my machine, but more because that's probably the most popular scenario in the industry right now.

To install Xenix, you'll need at least 1 megabyte of RAM and 20 megabytes of hard disk space (80286-based systems can get away with as little as 512K bytes of RAM). SCO recommends a minimum of 2 megabytes of RAM, with which I heartily concur, and I add my own recommendation of at least 40 megabytes of hard disk space (hopefully with a 28-millisecond average access time). Multiuser systems, especially those running database systems or VP/ix (which runs DOS under Xenix), will need a minimum of 4 megabytes of RAM to prevent swapping and excess paging. You'll want to avoid these conditions, as they signify that memory is being used inefficiently (e.g., by excess paging) or that processes are being saved to a special area of the disk due to lack of sufficient RAM (known as swapping). Both will slow the system down, though swapping is far worse.

The swap partition is a separate area of the disk that is reserved for those times when the system is running out of RAM, so it *swaps out*, or writes to the swap area, the process data for a program that is not running. When it's time for that program to run again, it is swapped back in: The system reads the data from the swap area back into RAM and runs the program again. Naturally, this takes some time, but it's the way a small system handles large programs. It's also the way virtual memory works—the swap area of the disk takes up the overflow when RAM runs out.

Even the relatively straightforward procedure outlined in current Xenix documentation can be confusing, since it tries to give as much information as possible. First-time users should essentially skip the swap space calculations and use defaults whenever possible. I understand that SCO has taken this into account for its new release of SCO Unix System

continued

V/386, which will have a single prompt that's something like "Do you want the system to install itself?" This will go over a lot better for new users.

About DOS

There are two ways to run MS-DOS with Xenix. One is to keep a DOS *partition* on your disk: a logically separate area that Xenix doesn't even know about. You can then boot up your system (from the hard disk) into either DOS or Xenix, but not both at once. This might be a good plan during a DOS-to-Unix transition, since you will still have the security of having all your DOS files and procedures intact.

A *few programs will balk at living in the Xenix partition.*

Another method is to purchase either VP/ix, which is a separate product that runs under Xenix on the 80386, or SCO's new Open Desktop product, which uses Merge 386 (a different product than VP/ix, but it performs about the same functions). Using one of these DOS migration packages allows you to essentially run the entire DOS operating system as a task or a program under Xenix. You can enter DOS, run your DOS programs, and then exit back to Xenix. Or you can set things up so you can type the name of your DOS application and run it, automatically entering and leaving DOS with no additional effort on your part. The advantage is that the DOS programs and files can be stored on the Xenix file system (transparently to DOS), so they can be manipulated, copied, and backed up like any other Xenix files. You still have access to your DOS partition, if there is one.

If you already have DOS, you are warned to back up all your DOS files before installing Xenix and to leave at least a 6-megabyte partition free for Xenix. I recommend 10 megabytes if you can afford the space. Even if you're planning to run VP/ix, I suggest setting up a small DOS partition anyway, because a few programs will balk at living in the Xenix partition or running on anything but native DOS.

Rolling Up Your Sleeves

Basic Xenix takes up eight floppy disks and will install on any normal IBM-compatible hardware, including Intel Inboards. Most video and serial cards will work, and both standard and nonstandard hard disk drives (including RLL [run length limited] or a second drive controller) are supported, although you should contact SCO for a complete list.

To get started, you simply insert a boot floppy disk, which brings up the Xenix kernel. The installation procedure leads you through a hard disk parameter menu, which you should be able to skip if your disk has already been installed under DOS. Then it shows you the partition table, where you allocate as much space to Xenix as you want, and allows you to specify any bad blocks on your disk (it can also scan the disk for bad blocks; any bad blocks are automatically remapped).

You're almost done with the hard part by now. The installation menu then runs a program that figures out how much swap space you'll need. After another few questions, the new file systems are created, you're prompted for your software serial number, and you reboot the system from the hard disk. At this point, it gets boring because you just keep inserting floppy disks in response to prompts.

Finally, you tell Xenix which time zone you are in, and you're up and running for real. You can log in, run background commands, and all that other good stuff.

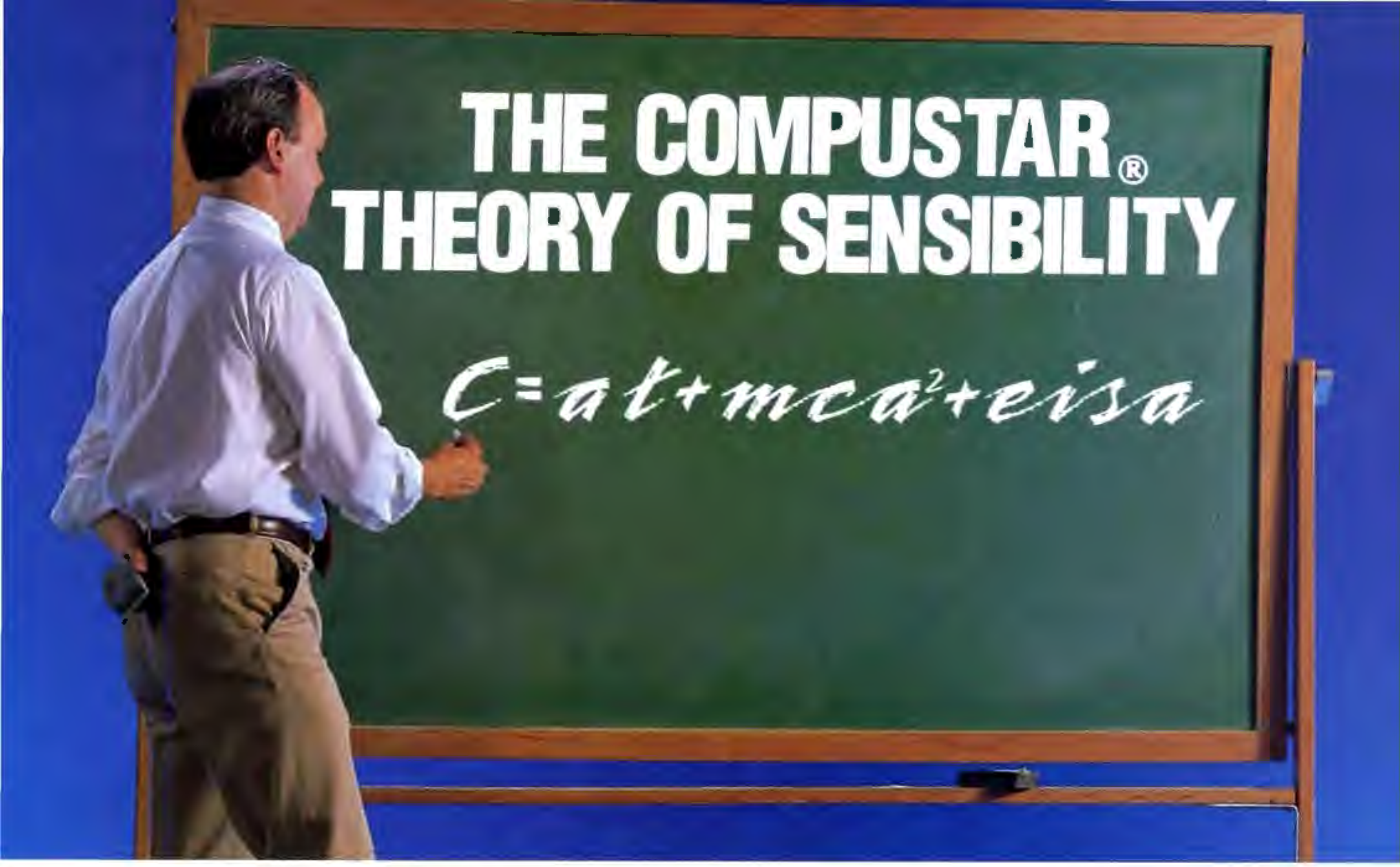
It's Alive!

Yes, you now have a live Unix system. But before setting off in full stride, you should be sure that it is tuned to your special needs (which I'll cover in next month's column). You will see the flexibility (and some of the complexity) that I have been talking about.

So, now the exciting part begins: getting the system configured to your hardware and learning how to make Xenix work the way you want it to. As the months go by, you will be seeing more and more gems for the Unix veterans as well. ■

David Fiedler is editor and publisher of the Unix newsletters Unique *and* Root *and coauthor of the book* Unix System Administration. *He can be reached on BIX as "fiedler."*

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.



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ON THE ROAD AGAIN

These days, you can take plenty of computer power on your business trips—but don't forget the screwdriver

As this is being written, I'm on assignment in Honolulu, seeing to the final stages of a LAN installation. I'm carrying a Zenith SupersPort 286 equipped with a hard disk drive, LAN diagnostic software, an Ethernet card, and a Diconix 150 Plus printer. (Who says portables have limited capabilities?)

I've carried other computers on trips throughout the world, to points as remote as the jungles of the South Pacific. Indeed, without a laptop, I'd be hard pressed to do my work, and it would be impossible to file my columns for BYTE and BYTE*week*.

Practical Concerns

Air travel has a number of perils for the computer user. Chief among them can be the security check, especially in these days of heightened concern about electronic devices. If you're traveling with a portable, be prepared to turn the machine on to prove that it *is* a computer and not some other kind of device. A battery-powered computer will be a lifesaver here. I watched a Compaq owner miss his plane from Washington-Dulles because his computer required a power cord to run and he had packed the cord in his checked luggage. My Zenith, with its battery, powered right up, and I was through the checkpoint in seconds.

These security hassles may be replaced by something worse—an outright ban on all electronic equipment on commercial airlines. At this writing, the Federal Aviation Administration is considering such a move. This ban would include carry-on and checked luggage. If it goes into effect, you will have to ship your laptop ahead of you. Of course, you could also take the train and avoid these problems entirely.

Some airlines operate special executive lounges for their business travelers. United's Red Carpet Clubs even go so far as to include a modem connector on each phone. Now, if they'd only put the power outlet close enough to the phone. . . . It's a common inconvenience in hotel rooms, as well.

One of your greatest challenges in working from your hotel room is simply attaching your computer to the telephone system. While many hotels, including Embassy Suites and Hyatt, have started providing telephones with modem ports, the majority of them do not. Fortunately, many do use the same RJ-11 modular connector your home phone uses. In either case, it's easy to plug your computer into the phone system.

There are always a few hotels that make it hard for the business traveler, though. Not only do they have no modem ports, their phones are hard-wired into the wall. In these hotels, you have no choice but to use your screwdriver (you *did* bring a screwdriver, didn't you?) to remove the wall plate for a look. Interestingly, many hotels have their modular connectors hidden behind a wall plate. Once you have access to the connector, you can use your modem to call BIX or other important services.

There are, of course, the hard cases—the ones that really *are* hard-wired, rather than simply disguised. If you are lucky, there will be a connection block behind the wall plate. Otherwise, you will have to dismantle the phone itself. In either case, you use a cable that has spade connectors on one end and a modular plug on the other. The leads are color-coded, and you will find screw terminals inside most phones. Simply connect the

continued

ILLUSTRATION: CHRIS SCHMIDT © 1989

color-coded wires to their like colors and reassemble the phone. Then connect the modular connector to use the modem.

But remember, when the hotel manager asks you what you're doing with that screwdriver, you're on your own....

Business Uses

There are as many uses for traveling computers as there are travelers with computers. When the FDIC shows up at a bank closing, it arrives with computers in hand. Likewise, many of today's auditors bring a computer along, as do lawyers and consultants. These computers run Lotus 1-2-3, dBASE, WordStar, or any of a thousand applications that people need in their work.

Some get even more exotic. Because I work with LANs a great deal, I am currently using a Xircom Pocket Ethernet Adapter. This is a slim box that attaches to the parallel printer port on the rear of the Zenith and allows me to connect to an Ethernet LAN. Xircom includes a disk containing Novell software, so you can configure your laptop computer either as a workstation or as a file server. I can use it to perform diagnostics and tests of a LAN without having to first transfer any software to another workstation.

At this point, unfortunately, most of the diagnostic software doesn't know about the Xircom, so those packages, including Brightwork Development's E-monitor, can't be used with it just yet. This is especially too bad with E-monitor, which is a very useful tool and would be even more so if it supported the Xircom Pocket Ethernet Adapter.

Having the Xircom adapter saves some time, of course, but it also gives me a known quantity with which to work. If need be, I can carry the SupersPort over to another LAN to confirm its proper operation. That way, LAN testing becomes somewhat less of a black art than is usually the case.

Portable Printing

If there is a portable printer designed with the business traveler in mind, it is the Diconix 150. This is a tiny ink-jet printer that runs on C cells, emulates either an IBM or Epson printer, and fits into the Zenith's carrying case, right along with the Zenith.

There are other portable printers, of course, and some that can be made portable. The Hewlett-Packard ThinkJet has been around for years. Like the Diconix, it's small and easy to carry. Unlike the Diconix, it doesn't come with built-in batteries. Some dot-matrix printers are small enough to be portable, although most of them are simply small desktop printers and aren't designed for the rigors of travel.

ITEMS DISCUSSED

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Inquiry 1101.

SupersPort 286 Model 20.... $4999
Zenith Data Systems
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Glenview, IL 60025
(312) 699-4800
Inquiry 1102.

T-1000............................$999
Toshiba America, Inc.
9740 Irvine Blvd.
Irvine, CA 92718
(714) 583-3000
Inquiry 1103.

Xircom Pocket Ethernet Adapter...........................$695
Xircom
22231 Mulholland Hwy.,
Suite 114
Woodland Hills, CA 91364
(818) 884-8755
Inquiry 1104.

Portable Pointers

Here are some ideas that will help you decide whether you want to do computing on the road, and if so, what to use. First, I'll consider the computer itself:

- Unless there is an overwhelming reason to do otherwise, consider a battery-powered computer. It will let you work along the way, and it will assure you that you will be able to operate your computer once you reach your destination.
- Unless you know you will never have to carry the computer through an airport on a tight connection, opt for something light. A 30-pound transportable is simply too heavy for most air travelers.
- A backlit screen is vital for marginal lighting conditions—as in all airplanes, most airline terminals, and nearly all conference rooms. If you don't have a backlit screen in these conditions, you may not be able to see it at all.
- A carrying case is usually expensive, but it will save your computer when nothing else will. The case also gives you somewhere to put chargers, cables, software, and even Diconix printers.
- An internal modem, portable fax cards, and network cards are invaluable if you need them. If you don't, they only add weight and take power.
- If you can get an extra battery for your computer, consider doing so. Batteries usually run out when you need them the most.
- A hard disk drive can make a portable computer seem just like your desktop model; without one, you may feel handicapped. So many of today's programs require enormous amounts of disk real estate. WordStar and WordPerfect, for instance, require a couple of megabytes to run properly, and they need to access additional files during operation.

While there is an additional battery drain with a hard disk drive, the Conner Peripherals hard disk drives used by Zenith and others use a mere 2 watts, which has very little impact on battery life. Most likely, doing without the software you are accustomed to would have a much greater impact on your work habits.

Finally, there's the question of survivability. No computer (except, perhaps, one designed for the military) is rugged enough to be checked as baggage. Nevertheless, some laptops, notably Zeniths, are awfully strong. In the course of my travels, I dropped a Zenith laptop on the railroad tracks beneath a train in Brussels. I also had one rained on while using it at Waikiki. Then there was the one that fell down the steps on a London double-deck bus. And of course, we can't forget the time the porter slammed it into a wall in Guam. In each case, the laptop survived with no ill effects. I suppose that Zenith's laptop contract with the military has had something to do with this.

Travel with a computer can be highly productive. It allows you to use time that would be wasted otherwise. It also allows you to be more effective once you reach your destination. In some cases, it makes jobs possible that weren't possible before. At the very least, it gives you the same level of support you were used to back at the office. ■

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Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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User Jeff Garbers, Crosstalk Communications' Director of Software Development, has been debugging with Periscope® Model IV and says, "The hardware really makes Periscope shine, especially when you've got timing-related problems. I can now track down changing pointers and altered buffers on my 386. I've been using it to debug Crosstalk® Mk. 4 and there's just no better way to do it."

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Ross Greenberg
"Best of 1988" (Development Tools)
PC Magazine, January 17, 1989

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DISASTER RECOVERY

After you crash and burn, getting back to work shouldn't be this hard

I am angry. Not a little bit, but a lot. Why? I just spent the better part of my evening trying to recover a crashed Jasmine DirectDrive 140 hard disk drive. You probably know that horrible warning dialogue by heart: "This disk is damaged. Do you want to initialize it?" Initialize it! Are they kidding? I had 128 megabytes of data on that disk! And you're given two pretty extreme options: Yes or Cancel. That's it.

If you say Yes, you also say yes to wiping the disk of all your files. Goodbye years of work. See you later. If you say Cancel, you can never mount and use the disk in its current shape, because somehow the directory structure has been scrambled. In both cases, you can't get to your files, which makes the disk useless, unless you need a paperweight.

Now you might say that this sort of thing goes with the territory, and in a calmer and more rational moment I'd agree. But I'm tired of being calm and rational when it comes to drive crashes, tape backups, and file recovery programs. So, even if it won't help me fix my sick drive, at least I'll feel better once I tell you what's wrong with all this hard disk drive backup and recovery business. And maybe it will save you from the same fate.

I do a full save to DC-2000 tape once a week, and daily incremental backups, also to DC-2000 tape. However, the problem is that no matter how religious you are in doing backups, restoring backed-up data is a pain. And backed-up data is *never* as fresh as the stuff that's on your disk, so you'll always lose a few files. Often, the few files you do lose are the most critical ones at the time the drive fails. Backups keep you from a catastrophic loss of data, but they just don't keep you from wasting time rebuilding a failed disk or recreating critical files.

A Solution?

If backups aren't going to save you from the drudgery of rebuilding a disk, what can? Symantec Utilities for Macintosh is supposed to. Unfortunately, I haven't had much luck with it. SUM is a package of several different disk management and recovery utilities. The important part for preventing hard disk drive losses is called the Guardian INIT.

Guardian installs on all your hard disks and records a separate hidden directory of the disk whenever you shut down or restart your Mac normally. Guardian can also save the directory information for deleted files into a hidden file so that you can recover them later (or at least until the files are overwritten). The hidden disk and file directories can also be backed up to floppy disks, tape, or another hard disk, in case the versions saved on the disk in question get trashed when it fails.

That's all fine in theory, but the practice leaves much to be desired. First of all, the only time the Guardian lists get updated is when you *normally* shut down or restart the Mac. If you've created or edited a bunch of files since your last normal shutdown/restart and your Mac disk fails, those files are not recorded on the Guardian lists. And if the Mac dies while writing the Guardian files, they're usually scrambled and unusable.

Second, the Guardian lists tend to be large. For example, on my hard disk drive, with 128 megabytes of files (over 4600 files in 600 folders), the Guardian disk record was more than a megabyte in size, so it wouldn't fit on an 800K-byte floppy disk.

Third, the Guardian files are no more

continued

resistant to damage caused by a software disk failure than any other files. If the disk sector that carries these hidden files was creamed during the failure, SUM can't use them to recover the disk's directory. And, unfortunately, SUM does a poor job of deciding whether or not the Guardian files on the crashed disk should be trusted or not.

I tried restoring my failed DirectDrive 140 over a dozen times using the Guardian files on that disk. Every time, the SUM Disk Clinic application told me that the disk had been fully recovered. Every time I quit that application and rebooted (as instructed), the Finder said that the disk was damaged and unreadable. I finally had to use a day-old set of Guardian files that I had backed up to tape to recover the disk. That recovery mostly worked, although so far I've found that about 10 percent of the files I try to launch have been damaged and need bit-tinkering.

The problem is even worse if you've failed to install Guardian or if none of your Guardian files can be read. Then you must use SUM's file-by-file disk recovery utility. This utility works. It will pull everything off your damaged disk (of course, you have to have another hard disk for copying). But your directory structure will be history: Files will be in and out of folders, and folders will be listed, but empty. Basically, you'll recover your files and little else. If you've got the amount of data that I have, it can take months to recreate some semblance of order from this chaos.

Although I'm annoyed that SUM doesn't do more in its current incarnation and doesn't make recovery easier, I have to give Symantec kudos for at least letting me salvage an otherwise dead disk. That's an important bottom line, and one to remember when you get that sickening "disk damaged" message. I've tried plenty of other disk recovery programs that don't come close to the sophistication and success rate of SUM.

Apple's Omissions

The basic problem, however, is not Symantec's. It's Apple's. Like many of you, I pored over the previewed specifications for System 7.0 that Apple released at the May Developer's Conference. I was impressed by the Finder enhancements, outline fonts, virtual memory, interapplication communications, improved print management, Communications Toolbox, and the rest of the goodies. But I wasn't impressed by the omissions—obvious ones from my point of view.

ITEMS DISCUSSED

DirectDrive 140 .... $1499
Jasmine Technologies, Inc.
1740 Army St.
San Francisco, CA 94124
(800) 347-3228
(415) 282-1111
Inquiry 981.

Symantec Utilities for Macintosh 1.1 .... $99.95
Symantec Corp.
10201 Torre Ave.
Cupertino, CA 95014
(800) 228-4122
(408) 253-9600
Inquiry 982.

Where was built-in scripting and a script editor, so that I can build an auto-backup script that would create shadow directories on other drives? Where were Apple's built-in disk recovery utilities? In short, where were the built-ins that will make disk crashes less frequent and less disastrous? Nowhere in the System 7.0 specifications that I saw.

Of all the suggestions that I've made to Apple in the past year about what needs to be in future operating systems, file integrity is the most important. If you can't trust your hard disk drive, using your Mac becomes a scary scenario. Apple must address this problem quickly. While I applaud the third-party efforts of Symantec and others, it's not their job to fix deficiencies in Apple's operating system. And let's be clear here: These are major deficiencies. Anytime that 128 megabytes of data can vanish without warning, you've got an operating-system problem.

We shouldn't have to waste our time running recovery programs. The Finder should have an entire menu just for disk integrity. This menu should include every manner of disk recovery utility that Apple can think of, and it should be transparent to the user. It should also include options for setting "reliability factors," so that users with large disks could opt for slower performance if it means their disks will be better protected (either by shadow directories, parallel structures on other disks, or the like) from software crashes.

Also on the menu should be disk analysis and modification tools for the technically sophisticated, who need to examine their disks and perform surgery on them. This menu should also include backup dialog boxes, for doing every kind of backup (e.g., tape, floppy disk, WORM [write once, read many times] drives, or erasable CD-ROM drives) in every kind of way (e.g., unattended, timed, or parallel structure).

Apple's Responsibilities

The point is that Apple should take the lead in making its operating system more robust, and not leave that to third-party vendors. Apple should take the lead in preventing drive crashes and making backups transparent, not third-party vendors. Apple should take the lead in making disk errors and failures easily recoverable, not third-party vendors.

Apple has often said that the Mac operating system is its competitive advantage, its intellectual property. That's one of the reasons that Apple has defended it with the suits against Microsoft and Hewlett-Packard. But intellectual property is a double-edged sword: It implies responsibilities on Apple's part that go way beyond the ownership of the system. These are Apple's responsibilities to its customers, to the MacFolk who have made Apple a 4-billion-dollar-a-year company. For them, disk and file-system integrity should be a given, and not something that they have to seek with outside utility programs and other kinds of baling wire and spit.

With System 7.0, Apple has shown us a solid view of what the 1990s will bring in personal computer operating systems. The distinction between personal computers and larger ones will become even more inconsequential as the small machines are given all the features that users of big machines have enjoyed for years. With the advent of OS/2, Apple has some serious competition with its vision and an even bigger reason to concentrate on the basics of file and disk integrity.

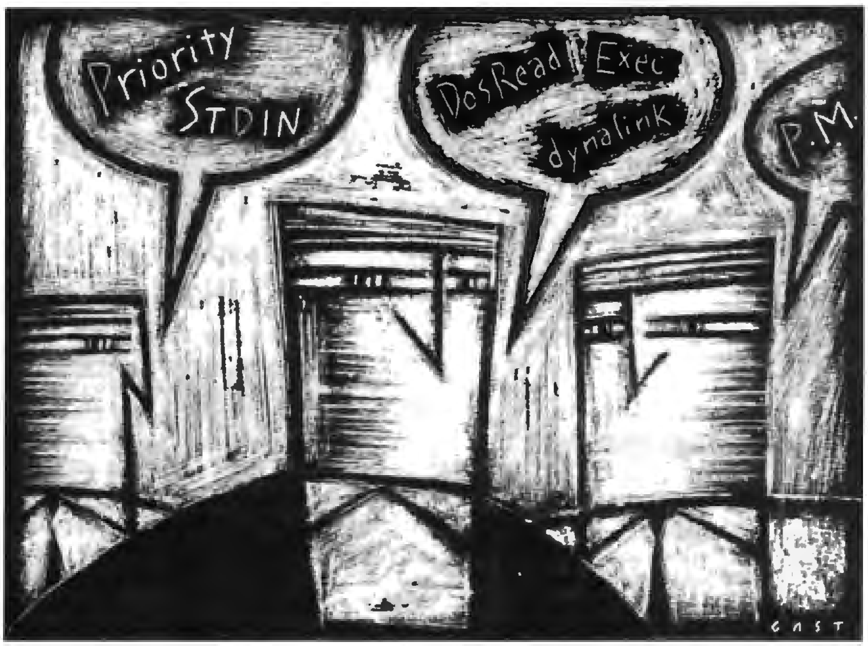
As small computers do more and more of the work of computing, the reliability of file systems may make the difference in the success or failure of an operating system and its computers. Apple needs to keep this thought at the forefront as System 7.0 and future Macintosh operating systems start to roll out of the Cupertino labs and into the disk-duplication factories. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. 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.

TALKING TO OS/2 DEVELOPERS

Pluses and minuses of OS/2 from those working with it



Last month, I talked about the latest developments in OS/2 programs. This month, I'll be talking to three of the people who are developing those programs: Dave Nanian, Doug Hamilton, and Martin Heller.

Nanian's text editor, BRIEF, needs no introduction. Ever since it appeared several years ago, BRIEF has accumulated a fair-size following in the programming community. That's no mean feat, because text editors are like favorite easy chairs to programmers. Nanian converted BRIEF to OS/2 because "I got tired of switching to the compatibility box [the DOS mode session] to run my editor when writing code."

Doug Hamilton doesn't come to OS/2 from DOS, but rather from an extensive Unix background. He worked until recently for Prime Computers. Prior to that, he worked for IBM. The Hamilton C Shell implements the popular Unix C shell under OS/2. OS/2's optional command-line interface looks like the DOS CLI, with many of the DOS limitations. The Hamilton C Shell will appeal to those who prefer Unix system commands—the Unix `ls` directory command works, for example—but the DOS commands also work, so you can use either `ls` or DIR. Unlike DOS commands, most of the C shell commands are self-documenting: If you just invoke them with the `-h` switch, you get help on the command.

Martin Heller has wide experience with several computer environments. He is now converting two packages to run under OS/2; they'll probably be on the market by the time you read this. The first product is an engineering application called MATDB, which provides metallurgical characteristics of hordes of materials. For each metal, MATDB gives data for 40 properties at 20 temperatures under 20 conditions. (*Conditions* refers to whether the material was cold-rolled, annealed, or the like.) The second product is ENPLOT, an engineering graphics program that is undergoing beta testing for Windows under DOS.

The programs that these developers work on provide an interesting cross section of genealogies: BRIEF started out life as a standard DOS application, the Hamilton C Shell is a new application first developed under OS/2, and MATDB was originally a Windows application.

Developers on OS/2 Acceptance

Despite the differences in the programs and the markets that they appeal to, all three developers agreed that OS/2 will be successful, even though it will take some time to become established.

Nanian says, "Debugging is far easier under OS/2, and OS/2 applications can be built to work under DOS. I do like OS/2, I hope it succeeds, but DOS will be around for a long while. Developers must make sure that their OS/2-inspired programs run well under DOS. An application can't work well and stink under DOS. Ignoring either DOS or OS/2 people is foolish. Virtual memory is an example. Just because DOS doesn't have that feature doesn't mean you can't add it to your application, if it's important."

While Hamilton agrees that OS/2 acceptance is going slower than he thought it would, he thinks that DOS-to-OS/2 conversion will be swift once it starts. "At some point, people will see just what OS/2 can do; then there'll be a flood of applications. Lots of new computers are being sold today. Lots of new machines mean lots of new people who haven't invested in DOS." He adds, "In 1992

continued

ILLUSTRATION: JOE GAST © 1989

we'll chuckle about all those folks who wondered if DOS would really be replaced."

Should you convert to OS/2 today? "Not unless you're a developer," says Heller, although he notes, "That will change this summer." Heller predicts that a "killer application" will be out soon. What would a killer application for OS/2 be?

The three agreed on the question of OS/2's value as a development platform, saying that OS/2 made development much easier.

"PageMaker," says Heller. "PageMaker really shines with more memory, and Presentation Manager applications have access to lots of memory. The PM version of PageMaker is at least three times better than the Windows version."

OS/2 as a Development Environment

The three agreed again on the question of OS/2's value as a development platform, saying that OS/2 made development much easier. Nanian and Heller commented that the virtual memory feature of OS/2 simplified their code. In both cases, they'd been forced to implement virtual memory under DOS, no picnic of a task.

Heller's MATDB program organizes data into folders. Under DOS, such folders must be limited to 200 materials. Under OS/2, there is virtually no limit. Another example comes from the database side. Under OS/2, the database's tables are built up in the background.

"OS/2 has some powerful debugging tools," says Heller, so that the conversion to OS/2 was really not a big investment. "It's actually easier to debug the OS/2 code than the DOS code. At this point, I make changes to the OS/2 version, *then* move the changes back to DOS. I found bugs in the OS/2 version that had eluded me for two years under DOS."

For much of the debugging, Heller is using Logitech's MultiScope debugger. "It's better than CodeView. It gives you more views of the application. Features like the postmortem debugger can be incorporated into your ordinary version."

Unlike CodeView, MultiScope will analyze after the fact why a program crashed. CodeView can do this only if the application was being run under CodeView at the time.

Hamilton likes OS/2's threads. "It's much faster to create a thread than to spawn a separate process. You can spawn and kill threads very quickly. The bad part about threads is, of course, there aren't fire walls between threads." In other words, threads (unlike processes) share memory and can therefore damage one another's data.

Nanian appreciates OS/2 stability and its debugging features. "They make development a lot easier. The virtual memory code that we had to write and maintain under DOS is not required under OS/2. It's nice to code to a platform that's fairly mature, compared to something like DOS 2.x."

What Developers Would Change

I asked the three developers what they would change about OS/2 if they could. What do they hate most?

Hamilton dislikes the way that text windows work. "Microsoft thinks we're going to go 100 percent to bit-mapped screens, and that just doesn't make any sense. There are plenty of uses for text-based screens, and the support of text windows under PM is awful, both in terms of speed and features."

Nor is he fond of the way icons work. "There aren't enough pixels for icons, so I'm afraid my icon turned out kind of hard to read. You can't control icon colors directly, so it limits your ability to design a nice icon."

Heller says that OS/2 is slow, compared to running DOS with various speedup aids. But he notes that the Hamilton C Shell actually solves some of those problems. "Also, I'd like to be able to develop for Windows under OS/2 and use other tools like On-Line and the Programmer's Library without going back to DOS to use them."

One of Nanian's gripes regards the High Performance File System, a feature of the upcoming OS/2 1.2. "There are no operating-system-level functions to parse and qualify filenames," says Nanian. "I can't just pass OS/2 a filename and say, 'Here's a filename—what part

continued

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BRIEF 2.11 ....$195
UnderWare, Inc.
321 Columbus Ave.
Boston, MA 02116
(617) 267-9743
Inquiry 983.

ENPLOT
MATDB
(not yet released)
Martin Heller & Co.
89 North Main St.
Andover, MA 01810
(508) 475-8088
Inquiry 984.

Hamilton C Shell 1.03 ....$395
Hamilton Laboratories
13 Old Farm Rd.
Wayland, MA 01778
(508) 358-5715
Inquiry 985.

is the extension?' A developer has to write these routines. Once we've got alternate installed file systems, we'll have to write a routine for each system. That's just not reasonable."

Nanian would also like a better debugger, something along the lines of the Borland Turbo Debugger with a mouse interface added. "Also, a version control program and a good profiler. Better printing utilities, also, like a spooler that works."

OS/2 Hardware

Finally, I asked the developers what hardware the average person needs to do real work with OS/2? Generally, they agreed that the more powerful, the better, but you don't need a 20-MHz 80386 to make headway. Hamilton uses a PS/2 Model 80 and insists that 8514 video is the only way to go. Heller also uses an 80386, a 20-MHz clone. On the other hand, Nanian used an 8-MHz AT to develop the first version of BRIEF for OS/2. ■

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Mono	$1455	$1530	$1730	$1890	$2496	$2890
EGA	$1810	$1885	$2110	$2245	$2890	$3245
VGA 16 bit	$1920	$1995	$2220	$2355	$3061	$3355
VGA/Mono	$1685	$1760	$1960	$2120	$2726	$3120

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Mono	$1555	$1630	$1830	$1990	$2596	$2990
EGA	$1910	$1985	$2210	$2345	$2990	$3345
VGA 16 bit	$2020	$2095	$2320	$2455	$3161	$3455
VGA/Mono	$1785	$1860	$2060	$2220	$2826	$3220

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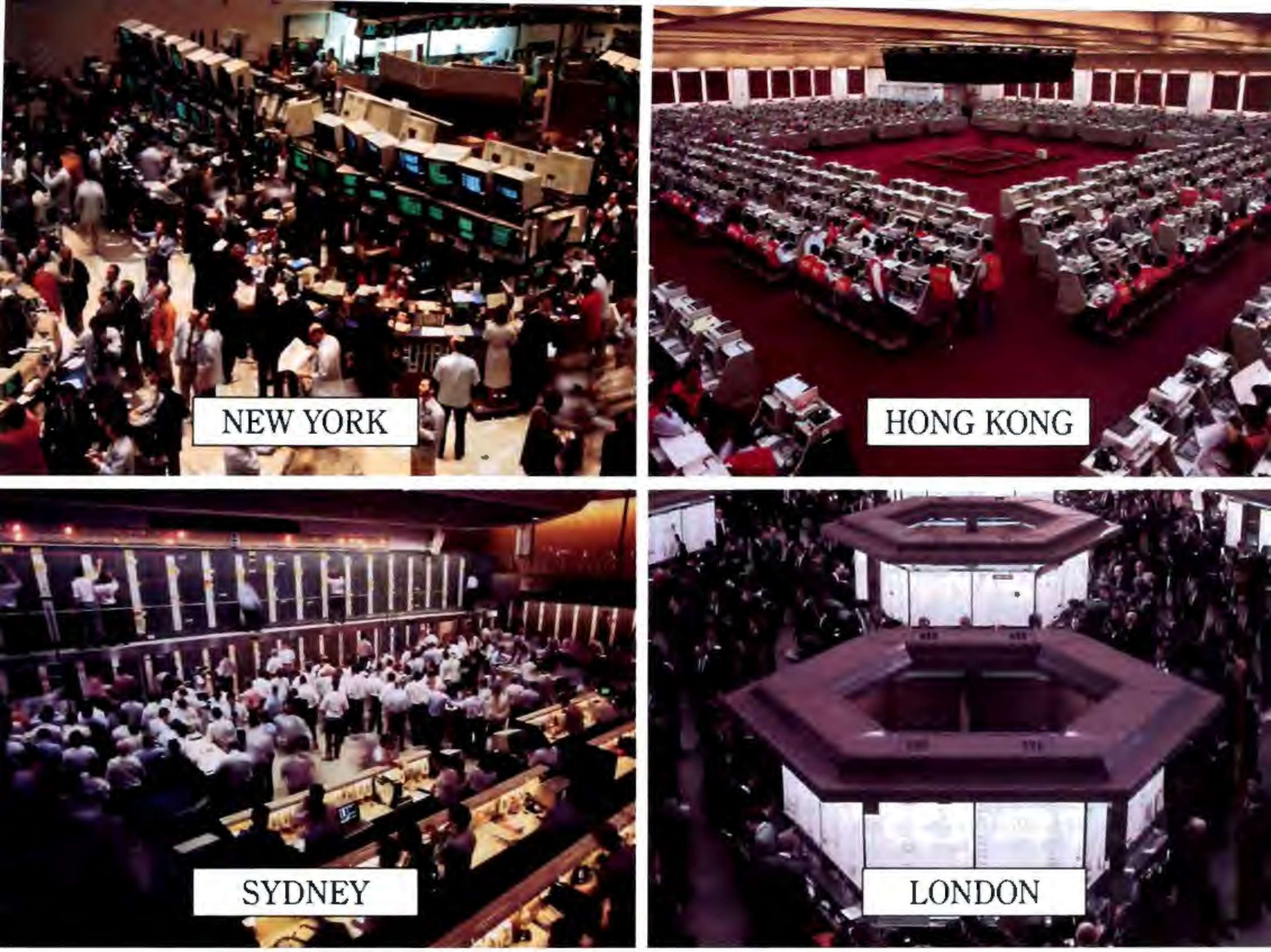

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LAN E-mail applications take different approaches to E-mail delivery

In previous columns, we've examined LAN operating systems and the Open Systems Interconnection (OSI) model. But up to now we've been intentionally vague about LAN applications and how they work. This month we'll remedy that omission by looking at E-mail, one of the most natural and common LAN applications, and compare two good LAN E-mail systems, cc:Mail's cc:Mail and Da Vinci Systems' eMAIL. Both packages can run on many different LAN operating systems, including Banyan's VINES, IBM's PC LAN, 3 Com's 3+, and Novell's NetWare.

Regardless of the LAN operating system on which they run, LAN mail packages offer the same basic services as mail systems on larger hosts—the same services you find today on BIX or MCI Mail, or in a mainframe mail package. But you can do more than send and receive messages. You can create and maintain mailing lists, reply to messages, forward messages, and file important messages for later use.

The main differences between microcomputer-based mail systems and their earlier counterparts lie in the interface they provide. While earlier packages were typically line-oriented, microcomputer-based mail systems offer full-screen interfaces.

Where the Mailboxes Are

To provide its services, every E-mail package must face three main issues: how to store messages, how to deliver them, and how to keep them secure.

There are two main approaches to message storage: distributed and centralized. A distributed mail system is much like the one that brings mail to your home; the mail comes to you. A centralized system is more like a post office box; all the mail is in individual compartments at a centralized location, and you have to go there to get it.

cc:Mail follows the centralized approach. It stores all the messages for a LAN and its users in a single database file. That file must reside in a location that is accessible to all those users, such as on a dedicated server.

cc:Mail manages that file in the same way that a multiuser database would. It uses DOS file- and record-locking primitives, which the underlying LAN must support, to let many users read from and write to that file concurrently. cc:Mail does not talk directly to NetBIOS or any other lower level.

In addition to the central message file, cc:Mail maintains, in the same location, a pointer file for each user. Each record in a user's pointer file contains one logical pointer into the message file for each of that user's mail messages. cc:Mail also uses record-locking primitives to manage these files, because many users could need the same pointer file simultaneously. For example, user A could be reading messages while user B is sending him or her a new message. Both would need access to the same pointer file at the same time.

Perhaps the biggest advantage of centralized message storage is that it can reduce the space that mail messages consume. A system with centralized storage needs to store only one copy of each message, even if that message was sent to 10 different people. Instead of 10 full copies of the message, a single copy exists in the central file, with a pointer to it in each of the 10 users' pointer files.

The drawback to this approach is that it brings with it all the concurrency problems of any multiuser database. If too

continued

many users try to read from and write to the central file simultaneously, for example, performance can suffer.

The Distributed Approach

The eMAIL package, by contrast, takes a more distributed approach. It still has a central "mailroom" directory—usually \EMAIL\MAILROOM on the server—where it stores messages awaiting delivery. It uses that mailroom, however, only as a staging place. Before a user ever sees a message, eMAIL moves it from the mailroom to a file in that user's own mail directory. Each user's mail directory contains one file for each of that user's messages.

The mail directories for all users typically reside in a central place; by default they are subdirectories of \EMAIL\MAILBOX on the file server. They do not, however, have to be there. You can move your own mail directory wherever you want.

This approach can consume more space than cc:Mail's message database; sending a message to 10 users creates 10 copies of that message, one in each recipient's mail directory. It is simpler to implement the distributed approach, however, because it requires only file-locking operations. Record locking is not necessary because each file contains only one message. eMAIL also does not require NetBIOS. All it needs is the ability to share and lock the mail files.

By requiring only file-locking operations, eMAIL can work on some low-end LANs, such as LANLink from The Software Link, on which cc:Mail and other mail systems can't run.

Special Delivery

In addition to storing messages in a particular way, a mail system must have a way to get those messages to their storage locations. Many minicomputer and mainframe mail systems use a single-server process to solve this problem. That process manages the mail in much the same way that a database server manages a central database. LAN mail systems, however, typically avoid the single mail server process, primarily because of a desire for portability.

A central mail server would have to run on a central machine, which on a LAN could be executing any of several different LAN operating systems. LAN mail vendors would have to write one mail server for each LAN operating system that they wanted to support. While some mail vendors are considering this approach, it could be expensive. They would have to write different mail servers for the very different architectures of such LAN operating systems as NetWare, Microsoft's LAN Manager, VINES, and CBIS's Network-OS.

Minicomputers and mainframes also have the advantage that interprocess communication between the mail server process and the message sender is usually straightforward. On a LAN, however, interprocess communication between the mail server machine and the sender's machine requires more network services than simple file and record locking. By requiring interprocess communication, a mail vendor would stop its product from being able to work on many low-end LANs.

Instead, all the LAN mail systems that we've encountered avoid the mail server process and make each user act as his or her own mailman.

In eMAIL, a "dispatcher" delivers each user's mail. When you run the eMAIL program, it automatically starts up the dispatcher executable file (by default, DSDISP.EXE) as well. When you want to send a message, the main eMAIL program hands that message to the dispatcher for delivery. The dispatcher also gets your incoming mail.

Da Vinci Systems delegated all of eMAIL's mail delivering and receiving to a dispatcher program to insulate the main program from having to deal with the peculiarities of various mail systems. This makes it possible to provide different dispatchers for different mail systems. Da Vinci Systems offers a version of eMAIL whose dispatcher uses Novell's MHS (for Message Handling Service) to store messages.

Regardless of the dispatcher you use, the main program stays the same. In terms of the OSI model, the main program operates at the application layer, while the dispatcher works at the presentation layer. By so segmenting these two programs, Da Vinci Systems will be able to provide an eMAIL dispatcher that directly communicates with mail systems that obey the X.400 mail standard when such systems become more widespread.

cc:Mail also makes each user's mail program deliver that user's messages, but it integrates the mail delivery services tightly with the main user program. The mail program places mail messages directly into the central mail database; the user-interface part of that program is essentially a front end to a dedicated database application. While cc:Mail can also link its package to X.400 hosts, this design will force the firm to use an X.400 gateway to establish such connections.

Mail Fraud

The final major problem confronting every E-mail system is how to keep mail messages secure. Every user's mail should be safe from tampering.

The need for such security is one of the main reasons why mail systems on larger hosts use a central mail agent. Without such an agent, every user must have at least write access to the mail file to be able to send messages. With a central mail process, only that process needs to have write access to the mail file.

Because cc:Mail uses a single-message database, each user must have both read and write access to that database file. cc:Mail encrypts its database so that users cannot easily read the messages in it, but there's no foolproof way to stop a malicious user from modifying that file.

cc:Mail does prevent users from deleting that file if the underlying LAN operating system offers appropriate file protections, such as those that NetWare provides. cc:Mail's main way of protecting the message database is a simple one: It hides the mail files so that they don't show up in directory listings.

eMAIL's individual mail files make for a more secure system. When a user sends a message, his or her dispatcher

continued

ITEMS DISCUSSED

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program puts that message in the central mailroom directory. If there are no other messages in the mailroom for that user, the dispatcher creates a file whose name is a hash value plus the extension .CNT. The hash value comes from a mailroom file, NAMES.DAT, that contains an eight-character hash value for each user. Each user's .CNT file contains the number of messages for that user. The dispatcher encrypts the message itself and then stores that message in another file whose name is the same hash value plus an extension that indicates the message's number. eMAIL can also send a notification to the recipient's screen that a new message has arrived.

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Beyond the Basics

We've only scratched the surface of the many features that these two products offer. Both, for example, can use gateways to transfer mail to other LANs.

cc:Mail in particular excels at environments with many LANs and many different LAN architectures. It comes in both Macintosh and PC versions; Mac cc:Mail stations need only be able to access the same message and pointer files on the server. cc:Mail also can use gateways to link to other mail systems, such as Western Union's EasyLink, IBM's PROFS, and Digital Equipment Corp.'s mail systems. ■

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The Multiuser Solution

Mainframe-style connectivity challenges LANs

Howard Eglowstein and Stanford Diehl

Now that the 80386 microprocessor, with its virtual 8086 mode, can supply the necessary horsepower, multiuser systems are emerging from hibernation. They're more compatible with DOS than ever before, loaded with new features, and ready to challenge LANs.

Multiuser operating systems that replace or extend MS-DOS aren't new, but they have caught on only recently. In the past, available hardware could not handle multiple DOS sessions effectively, and many users found the notion of a shared CPU unacceptable.

Those barriers are breaking down. Increasingly, users join microcomputers in LANs to pool hardware, software, and information. An irony not lost on the vendors of multiuser operating systems is that LAN connectivity emulates capabilities that are intrinsic to a multiuser system.

Products for this focus all emulate DOS as their primary function and support standard DOS applications on standard serial terminals. We evaluated four such systems: 386/MultiWare from Alloy Computer Products, Concurrent DOS from Digital Research, PC-MOS from The Software Link, and VM/386 from Intelligent Graphics (see table 1). We configured each system much as you'd configure a LAN and ran the same performance tests we use with LANs (see "Battle of the Network Stars," July BYTE). In addition to evaluating the systems on their own merits, we assessed how they are and are not appropriate substitutes for a LAN.

Variations on a Theme

To appreciate the benefits of a multiuser system, it helps to understand how multitasking, multiuser, and network environments differ. Multitaskers can load several programs into memory and rapidly switch from one to another. The simplest form of multitasking under DOS is the TSR utility program. Such programs—Borland's SideKick is a noted example—lie dormant in memory until activated by a hot key. More sophisticated multitaskers, such as Microsoft Windows and Quarterdeck's DESQview, can run several programs concurrently. You can, for example, perform a lengthy database search as a background task while editing a document in the foreground.

With a TSR utility program, you could even run two word processors at the same time, but under a multitasker, they would have to take turns using the screen and keyboard. It would be great to connect a second screen and keyboard to the system and let two users work at once. That's where multiuser operating systems come in. These systems are multitaskers that have the added capability to assign an external terminal to each program.

A single 80386-based computer, simple cabling, and standard terminals can do much the same job as a LAN. A LAN just gives separate computers common resources like disk drives and printers. But that requires sophisticated control mechanisms to prevent the multiple copies of DOS—one per workstation—from fighting over resources that each thinks it owns exclusively.

The multiuser solution is naturally superior to a LAN in this respect. A single operating system is in charge. It owns and can effectively manage the resources made available to multiple users.

Of course, there's always a catch. When you're not using the disk system, you're using the CPU. On a LAN, each user has his or her own CPU. The multiuser environment requires that you share the CPU with a number of other users, perhaps as many as 24. Simple math tells you that a 25-MHz processor split 25 ways would be, from a user's perspective, a 1-MHz processor. Happily, the performance is much better than that, thanks to the creative efforts of software designers.

A multiuser system isn't the answer for a group of software developers who need to test programs on real DOS machines, not virtual DOS tasks. Nor is it suitable for a group of high-powered financial analysts who run lots of CPU-intensive simulations. It may work well, though, for an office in which the mix of applications tends toward word processing and data entry. Here, a network may be overkill. Rather than giving everyone an XT- or AT-class machine to do word processing or database management, it might be better to invest in one expensive 80386 system and use terminals and multiuser software to turn it into a flock of virtual 8086s.

There's no reason why your multiuser workgroup can't peacefully coexist with a LAN. If the 80386 host computer is connected to a LAN, all the users it supports automatically share the LAN resources that are available to the host. Moreover, multiuser systems typically deliver multitasking at the terminal end, so you're not forestalling that option, either.

The Science of Multitasking

The host computer in a multiuser environment works much harder than the file server on a LAN. The file server provides a common file system, but it leaves the individual workstations to do their own computing. The multiuser host, on the other hand, divides its time among all the users it supports; it actually runs

The workstations, from left to right: WY-60, Link MC5, WY-150, Kimtron KT-70.

their applications. It must also provide DOS services to each user.

DOS is a *nonreentrant* operating system. When a DOS function is in progress, you can't interrupt it and execute another. To transform DOS into a multiuser system, you must do one of two things: make DOS reentrant, so that multiple users can share its code concurrently, or arrange for each user to get his or her own private copy of DOS.

PC-MOS and Concurrent DOS adopt the former technique. They replace DOS and the BIOS with code that is fully reentrant. VM/386 takes the other tack—it gives each user a copy of DOS and the BIOS. 386/MultiWare combines the two strategies—tasks share a reentrant BIOS, but they have their own copies of DOS (well, for the most part; a small part of DOS is shared).

Which technique is best? PC-MOS and Concurrent DOS require less memory for each task, but software compatibility depends on the correctness of their rewritten DOS functions. VM/386 and 386/MultiWare need more memory for each task, but those tasks run under genuine DOS.

Despite these differences, all the systems ultimately do the same thing. A multitasking kernel allocates a blob of memory for each task. It cycles through the list of tasks, mapping task data into active memory and passing control to the task for a discrete *time slice*. When an application's time is up, the kernel regains control and passes it to the next program.

Operating systems handle this task-switching in subtly different ways. Those that give each task lots of tiny slices appear to run more smoothly than systems that let each task run a little longer, but they accomplish somewhat less total work because they spend more time switching. With any of these systems, you can tune the time slice (and associated task priority) to maximize throughput for your mix of applications.

Time slices are integer multiples of some basic unit of duration. PC-MOS uses the standard system clock tick of 55 milliseconds. Each task's slice is 1 tick long, and each task normally executes with equal priority. There are 18 ticks in a single second; with five tasks active, each task can therefore expect to get three or four slices. Concurrent DOS uses a system tick of 16⅔ ms. With five active tasks, each gets 12 slices per second. The system does the same amount of total work (minus any switching overhead) but appears more responsive. VM/386 provides time slices in 1-ms increments, the minimum slice being 6 ms. Its System Resource Manager dynamically allocates time slices as a function of task activity. In this respect, VM/386 is self-tuning. 386/MultiWare uses an 18-ms time slice.

Each operating system lets you tailor the memory allotted to each program. You need 640K bytes to 1 megabyte (depending on the system) for each full 640K-byte application that you plan to run. You can, of course, allocate smaller pieces for programs that don't need

continued

640K bytes. All the systems we tested except for 386/MultiWare allocate the memory in contiguous pieces as soon as it's requested. 386/MultiWare can take better advantage of the 80386 system page tables. It can build contiguous memory blocks out of memory that may be scattered throughout the physical address space, but it doesn't actually allocate physical memory until it's needed.

Putting the Systems to the Test

Our multiuser host was a Compaq Deskpro 386/20 with an 80387 processor, a Compaq VGA card, a 135-megabyte hard disk drive, and 6 megabytes of memory.

Table 1: *The new breed of multiuser operating systems boasts an impressive array of features (● = yes; ○ = no).*

	386/MultiWare	Concurrent DOS	PC-MOS	VM/386
Job/task control				
Multiple tasks on serial terminals (maximum no.)	21	10	25	9
Adjustable task priorities	Automatic	●	●	●
Text windows (multiple on-screen)	○	●	○	○
Administrative functions from any terminal	●	○	●	○
Reboot task from the terminal	●	○	○	●
Environmental				
DOS replacement	○	●	●	○
DOS add-on	●	○	○	●
Works with DOS version	3.30 and up	3.0 and up	3.0 and up	3.0 and up
Full set of DOS utilities	○	●	●	○
RAM disk support	●	●	●	●
EMS support	○	●	●	To 4 megabytes
Disk cache	64K to 1 megabyte	○	Available memory	32K up to available memory
Virtual serial ports	●	○	○	○
Maximum partition size (K bytes)	640	640	590	640
Security				
File system security (no. of levels)	○	3 levels	26 classes	○
Supervise other remote tasks	○	●	●	○
Separate start-up for each user	●	●	●	●
Ctrl-Alt-Del protection	●	Optional	○	●
Resource locking	●	○	○	○
Hardware protection for COM ports	●	○	○	●
Host system compatibility				
Runs on 8088 machines	○	○	●	○
Runs on 80286 machines	○	○	●	○
Network-compatible	●	●	●	●
NetBIOS-compatible	○	○	●	○
CP/M and CP/M-86 file compatible	○	●	○	○
Miscellaneous				
Print spooling	●	●	●	●
Supports local printing at workstation	●	●	●	●
Interterminal messages	●	○	○	○
Programmable function keys	○	●	○	○
Remote program execution	●	○	○	○
Multiuser access				
Allows terminals on COM1 and COM2	○	●	●	○
PCTERM terminal support	●	●	●	●
Other terminal support	○	●	●	○
Maximum terminal baud rate (bps)	38.4	38.4	38.4	38.4
Log-in from a modem	●	●	●	○
Log-in password	●	○	●	●
Supports direct or high-speed video terminals	○	●	●	○

We used standard terminals from Wyse Technology, Link Technologies, and Kimtron, connected to multiport serial cards specified by the software vendors (see the text box "Terminals and Multiport Boards" at right). We reformatted the hard disk drive and installed the software according to the manufacturer's instructions. All relevant system parameters remained in their default conditions, including time slicing, keyboard control, and disk caching.

To gauge the systems as LAN alternatives, we used the same test suites featured in our July LAN Product Focus, "Battle of the Network Stars." The systems performed file I/O, DOS COPY, and database operations while subjected to increasing load. Figures 1 through 4 show the results of our network-oriented tests. For comparison, we've included the results for two LANS—3Com's 3+Share, which has average performance (at a per-user cost that's comparable to that of the multiuser systems), and Novell's NetWare, an excellent performer (though far more expensive). In general, the multiuser systems are faster than 3+Share but slower than NetWare.

Of course, these systems don't just provide a shared file system; they supply processors, too. So we tested each system's virtual 8086 tasks as single-user machines. We ran the standard BYTE low-level and application benchmarks from the host, in the presence of a constant load produced by two additional tasks running file I/O tests in the background. Figure 5 shows the results for these low-level and application tests. Here, Concurrent DOS outperformed the pack. We ran into a few incompatibilities, though. Because 386/MultiWare didn't support the 80387 numeric coprocessor, we couldn't run the low-level FPU test with it. And VM/386 didn't successfully complete our string-move benchmark, so we can't include its CPU index.

The testing procedure also gave us a good chance to evaluate the systems' ease of use, ease of installation, and responsiveness. PC-MOS proved hardest to install. We had to format the hard disk, manually create a complicated CONFIG.SYS file, and sort through a fair amount of detailed documentation. We wished the manual had documented a sample installation. But for any of these systems, you have to do more than just boot from a floppy disk and type COPY A:*.* C:. The operating system needs to know the I/O address of your interface card, the amount of free memory you have, the type and data transfer rate of each terminal, the size of your cache, and so on. The procedure is not much different from that of a LAN.

We found both VM/386 and MultiWare extremely easy to use, while PC-MOS suffered from an especially steep learning curve. Once you find your way around PC-MOS, though, it is quite flexible. PC-MOS's best performance comes from careful tweaking of a task's system parameters, and its command-line interface makes that customization easy for an experienced administrator. VM/386's relatively short time slices make for a responsive system—it keeps up with

continued

Terminals and Multiport Boards

Multiuser DOS systems work best with PCTERM terminals. Unlike standard terminals such as the VT-100, these terminals have standard 84- or 101-key IBM PC keyboards complete with Home, End, PageUp, and PageDown keys. PCTERM terminals support the same escape sequences that control conventional terminals and extend these codes to control attached mice and printers. But what makes them different is that they transmit PC-compatible *scan codes* rather than ASCII characters.

Normally, you don't need to be aware of the PCTERM/ASCII distinction unless you're accessing your multiuser system remotely. Modem access is a natural extension of the multiuser environment. You connect an auto-answer modem to one of the host's serial ports, dial in from a terminal or terminal emulator located elsewhere, and voilà—you have access. There's just one catch. If the dialing modem is Hayes-compatible, you'll have to make the connection in an ASCII emulation and then switch to PCTERM.

By the way, this method of remote access is simpler than the LAN equivalent. On a LAN, you normally have to dedicate a local workstation as an "access server." It runs Carbon Copy, PC-Anywhere, or an equivalent program that can route the workstation's keyboard and screen activity through a serial connection to a remote user. With a multiuser system, you don't need to dedicate a terminal to achieve the same result—just a modem.

Wyse Technology provided us with samples of the WY-60, the WY-150, and the WY-99GT. All three support PCTERM and a cornucopia of conventional terminal emulations. The WY-99GT also provides Hercules graphics-emulation modes for those operating systems that can use it. Both PC-MOS and 386/MultiWare provide WY-99GT drivers. Link Technologies sent us its MC5, which, like the Wyse terminals, supports speeds of up to 38.4 kilobits per second. Kimtron supplied two KT-70 terminals. These offer a standard AT keyboard but go only as fast as 19.2 kbps—a little slow for screen-intensive applications. Of the bunch, we favored the WY-60 for its nice bright display and the WY-150 for its superior screen speed and low price—it's the cheapest terminal we tested.

Multiuser operating systems connect their terminals through serial ports on multiport cards. The PC normally supports two serial devices, called COM1 and COM2. A multiport card extends that support to a larger number of devices. You can get four, eight, or more serial ports on a single card. Because these cards are nonstandard, you'll have to buy one that is supported by the operating system you choose.

PC-MOS supports the Maxpeed card, available through your PC-MOS value-added reseller. It's easy to install and to connect to terminals. The Maxpeed is currently available only for AT-bus computers.

Alloy's 386/MultiWare requires one or more IMP cards, available in both two- and eight-user configurations for either the AT or Micro Channel bus. Concurrent DOS and VM/386 support a wide variety of multiport cards. We used an eight-user Arnet Multiport-8, also available in a four-user configuration, to test both systems.

If you choose PC-MOS, Concurrent DOS, or VM/386, you can also opt for one of the high-speed graphics terminals. These connect by way of fiber optics or a direct bus connection and provide full color graphics on the workstation.

Multiuser Performance Results

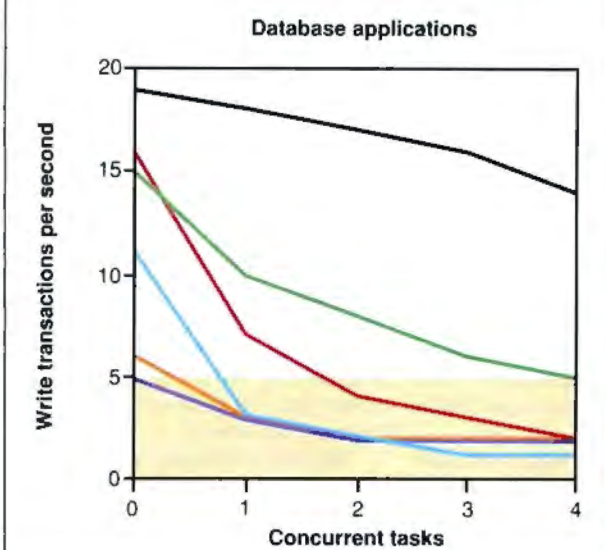

Figure 1: *Multiuser performance on our network-based database test. The graph also depicts how much degradation you might expect from each system. PC-MOS outperforms the others when unloaded, but 386/MultiWare holds up to increasing loads.*

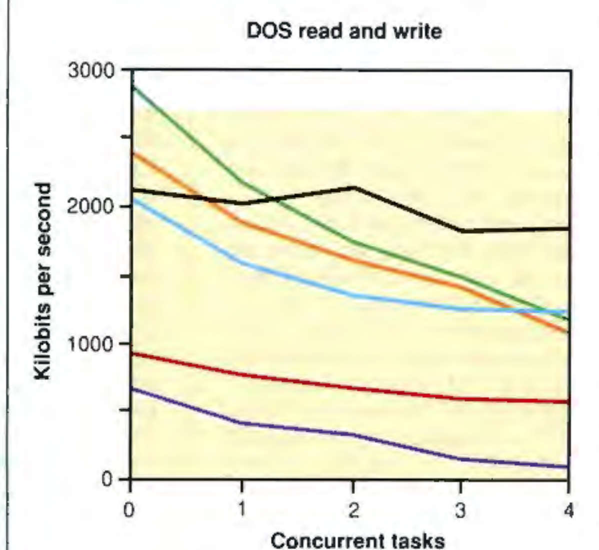

Figure 2: *DOS operations. VM/386 and 386/MultiWare operate under DOS, while Concurrent DOS and PC-MOS are DOS replacements.*

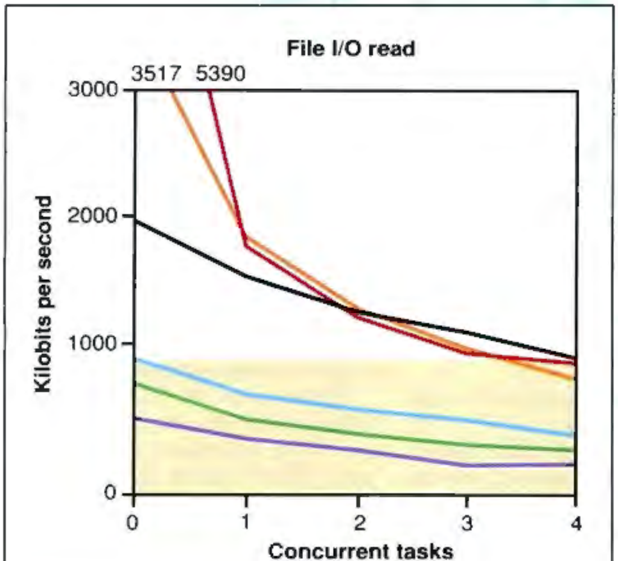

Figure 3: *Accessing the file system. Again, PC-MOS displays strong single-user performance, but it degrades quickly.*

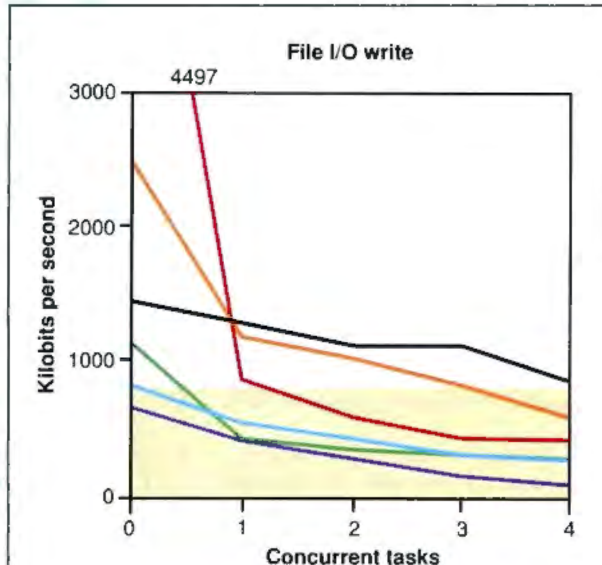

Figure 4: *Writing to a file. The multiuser systems stack up very well against the networks when performing file I/O tasks.*

PC-MOS · Concurrent DOS 386 · VM/386 · 386/MultiWare
3+Share · NetWare · Single-user DOS performance

keystrokes, even under heavy loads. And because VM/386 adjusts task priorities automatically, a task that needs CPU attention will get it. The other systems didn't do so well when heavily loaded; at times we experienced delays of several seconds.

The most exciting aspect of multiuser systems is their power to exploit the increased processing power of the 80386 processor without sacrificing the compatibility of DOS. But users who expect to load their present programs onto the host drive and happily run them may be disappointed. PC-MOS ran XyWrite Plus 3.52 sporadically. Concurrent DOS flunked Excel 2.0. MultiWare failed to run Lotus 1-2-3 release 2.01 unless we installed it from real-mode DOS, and only VM/386 successfully launched Windows 2.03. They all ran SideKick Plus as long as each terminal retained its own directory and files. We saw some peculiar anomalies and even a few spectacular crashes.

Compatibility with the standard disk devices on our Compaq Deskpro 386/20 was excellent. Each of the operating systems was able to read from and write to any disk we placed in the 1.2-megabyte disk drive, with only one exception—MultiWare failed to read the copy-protected Lotus 1-2-3 disk. Other devices we tried didn't work as well. If you have a CD-ROM drive or some other uncommon device, check with the vendor for specific compatibility. We achieved mixed results with a Bernoulli drive and a CD-ROM player.

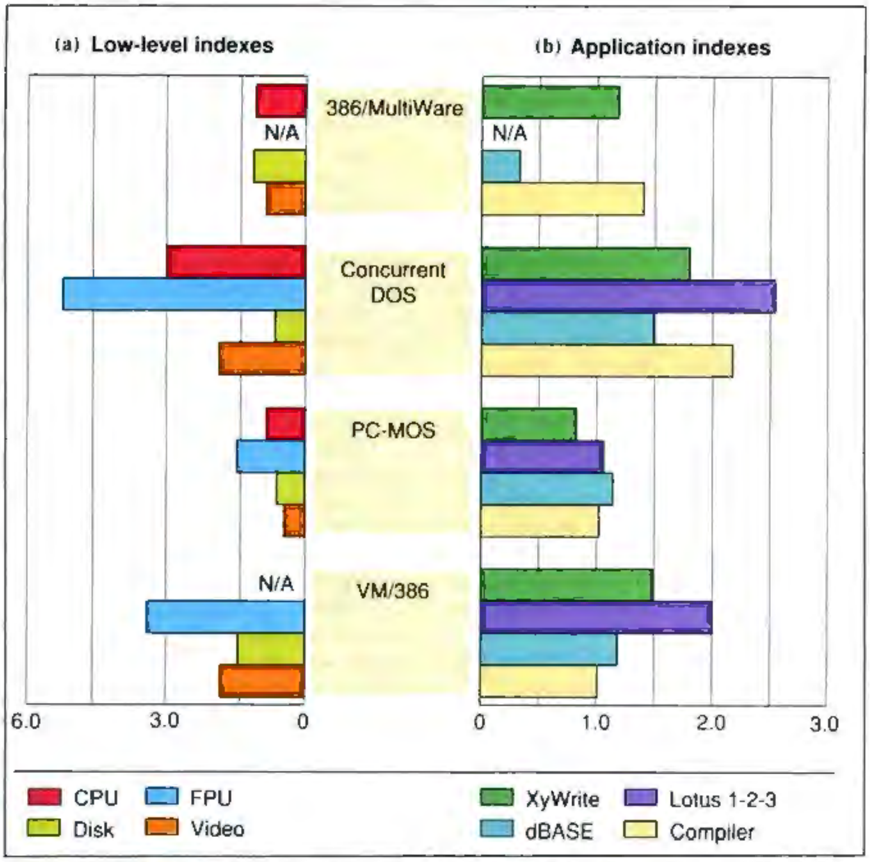

Figure 5: (a) *Loaded low-level benchmarks. We loaded each system by running a file I/O loop at two terminals. The host then ran the low-level tests. 386/MultiWare, which does not support a coprocessor, lacks an FPU index. VM/386 did not negotiate our string move tests, so it did not register a CPU index.* **(b)** *Loaded application benchmarks. Again, we loaded each system with two active tasks. Concurrent DOS consistently displayed superior performance. 386/MultiWare would not run our copy-protected version of Lotus 1-2-3.*

386/MultiWare

MultiWare was the easiest system to install. Alloy's IMP-8 multiport adapter card is a full-length card with one large connector on the rear panel. We installed the card and then attached a short cable to a panel with 16 serial ports—eight for terminals and eight for devices such as mice and serial printers. The software loads as a normal DOS 3.3 executable file. At start-up, MultiWare automatically finds and self-tests the interface, determines the baud rates of the terminals, and runs the start-up files at each workstation.

To add a new workstation, you fire up the MultiWare administrative program and enter a name for the workstation; MultiWare does the rest. It has three levels of user privilege. A supervisor can add new users and assign passwords. High-level workstations get the best performance and the ability to create and switch among eight tasks. Low-level workstations run a single task. All workstations enjoy password protection.

The Alt-F9 sequence, issued from any keyboard, brings up MultiWare's Task Manager. Menu-driven commands provide control over disk drives, COM ports, messages, and users. Alt-F8 brings up the Task Swapper, which navigates among active tasks. Other tools include a message facility and a dispatcher that can execute programs on other terminals.

As noted, MultiWare does not support the 80387 math coprocessor. Equally disturbing was our test system's inability to install Lotus 1-2-3 release 2.01. Our Lotus 1-2-3 installation runs off the hard disk drive after reading from a key disk. MultiWare was unable to read from the key disk; the workstation just locked up. Alloy suggests that some products should be installed from real-mode DOS before starting MultiWare—and that worked for Lotus 1-2-3. A number of text-based applications ran erratically; both XyWrite and the Microsoft C Compiler had a couple of false starts before they finally ran.

Microsoft Windows made trouble for all the systems except VM/386. Windows is an invasive program that takes radical control of the system. MultiWare was able to start Windows on the host and run it for a while, but then the cursor just up and vanished.

MultiWare's file-system performance varied, depending on the type of I/O. It had a strong showing on the DOS COPY test, outperforming all the other multiuser systems and 3+Share. Curiously, it even did better than DOS when only one workstation was active—probably thanks to its disk caching. File I/O performance started a tad below DOS and degraded quickly as the system load increased.

But perhaps more important than the measured performance is a user's perception of system response—the way the keyboard responds. Despite the system loads, applications on a heavily loaded

continued

MultiWare system still perform reasonably. When you press a key on the keyboard, it shows up quickly on the screen. It took a fair amount of loading to bog down MultiMate Advantage II to the point where it was unusable.

Concurrent DOS

The 80386 version of Concurrent DOS is the latest in a line of operating-system products. Concurrent DOS clearly shows its roots in CP/M-86 and CP/M, even preserving file compatibility. In fact, the system command files for Concurrent DOS carry the CP/M-86 .CMD file extension. We installed our 10-user copy of Concurrent DOS with an Arnet Multiport-8 board. Installation involved setting the Arnet card's switches to the recommended I/O address settings and following Arnet's instructions for installing the card. Two ribbon cables must be precisely routed in order to install the card (see photo 1).

You can choose to retain DOS on your hard disk (and launch Concurrent DOS from the AUTOEXEC batch file) or to replace DOS so the host simply boots Concurrent DOS. In either case, Concurrent DOS takes over the machine. It provides all your favorite DOS functions using commands that feel similar, if not identical, to the DOS repertoire. Where there are differences, they're minor. For example, Concurrent DOS merges the DOS BACKUP and RESTORE commands into a single BACKUP command. And some of Concurrent DOS's DOS-equivalent commands have menu-driven interfaces.

Power users will like Concurrent DOS's speed—its virtual 8086 tasks consistently outperformed those of the other systems, especially under load. Although the multiuser R:base tests showed a sharp degradation of performance as the system load increased—fully loaded, Concurrent DOS fell to the bottom of the pack—we nevertheless found it overall the fastest of the systems we tested.

Concurrent DOS also ran most of our applications, although it doesn't do Windows. It handily took on SideKick Plus and our graphics packages, AutoCAD 2.52 and MathCAD 2.0. Running Lotus 1-2-3 produced an unexpected "memory full" error. Microsoft Word ran, but with a very slow cursor. Word's performance was about a third of what you'd expect on a standard 8-MHz IBM AT.

Concurrent DOS does a particularly nice job with passwords. You can assign a password to each directory, or even to each file. You can also specify separate passwords for read, write, and delete privileges. There's no general log-in password because you don't need one: If all the directories in a system are password-protected, an unauthorized user can see the names of the directories but nothing more. With 386/MultiWare and VM/386 there's a log-in password, but once you're through the front door, you have full access to the system. Concurrent DOS's password support lets the administrator restrict access to some programs and give free access to all others.

Concurrent DOS has also carried over the multiple text windows that made the original Concurrent DOS so unique. The system console can run four tasks and provides control keys to switch from one task to another. A workstation can switch freely between two tasks. The console can also place each of the four tasks in a different window and freely resize and color the windows. This works well on applications that follow the standard rules for writing to the screen, but it's ineffective with applications that write directly to video memory.

In addition to the standard PCTERM terminal type (see the text box "Terminals and Multiport Boards"), Concurrent DOS supports ASCII terminals. Concurrent DOS lets you prevent the Ctrl-Alt-Del sequence (at the host console) from rebooting the computer. If you choose to keep the sequence enabled, a Ctrl-Alt-Del will pull the plug on all users. The REBOOT command does what Ctrl-Alt-Del does and can be performed from any workstation. You can choose the Ctrl-Alt-Del lockout and control access to the REBOOT command by means of password protection, and there won't be any accidents. 386/MultiWare and VM/386 require you to use the administrative menus to reboot the host, while PC-MOS allows Ctrl-Alt-Del to work from the host console at any time.

PC-MOS 3.00

The Software Link has devised a unique approach to software evaluation. Like many vendors, the company offers a demonstration version. Unlike many demonstration products, however, this one is fully functional. The hitch? It locks up after 30 minutes, forcing you to reboot. The half-hour session gives you enough time to evaluate the product, but it's disruptive enough to keep you from just using the demo forever. It's a nice idea. You should take advantage of it to try out your applications and see how well they run.

While PC-MOS ran many of the programs we launched, it seemed, well, flaky. For instance, we ran all the XyWrite benchmarks under PC-MOS, but not without tribulations. Keystrokes were

continued

Photo 1: *Eight-user Maxpeed (left) and Arnet's Multiport-8 multiport boards.*

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often doubled on the screen, demanding excessive correction and rekeying. A Ctrl-Alt-Del from the PC-MOS host brought the whole system down—there's no reboot protection.

The Software Link recommends that a value-added reseller install the PC-MOS system, and for good reason. A number of tweakable parameters require technical expertise. The FREEMEM statement in the CONFIG.SYS file allocates free memory space above C0000 for use by PC-MOS. PC-MOS can then relocate itself out of the primary (0 to 640K bytes) address space, leaving more memory for applications. It's an advanced and highly useful feature, but not for the casual user. Although you're not required to use FREEMEM, some applications won't run without it.

Another tricky configuration statement is SMPSIZE, which allocates RAM for the System Memory Pool. PC-MOS uses the SMP to keep track of open files and active tasks. Device drivers are also loaded into the SMP. A small SMP frees memory but limits the number of available tasks and devices. A large SMP soaks up RAM, leaving insufficient memory for your tasks. Finding the optimal setting takes trial and error. It took us a while to get PC-MOS up and running.

Connecting terminals is easier. You just cable a modem or a terminal to the serial ports. The Maxpeed multiport serial board is manufactured exclusively for The Software Link. It supports eight users at speeds of up to 38.4 kilobits per second and allows you to install three boards for a total of 25 users. To start a task on a terminal, you supply the terminal type, location, and baud rate as arguments to the ADDTASK command.

PC-MOS supports several types of terminals, but there's a catch. A standard terminal supports only 24 lines and does not have all the extra PC keys like Home and PageUp. PC-MOS provides emulation for these keys by mapping them to escape sequences. For example, the VT-100 (ANSI) terminal emulation defines Esc-S-H as the equivalent of Home. The escape sequences can get very tedious, though, and arrow keys are not supported. To its credit, PC-MOS was the only system we tested that even attempts to support full-featured standard terminals other than PCTERM compatibles.

The ADDTASK command can specify the amount of memory allocated to a task, the task's ID, its security class, and the name of its start-up batch file. You can switch among tasks by using the Alt key combined with the ID number. By invoking the ADDTASK command from within your partition, you can start additional tasks. You can keep track of task activity with the MOS MAP command.

The MOSADM command adjusts the number of time slices granted to each task, sets priority levels, and turns the cache on and off. You've got to be careful when assigning priorities. We passed top priority to a remote task and could never recover time slices for the host. You can also pass control of specific interrupt vectors to a device or to an active task. The selected task or device then owns the interrupt, and no other device or task can use it. For instance, we had to give control of IRQ 4 to our LapLink task in order to use COM1. You can even assign an interrupt vector to a number of different serial ports. Each task could then use the interrupt through its own port. This enables mouse support at each station.

PC-MOS employs a rather unusual security scheme. Each file or directory has a security class represented by an uppercase letter. Each user has a four-character name, a six-character password, and a level of access to each of the 26 classes. Access levels range from 0 (no access) to 3 (full read/write/delete). The administrator retains full access to all 26 classes. For example, a secretary could have full access to word processing files and no access to spreadsheet files, while the accounting department could have access to its spreadsheets but could not snoop around in other directories. All the security information resides in the $USER.SYS file.

As a single-user operating system, PC-MOS performs admirably. It consistently placed at or near the top of our benchmark charts when unloaded. Unfortunately, when you start adding tasks, PC-MOS quickly bogs down. Despite its problems, however, PC-MOS is the most flexible package we reviewed. Each user can run up to 255 tasks from a remote terminal, depending on available memory. The command-line structure supports some powerful features. And it's the only system that lets the supervisor hot-key into another terminal's task.

VM/386

We had heard that VM/386 is bulletproof; it's true. It ran every application we threw at it. The other packages may

continued

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COMPANY INFORMATION

Alloy Computer Products, Inc.
(386/MultiWare)
100 Pennsylvania Ave.
Framingham, MA 01701
(617) 875-6100
NX386E, five users $395
NX386, 21 users $895
IMP2 or IMP2/PS $495
IMP8 or IMP8/PS $1195
Inquiry 1071.

Arnet
(Multiport-4 and Multiport-8)
618 Grass Mere Park Dr., Suite 6
Nashville, TN 37211
(800) 366-8844
Multiport-4 ....$495
Multiport-8 ....$735
Inquiry 1072.

Digital Research, Inc.
(Concurrent DOS)
60 Garden Court
P.O. Box DRI
Monterey, CA 93942
(408) 649-3896
Three users $395
10 users.............................$495
System Builder's Kit $700
Programmer's Toolkit $200
Inquiry 1073.

Intelligent Graphics Corp.
(VM/386)
4800 Great America Pkwy.
Santa Clara, CA 95054
(408) 986-8373
1.21 Multiuser $895
Inquiry 1074.

Kimtron Corp.
(KT-70)
1709 Junction Court, Building 380
San Jose, CA 95112
(408) 436-6550
$569
Inquiry 1075.

Link Technologies, Inc.
(MC5)
47339 Warm Springs Blvd.
Fremont, CA 94359
(415) 651-8000
$579
Inquiry 1076.

The Software Link, Inc.
(PC-MOS)
3577 Parkway Lane
Norcross, GA 30092
(404) 448-5465
Five users $595
25 users............................$995
Maxpeed board, eight users....$695
Inquiry 1077.

Wyse Technology
(WY-60, WY-99GT, WY-150)
3571 North First St.
San Jose, CA 95134
(408) 433-1000
WY-60 ....$599
WY-99GT..........................$649
WY-150............................$549
Inquiry 1078.

have their virtues, but none can make that claim. VM/386 wasn't the fastest operating system, or the slickest, but it was refreshingly reliable. It was also the most responsive of the systems we tested. Rarely did the display lag behind typed input. As we've mentioned, VM/386 dynamically adjusts time slices according to each task's needs. Its System Resource Manager (SRM) even suspends tasks that aren't receiving external interrupts, passing valuable time slices to active tasks.

The SRM also provides you with additional performance options that you can adjust manually. For instance, some applications run long processes in memory. It is possible that the SRM will interpret these operations as an idle task, thus denying the task the necessary time slice. You can either set the SRM to stop analyzing the task altogether so that the task is always active, or you can adjust the SRM Burst (the amount of time without external interrupts before a task is suspended). You can also increase the foreground slice if your application doesn't seem to be responsive enough. All this clever engineering results in remarkably smooth operation.

Installing VM/386 was quick and painless. The documentation guided us through the Arnet Multiport-8 card configuration, and the software installation flowed smoothly through a series of questions. Usually, default values were acceptable. We had the system up in a matter of minutes. Configuration changes took effect immediately—there was no need to reboot after each change.

You create so-called virtual machines from a series of menus. A list of profiles provides templates for the most popular configurations. You can load a profile and then adjust individual parameters to your liking. VM/386 lets you set up tasks with the full 640K bytes of memory that DOS allows, accommodating even the most RAM-hungry applications. (Concurrent DOS and MultiWare also support full 640K-byte tasks; only PC-MOS necessarily steals some conventional memory from DOS programs.) Tasks retain their own DOS and BIOS.

Once your virtual machines are configured, you can access the Switcher from any terminal by pressing the Alt and SysRq keys simultaneously. Active tasks appear in a window. You simply select a task and press Return to bring the task to your screen. You can also use a quick-key sequence (hold down the Alt key and press SysRq twice) to cycle through all your tasks.

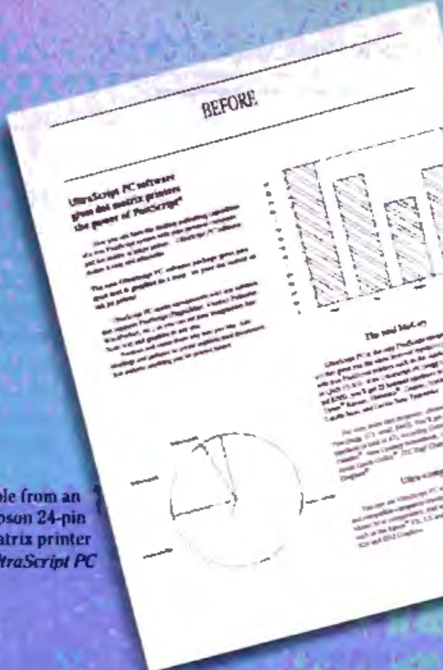
VM/386 also lets you link devices to virtual machines. This prevents two tasks from accessing the same output device, such as a modem or a floppy disk drive. You can either link the device to a number of terminals or force an exclusive link to one terminal. You can link a device from the DOS prompt or from a VM/386 menu. All the systems provide some method of protecting your task's devices from other users. VM/386's method worked as well as those of the other systems.

Our benchmarks showed VM/386 to be an adequate, though not spectacular, performer. It excelled on DOS and file I/O operations but lagged somewhat on application tests. On the other hand, it was the only package to run every test in our application suite. So although it may be a bit slower than the others, you won't waste precious time trying to get things to work. From installation to configuration to applications, everything ran flawlessly.

What Will It Cost?

We compared the prices of each of the multiuser systems—with terminals for three, five, 10, and 20 users—with two LANs (3Com's 3+Share and Novell's NetWare). The multiuser environment requires a fast 80386-based computer with a lot of memory—640K bytes to 1 megabyte per person. For comparison, assume that you could buy a machine like this for about $10,000. The multiuser workstations we selected were dedicated terminals, in this case WY-150s from Wyse. The price of an average dedicated terminal was about $600. If you have microcomputers lying around, you can

continued



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save some money by using terminal-emulation software and connecting them instead of terminals. You gain the option of local autonomy, but you'll be transferring files between the workstation and the host, not sharing them.

For the LAN setup, we chose a 12-MHz 80286 with 640K bytes of memory and a single floppy disk drive to represent a typical workstation. Dell Computer will sell you a System 200 for about $1600. Add a copy of DOS, the network card, and cabling, and the workstation comes to about $2100. The LAN's server needs less processor power and memory than the multiuser system's host. A $7000 80286-based machine should make a reasonable server for a small office.

For a small installation of three users, the higher cost of the 80386 computer makes the comparison close. When using PC-MOS or Concurrent DOS with three users, you can connect terminals to COM1 and COM2 and so eliminate the need to buy a special multiport card. Our cheapest multiuser system came in at about $3800 per user. The LAN weighed in at a hefty $4800. A large installation of 20 or so users can lower the per-workstation cost of the multiuser solution to $1100—cheaper than the equivalent

continued

Table 2: *Comparative costs for different multiuser operating systems. As the number of users increases, the higher cost of the 80386 host is distributed, making the multiuser solution more economical. Costs for 3+Share and NetWare are included for comparison.*

	386/MultiWare	Concurrent DOS	PC-MOS	VM/386	3+Share	NetWare
Workstation						
Wyse WY-150	$549.00	$549.00	$549.00	$549.00		
Dell System 200					$1600.00	$1600.00
Network adapter					$399.00	$399.00
DOS					$100.00	$100.00
Cabling	$25.00	$25.00	$25.00	$25.00	$25.00	$25.00
Total	**$574.00**	**$574.00**	**$574.00**	**$574.00**	**$2124.00**	**$2124.00**
System cost — 3 users						
Host computer	$10,000.00	$10,000.00	$10,000.00	$10,000.00	$7000.00	$7000.00
DOS (for host)	$100.00			$100.00	$100.00	$100.00
Server software	$395.00	$395.00	$595.00	$895.00	$595.00	$4695.00
Interface card	$495.00	N/A	$695.00	N/A	$399.00	$399.00
Workstations	$1148.00	$1148.00	$1148.00	$1148.00	$6372.00	$6372.00
Total	$12,138.00	$11,543.00	$12,438.00	$12,143.00	$14,466.00	$18,566.00
Cost/user	**$4046.00**	**$3847.67**	**$4146.00**	**$4047.67**	**$4822.00**	**$6188.67**
System cost — 5 users						
Host computer	$10,000.00	$10,000.00	$10,000.00	$10,000.00	$7000.00	$7000.00
DOS (for host)	$100.00			$100.00	$100.00	$100.00
Server software	$395.00	$495.00	$595.00	$895.00	$595.00	$4695.00
Interface card	$1195.00	$495.00	$695.00	$495.00	$399.00	$399.00
Workstations	$2296.00	$2296.00	$2296.00	$2296.00	$10,620.00	$10,620.00
Total	$13,986.00	$13,286.00	$13,586.00	$13,786.00	$18,714.00	$22,814.00
Cost/user	**$2797.20**	**$2657.20**	**$2717.20**	**$2757.20**	**$3742.80**	**$4562.80**
System cost — 10 users						
Host computer	$10,000.00	$10,000.00	$10,000.00		$7000.00	$7000.00
DOS (for host)	$100.00				$100.00	$100.00
Server software	$895.00	$495.00	$995.00		$2495.00	$4695.00
Interface card	$1690.00	$735.00	$1390.00		$399.00	$399.00
Workstations	$5166.00	$5166.00	$5166.00		$21,240.00	$21,240.00
Total	$17,851.00	$16,396.00	$17,551.00		$31,234.00	$33,434.00
Cost/user	**$1785.10**	**$1639.60**	**$1755.10**		**$3123.40**	**$3343.40**
System cost — 20+ users						
Host computer	$10,000.00		$10,000.00		$7000.00	$7000.00
DOS (for host)	$100.00				$100.00	$100.00
Server software	$895.00		$995.00		$2495.00	$4695.00
Interface card	$4980.00		$2085.00		$399.00	$399.00
Workstations	$11,480.00		$13,776.00		$53,100.00	$53,100.00
Total	$27,455.00		$26,856.00		$63,094.00	$65,294.00
Cost/user	**$1307.38**		**$1074.24**		**$2523.76**	**$2611.76**

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LAN cost of $2500. Table 2 shows the breakdown. If your application mix is an appropriate one, the multiuser solution is clearly cheaper.

Multiuser Operating System or LAN?

There's no simple answer. Like a LAN, a multiuser operating system provides a shared file system, but with faster disk access. Screen performance is slower if you compare a serial terminal to a LAN user's microcomputer. But text applications run beautifully on the new generation of serial terminals, and the display quality of our test terminals is sure to please any experienced microcomputer user. The fonts easily rival those of a good monochrome display.

Performance can vary widely depending on your application. The best applications for a multiuser environment are those that spend a fair amount of time waiting for keyboard input, such as word processing and data entry. The worst applications are the CPU-intensive ones. These have no effect on a LAN, but they can cripple a multiuser system.

Databases that require a fair amount of disk access may run better on a multiuser system. LAN-oriented databases normally ship all data through the network to workstations, where the processing happens. Server-based LAN applications now emerging will change that, but most people aren't using them yet. Transferring all those packets over the wire incurs a substantial cost. A multiuser system processes data in place (that's just what LAN server-based applications aim to achieve), avoiding all that traffic.

The issue of application compatibility is one you should address on a case-by-case basis. We doubt that Windows (or any other graphically intensive application) makes sense for the multiuser environment. But text-oriented programs and character-based graphical programs may make sense—it just depends on which ones. Be sure to specify to your dealer the applications (and external devices, such as CD-ROMs) that you plan to use, and make sure that everything will work.

If you're interested in custom application development, note that Concurrent DOS and PC-MOS provide functionality above and beyond DOS. Applications specially written for these systems can take full advantage of task spawning, background processing, and the ability to change their priorities depending on need. Both manufacturers will sell you system developer's kits with utilities and enhanced documentation.

Choosing between these operating systems wasn't easy. While testing each of them, it became clear to us that they all have specific strengths and weaknesses. In spite of the developer's features of Concurrent DOS and PC-MOS, we thought that either 386/MultiWare or VM/386 would be the best substitute for an office LAN. Both run applications more reliably than the other two, and we attribute this to the real copy of DOS underlying the multiuser shell. 386/MultiWare was the easiest to install and use. VM/386 was the most compatible. Ultimately, you have to select a product that takes care of the details of resource sharing and allows you to get your work done. For some environments, a multiuser solution may be the way to go. ■

Howard Eglowstein and Stanford Diehl are BYTE Lab testing editors. You can reach them on BIX as "heglowstein" and "sdiehl," respectively.

ALR Revs Up MCA

The MicroFlex 7000 is a fast, expandable MCA clone, but is it better than an AT?

Bill Catchings
and Mark L. Van Name

Advanced Logic Research's MicroFlex 7000 combines the Micro Channel architecture (MCA) with a 25-MHz 80386 and a proprietary cache architecture to raise the performance ante for MCA machines. Its cache architecture is similar to that used in ALR's AT-compatible FlexCache 25386, which combines a high-speed static RAM (SRAM) cache with dual memory and I/O buses to let the 80386 CPU run with no wait states most of the time.

The MicroFlex 7000 cache differs from that of the FlexCache 25386 in two ways: It uses the MCA bus, and it moves data between the cache and main memory 64 bits at a time. While it uses the same 64K-byte cache of 25-nanosecond SRAM as the FlexCache 25386 does, the MicroFlex replaces the FlexCache's 60-ns DRAM with slower 80-ns DRAM.

The slower DRAM seems to cancel out the improved cache system to yield a processor/memory combination that is close to the speed of the FlexCache. That's not bad, however, because the FlexCache 25386 is the fastest IBM PC compatible that BYTE has reviewed.

A Lot of Box, a Lot of Money

The MicroFlex 7000's high performance and MCA bus do not come cheap; the Model 120-A21 (with a 150-megabyte hard disk drive) costs $8499, while the Model 300-A31 (with a 310-megabyte hard disk drive) runs $12,397. Standard features include 2 megabytes of DRAM, a math coprocessor socket, SuperVGA circuitry, a 1.44-megabyte 3½-inch floppy disk drive, and an ESDI controller. Software includes an ALR Reference Diskette that lets you configure MCA peripherals; Multisoft's Super PC-Kwik disk cache; and Quarterdeck's DESQview and Expanded Memory Manager (QEMM-386).

The Model 300-A31 evaluation system included three optional components. One was a VGA monitor, which BYTE supplied. ALR now offers a 14-inch VGA monitor for $499. The unit also came with an 80387 coprocessor and MS-DOS 3.3. (ALR now offers only MS-DOS 4.01.) With these extras, the evaluation unit costs a tidy $13,940.

Oddly enough, a MicroFlex 7000 Model 120-A21 with the same extras as our evaluation unit would run a far more reasonable $10,042. That means ALR is hitting you for $3898 for the additional 160 megabytes of disk space. We suspect that this is because ALR is pricing its

continued

ALR MicroFlex 7000

Company
Advanced Logic Research, Inc.
9401 Jeronimo
Irvine, CA 92718
(714) 581-6770

Components
Processor: 25-MHz 32-bit Intel 80386; socket for 25-MHz Intel 80387 or Weitek 3167 math coprocessor
Memory: 2 megabytes of 32-bit 80-ns DRAM in two 1-megabyte IBM PS/2-compatible SIMMs; 64K bytes of 25-ns static RAM for the cache; 128K bytes of 200-ns BIOS ROM
Mass storage: 1.44-megabyte 3½-inch floppy disk drive; 150-megabyte hard disk drive (Model 120-A21) or 310-megabyte hard disk drive (Model 300-A31)
Display: ALR 14-inch VGA monitor; VGA circuitry and DB-15 connector on motherboard
Keyboard: 101 keys in a modified IBM-Enhanced keyboard layout, with separate numeric keypad and cursor-control clusters
I/O interfaces: RS-232C serial port with DB-25 connector; DB-25 parallel port; AT-style keyboard connector; PS/2-style mouse connector; eight Micro Channel expansion slots (three 32-bit and five 16-bit)

Size
7½ by 17½ by 23 inches, 70 pounds (maximum)

Software
MicroFlex 7000 Reference Diskette and custom utilities; Multisoft Super PC-Kwik disk cache 3.23; Quarterdeck DESQview 2.25 with QEMM-386 version 4.23

Documentation
User's manual

Price
Model 120-A21: $8499
Model 300-A31: $12,397
System as reviewed: $13,940

Inquiry 852.

MicroFlex 7000 models to compete with comparable IBM PS/2s—the Models 70-A21 and 80. From that perspective, ALR's Model 120-A21 does reasonably well; it costs $451 less than IBM's Model 70-A21. The IBM system, with its maximum disk size of 120 megabytes and its meager three MCA slots, is also far less expandable than the ALR system.

Another MCA compatible, the 20-MHz Tandy 5000 MC, is a bit cheaper than the MicroFlex 7000: With a 170-megabyte SCSI hard disk drive and a smaller (32K-byte) cache, it costs about $200 less than the MicroFlex 7000 Model 120-A21.

The MicroFlex Architecture

Most cached 80386 systems, MCA or otherwise, use the Intel 82385 cache controller. ALR bucks this trend by implementing in discrete logic its own improved version of the 82385. ALR gains performance with this approach, but at the cost of quite a few chips on the motherboard.

The most important improvement of ALR's cache controller over the 82385 is in its handling of direct-memory-access writes. When a DMA write changes a memory location whose contents are in the cache, the ALR controller updates the cache data; the 82385 would simply mark the location invalid. ALR's cache also fetches 64 bits of memory when there is a cache miss. Because most memory accesses are sequential, pre-fetching the second 32 bits increases the cache's hit ratio.

ALR packages the main memory on two 1-megabyte single in-line memory modules that the firm claims are compatible with IBM's PS/2 memory modules. Because of the 64-bit-wide bus between the cache and main memory, the MicroFlex 7000's memory must come in pairs of SIMMs. With 2-megabyte SIMMs in the eight SIMM slots, the MicroFlex 7000 can handle up to 16 megabytes of DRAM. (ALR does not yet offer 2-megabyte SIMMs, but the company claims that the MicroFlex 7000 will work with IBM's 2-megabyte PS/2 memory modules.)

Performance

The result of this fancy architecture is an extremely fast system. The BYTE CPU, FPU, and text video tests place the MicroFlex 7000 about 20 percent faster than Compaq's 386/25 and within 1 percent of the performance of the FlexCache 25386.

On the hard disk tests, the news is not so good. Here, the MicroFlex 7000 Model 300-A31 is significantly slower than a FlexCache 25386 with a similar 300-megabyte hard disk drive. An ALR spokesperson said that the overhead of the MicroFlex 7000's emulation of the IBM PS/2 Model 70's hard disk drive and the fact that the BIOS checks the disk status after every read and write operation slow the performance. ALR plans to fix this in a future release of the BIOS.

Still, the performance of the MicroFlex 7000's 310-megabyte hard disk drive is not that bad. The system is about 10 percent faster than the 150-megabyte hard disk drive version of the FlexCache 25386, and it compares favorably with other MCA machines—it's about 50 percent faster than the 20-MHz IBM PS/2 Model 70-A21 and almost twice as fast as the Tandy 5000 MC.

Compatibility

Speed alone, of course, is not the whole story, especially with MCA systems. The system must be able to handle MCA expansion boards and run standard software. The MicroFlex 7000 does well on both counts.

It had no problems running a simple MCA internal modem (Computer Peripherals' Hook-Up PS2400). More impressively, it also worked with a bus-master card, Pixelworks' Ultra Clipper UM1280 high-resolution graphics card. The MicroFlex 7000 successfully ran a Pixelworks test that alternately exercises that video card and the ESDI controller, which is also a bus master. According to Pixelworks, this test can use as much as 50 percent of the MCA bus bandwidth. The MicroFlex 7000 also had no trouble with a Xircom Pocket Ethernet Adapter that attaches to the unit's parallel port.

It did not fare as well with a simple Microsoft Serial Mouse. When we tried to load the mouse driver software, the system claimed that no mouse was attached. An ALR spokesperson said the company plans to fix this problem by making minor changes to the MicroFlex 7000's motherboard, and that a Microsoft Mouse works with the MicroFlex 7000's built-in, PS/2-style mouse port.

The MicroFlex 7000 ran all the software we tried on it, including Borland's Quattro 1.0, Reflex 1.14, SideKick Plus 1.00A, SuperKey 1.16A, Turbo C 1.0, and Turbo Pascal 4.0; Digitalk's Smalltalk/V 1.2; Kermit 2.32/A; MicroPro's WordStar 3.3 and 4.0; Lotus's Symphony 2; Microsoft's PC Paintbrush 2.0, Windows/386 2.0, and Word 4.0; Norton Utilities 3.00; Novell's NetWare 2.15; and Symantec's Q&A 1.1.

In fact, the only software problem we found was a holdover from the FlexCache 25386. The MicroFlex 7000's FDISK program froze when we tried to make the penultimate partition of the 310-megabyte hard disk drive a full 32 megabytes. (You can work around this problem easily by making that partition smaller.) An ALR spokesperson said that the problem was due to an odd interaction between the DOS 3.3 FDISK

continued

ALR MicroFlex 7000

APPLICATION-LEVEL PERFORMANCE

ALR MicroFlex 7000 **17.6***

WORD PROCESSING	
XyWrite III+ 3.52	**Medium/Large**
Load (large)	:11
Word count	:03/:15
Search/replace	:04/:14
End of document	:02/:08
Block move	:08/:09
Spelling check	:06/:38
Microsoft Word 4.0	
Forward delete	:11
Aldus PageMaker 1.0a	
Load document	:06
Change/bold	:16
Align right	:13
Cut 10 pages	:11
Place graphic	:03
Print to file	1:24
Index:	**3.54**

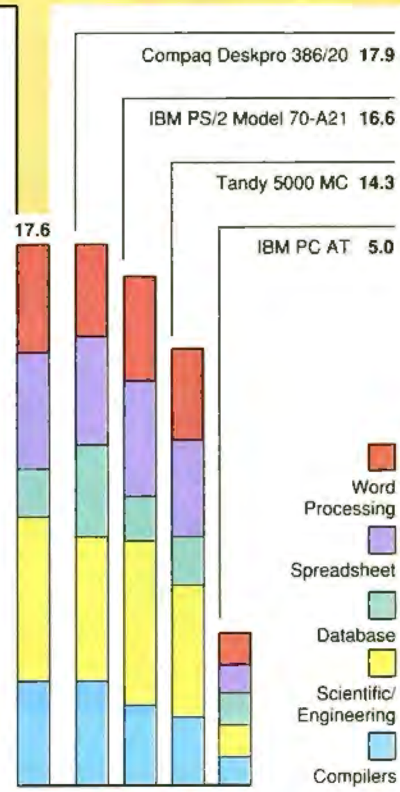
SPREADSHEET	
Lotus 1-2-3 2.01	
Block copy	:02
Recalc	:01
Load Monte Carlo	:14
Recalc Monte Carlo	:03
Load rlarge3	:04
Recalc rlarge3	:01
Recalc Goal-seek	:02
Microsoft Excel 2.0	
Fill right	:03
Undo fill	1:09
Recalc	:01
Load rlarge3	:14
Recalc rlarge3	:01
Index:	**3.82**

DATABASE	
dBASE III+ 1.1	
Copy	1:10
Index	:19
List	1:18
Append	1:37
Delete	:03
Pack	1:19
Count	:17
Sort	1:11
Index:	**1.50**

SCIENTIFIC/ENGINEERING	
AutoCAD 2.52	
Load SoftWest	:31
Regen SoftWest	:21
Load StPauls	:07
Regen StPauls	:04
Hide/redraw	7:00
STATA 1.5	
Graphics	:21
ANOVA	:10
MathCAD 2.0	
IFS 800 pts.	:10
FFT/IFFT 1024 pts.	:09
Index:	**5.45**

COMPILERS	
Microsoft C 5.0	
XLisp compile	2:40
Turbo Pascal 4.0	
Pascal S compile	:04
Index:	**3.30**

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]

ALR MicroFlex 7000

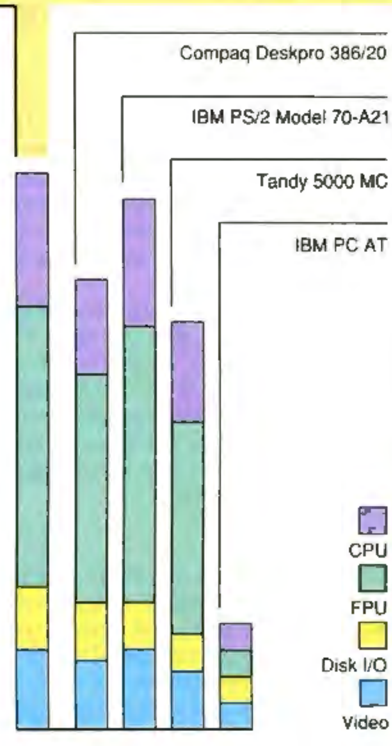
CPU	
Matrix	2.65
String Move	
Byte-wide	16.58
Word-wide:	
Odd-bnd.	22.60
Even-bnd.	8.30
Doubleword-wide:	
Odd-bnd.	16.47
Even-bnd.	4.15
Sieve	14.06
Sort	10.52
Index:	**4.99**

FLOATING POINT	
Math	4.87
Error[2]	0.00E+00
Sine(*x*)	1.66
Error	2.00E−09
e^x	1.82
Error	1.00E−09
Index:	**10.29**

DISK I/O	
Hard Seek[3]	
Outer track	3.33
Inner track	3.33
Half platter	6.67
Full platter	8.39
Average	5.43
DOS Seek	
1-sector	8.38
32-sector	16.86
File I/O[4]	
Seek	0.04
Read	0.89
Write	0.82
1-megabyte	
Write	2.97
Read	4.36
Index:	**2.41**

VIDEO	
Text	
Mode 0	3.27
Mode 1	3.18
Mode 2	3.54
Mode 3	3.55
Mode 7	N/A
Graphics	
CGA:	
Mode 4	1.19
Mode 5	1.16
Mode 6	1.33
EGA:	
Mode 13	2.27
Mode 14	2.85
Mode 15	N/A
Mode 16	2.78
VGA:	
Mode 18	2.96
Mode 19	1.25
Hercules	N/A
Index:	**2.97**

CONVENTIONAL BENCHMARKS	
LINPACK	135.33
Livermore Loops[5] (MFLOPS)	0.22
Dhrystone (MS C 5.0) (Dhry./sec.)	8278



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.

MP386

MP286

MP386s

mp286L

program and the MicroFlex 7000's hard disk subsystem.

Disk Space to Burn

The MicroFlex's hard disk drive is a 310-megabyte, 5¼-inch, full-height Control Data drive. An Adaptec ESDI controller with an on-board 32K-byte cache uses a 1-to-1 interleave with that drive; the combination delivers an average access time of 16 milliseconds.

The MicroFlex 7000 has two empty 3½-inch drive bays, plus two open 5¼-inch half-height bays. ALR offers as options a 1.2-megabyte 5¼-inch floppy disk drive and a 150-megabyte ¼-inch streaming tape drive. The system's standard floppy disk drive is a 1.44-megabyte 3½-inch Fujitsu unit.

The Wrapper

All this hardware is in a tower that can weigh up to 70 pounds. Getting into that box starts out easy: You remove two thumbscrews on the rear and slide off its left side panel. From there, however, the going gets tough. Just to insert an expansion card you must first remove a 3-inch-wide metal support that runs the height of the unit. Then you have to swing out a metal arm that holds the standard hard disk drive and one of the optional 3½-inch hard disk drives. Finally, you must remove a restraining brace that helps hold the expansion boards in place.

The MicroFlex 7000 has no pop-out components. It packages MCA technology in AT-style mechanical engineering.

This process illustrates the difference between an MCA compatible and a PS/2 clone. Unlike the PS/2s, the MicroFlex 7000 has no pop-out components. Instead, it packages MCA technology in AT-style mechanical engineering. Because PS/2s are much simpler to disassemble, users and in-house service organizations can easily add boards and replace and upgrade parts in their systems. ALR relies on its dealers to perform such tasks.

The reward for the journey inside the MicroFlex 7000 is eight MCA slots, only one of which—the uppermost 16-bit slot—is full; it contains the hard disk drive controller. Open are three 32-bit slots and four 16-bit slots.

The heart of the system is ALR's proprietary 14-inch-square motherboard. It uses Chips & Technologies' seven-chip Chips/280 chip set, which implements the MCA interface, the communications, and the 16-bit VGA circuitry. Even with these highly integrated chips, however, the motherboard contains an amazing 164 chips. The board was also fairly new; the 19 wires on its underside plainly marked many last-minute fixes.

The large chip count, by the way, does not include the memory on the SIMMs. Each 1-megabyte SIMM contains 12 chips, including eight 1-megabit memory chips; there is no parity on this memory.

The MicroFlex 7000's keyboard controller and ROM BIOS (version 1.02.02) are by Phoenix Technologies. The ROM BIOS automatically steps down the effective speed of the system when it reads or writes to the floppy disk; otherwise, the MicroFlex 7000 does not offer any compatibility speeds.

Odds and Ends

The MicroFlex 7000's keyboard follows the IBM Enhanced keyboard layout, except that it places the backslash (\) key next to a reduced Backspace key, in the older AT style. This keyboard also uses an AT-style, rather than PS/2-style, connector. While the keyboard has a nice feel and an audible, mechanical click, we miss the switch on the back of older ALR keyboards that lets you swap the function of the Control and Caps Lock keys.

The MicroFlex 7000's Reference Diskette includes the Phoenix Reference Diskette, which provides an attractive, simple user interface for MCA configuration. The Reference Diskette also contains other useful software, including NetWare Ethernet drivers, a low-level disk formatter, and VGA drivers for programs such as AutoCAD, Ventura Publisher, and Windows. Drivers for the VGA's higher 800- by 600-pixel modes were not available at this writing.

The MicroFlex 7000's documentation is too technical for novices, containing such occasionally useful information as the pin-outs for the external connectors. It also has at least one error: Its list of ROM BIOS drive types does not include any disk drives over 300 megabytes.

Service and Assistance

The MicroFlex 7000 comes with a one-year parts-and-labor warranty. You can also buy from one to three years of extended warranty service, but it's not cheap: One extra year costs $600 for the Model 120-A21 and $680 for the Model 300-A31.

When the MicroFlex 7000 needs maintenance, you can mail it either to ALR or to one of Intel's 35 service locations. Intel will also provide on-site service within 50 miles of any of those locations for $30 per month.

ALR also gives you unlimited telephone support. The support people with whom we spoke were knowledgeable and helpful. Our only complaint is that ALR does not provide a toll-free number.

The Bottom Line

If you need a high-performance MCA server, the MicroFlex 7000 is currently your best choice. It has more expansion capability than IBM's PS/2 Model 70 and much greater performance than such other large MCA boxes as the Tandy 5000 MC and the IBM Model 80.

The big question is whether you need an MCA system. You pay more money, but BYTE's benchmarks don't show any performance gains over fast AT machines. Furthermore, few add-in boards are available to take advantage of the MCA bus, although IBM and other vendors have promised more.

If you do decide to purchase an MCA PC, the MicroFlex 7000 is a good, very expandable, high-performance option. ■

Bill Catchings and Mark L. Van Name are independent consultants and freelance writers based in Raleigh, North Carolina. They can be reached on BIX as "wbc3" and "mvanname," respectively.

Northgate's 386 SuperMicro

800,000 BYTES PER SECOND SYSTEM THROUGHOUT . . . Northgate system throughput is second to none. We understand how to design, engineer and produce for optimum throughput. Using specially manufactured and modified components —controllers, bus, software, etc.— Northgate gives you maximum performance —800,000 bytes per second or more.

Few others can hardly coax a 300,000 BPS data transfer rate out of their systems. So why spend good money for ordinary performance when you can get Northgate-optimized performance for the same or less price?

VGA VIDEO TWICE AS FAST AS MOST OTHERS . . . Again, optimized performance from Northgate. We've gone right past EGA straight to 16-bit VGA as standard, not 8-bit as many others offer. It's more than twice as fast as standard monochrome!

You get a wider VGA video selection with Northgate. Either VGA Greyscale, Analog or Multi-synchronous models are available. VGA Greyscale adds only $395.00 to monographics costs.

Of course, we still offer monographics featuring 14" flatscreen with 1000 line resolution capability in either amber or the increasingly popular paper white screen.

NOW, THE SYSTEMS WITH SCSI CAPABILITY . . . SCSI (Small Computer System Interface) is the technology of the future and Northgate offers it today! Our SCSI model has an SCSI host adapter. Connect as many as 7 intelligent devices—hard drives, tape backups that can run in background, optical laser drives, etc.

Now SCSI technology no longer costs a fortune. Check our prices for SCSI with a 40MB hard drive. Performance rips with these drives—under 18 Millisecond access speeds. Ideal for intensive data base applications, or loading your spreadhseet in a blink.

Check our prices and phone for more details on how Northgate's SCSI technology can put more zip in your system performance at a price that more than pays for itself.

ESDI HIGH SPEED DRIVES TO 600 MEGABYTES . . . Northgate brings price reality to high capacity hard drive systems. Where others charge outlandish prices, Northgate's down-to-earth pricing puts these memory monsters well within your budget. Cost per megabyte is nearly halved when you enter this realm.

OMNIKEY/102 IS A NO-COST OPTION . . . You'll delight in using Omnikey/102. Every magazine review and thousands of users agree, Omnikey is the standard against which all other keyboards can be judged. And it comes with all Northgate systems as a no-cost option. If you don't buy a Northgate system and still want the best keyboard in the world, you can buy OmniKey separately for $99.00.

Add it all together. Compare with the other buys. Then call Northgate and feel confident you're buying the best!

Long Live the Low End

The smartly designed AST Bravo/286 is a winner among the 8-MHz AT compatibles

Roger C. Alford

AST Research is known for producing well-made IBM PC-compatible machines, and its newest entry, the Bravo/286, is no exception. While it might seem late in the game to introduce a low-end AT system, the 8-MHz Bravo/286 is stylish and cost-effective, with several built-in peripheral devices, a small footprint, and a high level of compatibility.

A Look from the Outside

The Bravo/286's 14¾- by 15-inch footprint takes up minimal desk space, and its 5-inch height is less than that of most XT systems. The system has an attractively simple front panel. Its two half-height drive bays are accessible from the outside of the unit. Besides the normal disk-access LEDs on the installed drives, the front panel has only a power-on LED, and the little-used keylock is absent.

I have one nit to pick: The power-on and floppy disk drive access LEDs on the front panel are visible only from a limited viewing angle. If you are too far above or to one side of the LEDs, it is difficult to tell when they are on.

The rear of the unit provides clues to how AST put so much computer into such a small box. The most notable difference from a standard AT is the orientation of the four expansion slots: They are horizontal instead of vertical. Below them are two 25-pin D-shell connectors—a parallel printer port (female connector) and an RS-232C serial port (male connector). A recessed reset button resides at the far bottom-left corner.

An Inside Look

The power supply is physically much smaller than that of a normal AT and sits immediately behind the drive bays. Its 100-watt output is meager by today's standards, but the low-power design of the logic board and the four-slot, two-bay limitations of the system minimize power requirements. The Bravo's power supply is adequate for most situations.

The logic board is simply elegant. It is almost evenly split between through-hole and surface-mount components, and single in-line memory modules are used for the main DRAM to provide high-density storage. The combined use of surface-mount parts, SIMMs, and the highly integrated G-2 80286 chip set allowed AST to combine a lot of circuitry on a small motherboard, which takes up the entire floor of the left side of the chassis. The motherboard is nicely built; I found only two engineering jumper wires on it.

To keep the height of the system low, the expansion slots are horizontal. To accomplish this, a separate "bus card" containing the expansion connectors plugs vertically into a special connector

continued

AST Bravo/286

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

Components
Processor: 8-MHz 80286, socket for 80287 coprocessor
Memory: 512K bytes of DRAM, expandable to 4 megabytes
Mass storage: 1.2-megabyte floppy disk drive
Keyboard: 101 keys in IBM Enhanced layout
I/O interfaces: RS-232C serial port (DB-25P connector); parallel printer port (DB-25S connector); 5-pin DIN keyboard connector; floppy disk drive controller; IDE hard disk drive interface; four AT expansion bus slots (three 16-bit and one 8-bit)

Size
14¾ × 15 × 5 inches; 30 pounds

Software
Setup and disk utilities

Documentation
User's manual

Price
Model 1: $1095
Model 5 with 1.2-megabyte 5¼-inch floppy disk drive: $1245
Model 45 with 1.2-megabyte 5¼-inch floppy disk drive and 40-megabyte hard disk drive: $2095
System as reviewed: $3834

Inquiry 851.

on the motherboard. The bus card then provides the four expansion slots—three 16-bit slots and one 8-bit slot. Because of the unusual orientation of these slots, AST provides an extra support for the expansion boards. You must remove this support to install or remove a board, so there's one more step than usual.

The drive bays are a little narrower than those in a standard AT system. AT systems typically have slide-rail guides for the drive bays, so drives need a slide rail on either side. The Bravo/286's drive bays lack these guides. Instead, AST used the approach typically found in XT systems, securing the drives to vertical metal plates by two screws on either side.

In addition to the standard motherboard parts (the 80286 processor, the 80287 coprocessor socket, the keyboard controller, the G-2 chip set, and the memory), several other circuits are worth noting. A serial port and a parallel port are accessible by connectors on the rear panel. A floppy disk drive controller is also included on the motherboard, as is an Integrated Drive Electronics (IDE) hard disk drive interface. A small piezoelectric transducer mounted on the motherboard functions as a speaker.

For the real-time clock, AST used the Dallas Semiconductor DS1287. This single module has all the circuitry needed for the real-time clock (including the crystal and oscillator) and includes a built-in lithium battery with an expected 10-year life. This circuit not only saves board space but virtually eliminates the need to ever replace the battery.

Standard Equipment

Unlike most AT systems, where many components cost extra, the Bravo/286 includes several common peripheral devices as standard equipment. Most are integrated directly onto the motherboard. The primary extras are the serial and parallel ports, the floppy disk drive controller, and the IDE hard disk drive interface. On other systems, these items often require one or more add-in boards.

With all these peripherals integrated, having only four expansion slots seems more reasonable; the Bravo/286 doesn't need the "standard" add-in boards (a floppy/hard disk drive controller and a multifunction card). You probably won't need a memory board, either, since the system's four SIMM sockets can hold either 256K-byte or 1-megabyte SIMMs, allowing up to 4 megabytes of DRAM on the motherboard. The standard system ships with only 512K bytes of DRAM.

My evaluation system reflected the efficiency of the Bravo/286's design. It had 1 megabyte of DRAM (a $350 upgrade), a 1.2-megabyte 5¼-inch floppy disk drive, a 40-megabyte hard disk drive, an AST VGA adapter ($599), and the serial and parallel ports, yet only the VGA adapter used an expansion slot.

The system also came with a good 101-key keyboard, MS-DOS 3.3 (a $95 option), a well-designed and well-illustrated user's manual, and the system setup and disk utilities. The setup utility offers the flexibility you need when so many devices are integrated on the motherboard. It lets you enable or disable each standard peripheral device so you can plug in expansion boards with these functions, if you desire.

Performance

With an 8-MHz 80286 processor as its workhorse, the Bravo/286 is clearly de-

continued

AST Bravo/286

APPLICATION-LEVEL PERFORMANCE

AST Bravo/286 6.9*

WORD PROCESSING

XyWrite III + 3.52	Medium/Large
Load (large)	:14
Word count	:06/:41
Search/replace	:09/:40
End of document	:02/:21
Block move	:12/:13
Spelling check	:17/2:16
Microsoft Word 4.0	
Forward delete	:26
Aldus PageMaker 1.0a	
Load document	:16
Change/bold	:48
Align right	:37
Cut 10 pages	:32
Place graphic	:07
Print to file	3:25
Index:	**1.57**

SPREADSHEET

Lotus 1-2-3 2.01	
Block copy	:07
Recalc	:03
Load Monte Carlo	:32
Recalc Monte Carlo	:09
Load rlarge3	:08
Recalc rlarge3	:02
Recalc Goal-seek	:06
Microsoft Excel 2.0	
Fill right	:11
Undo fill	3:58
Recalc	:03
Load rlarge3	:47
Recalc rlarge3	:03
Index:	**1.30**

DATABASE

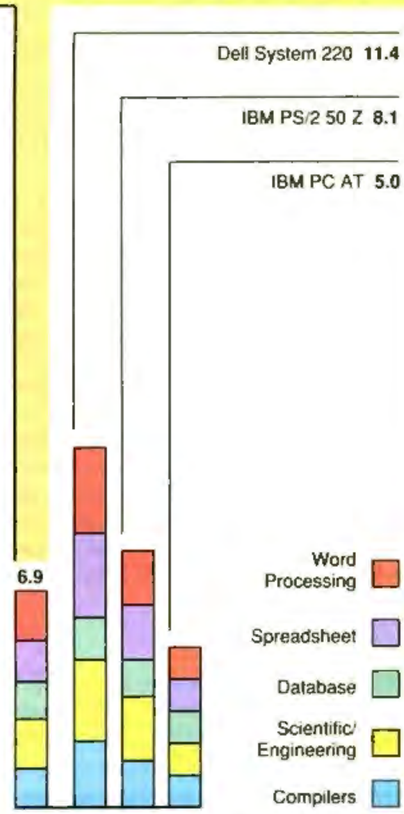
dBASE III + 1.1	
Copy	1:16
Index	:19
List	1:39
Append	2:29
Delete	:04
Pack	1:46
Count	:18
Sort	1:30
Index:	**1.22**

SCIENTIFIC/ENGINEERING

AutoCAD 2.52	
Load SoftWest	1:48
Regen SoftWest	1:31
Load StPauls	:23
Regen StPauls	:17
Hide/redraw	29:35
STATA 1.5	
Graphics	:41
ANOVA	:25
MathCAD 2.0	
IFS 800 pts.	:43
FFT/IFFT 1024 pts.	:44
Index:	**1.53**

COMPILERS

Microsoft C 5.0	
XLisp compile	7:25
Turbo Pascal 4.0	
Pascal S compile	:09
Index:	**1.27**



*Cumulative application index. Graphs are based on indexes at left and show relative performance.

All times are in minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT = 1.

LOW-LEVEL PERFORMANCE[1]

AST Bravo/286

CPU

Matrix	9.58
String Move	
Byte-wide	53.64
Word-wide:	
Odd-bnd.	53.64
Even-bnd.	26.83
Sieve	56.12
Sort	42.71
Index:	**1.48**

FLOATING POINT

Math	45.26
Error[2]	0.00E+06
Sine(*x*)	19.49
Error	2.00E−09
e^x	1.66
Error	1.00E−09
Index:	**1.03**

DISK I/O

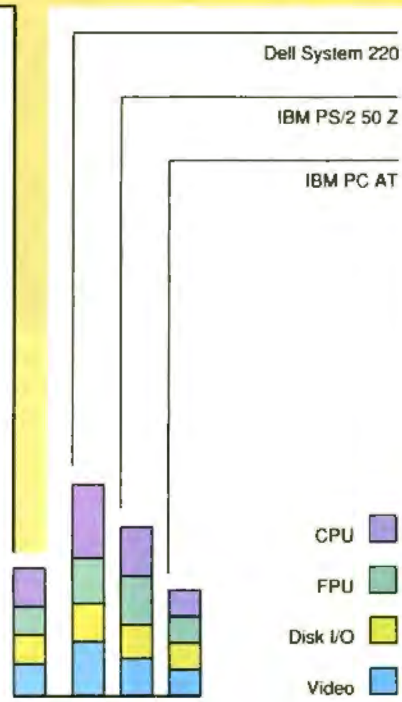
Hard Seek[3]	
Outer track	3.33
Inner track	3.26
Half platter	8.76
Full platter	10.03
Average	6.34
DOS Seek	
1-sector	14.80
32-sector	46.58
File I/O[4]	
Seek	0.39
Read	1.26
Write	1.16
1-megabyte	
Write	7.43
Read	7.28
Index:	**1.12**

VIDEO

Text	
Mode 0	7.60
Mode 1	7.60
Mode 2	7.52
Mode 3	7.54
Mode 7	7.56
Graphics	
CGA:	
Mode 4	3.93
Mode 5	3.92
Mode 6	4.21
EGA:	
Mode 13	6.46
Mode 14	7.12
Mode 15	N/A
Mode 16	7.12
VGA:	
Mode 18	7.47
Mode 19	4.29
Hercules	N/A
Index:	**1.18**

CONVENTIONAL BENCHMARKS

LINPACK	959.11
Livermore Loops[5] (MFLOPS)	0.02
Dhrystone (MS C 5.0) (Dhry./sec.)	2253



N/A = Not applicable

[1] All times are in seconds. Figures were generated using the 8088/8086 version (1.1) of Small-C.

[2] The errors for Floating Point indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.

[3] Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).

[4] Read and write times for File I/O are in seconds per 64K bytes.

[5] For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance.

signed to maximize economy, not performance. Indeed, a quick check revealed that the IBM PC AT is the only 8-MHz 80286 system for which the BYTE Lab has benchmark results, using the new BYTE benchmarks. Thus, I had to compare the Bravo/286 to 10-MHz 80286 machines.

The Bravo/286 compares favorably to the true-blue IBM AT in all the benchmarks, probably because of improved memory and I/O accessing. The benchmarks reveal similar performance between the Bravo/286 and IBM's original 10-MHz PS/2 Model 50, except in the disk and database areas, where the Bravo/286 is noticeably faster. The newer IBM PS/2 Model 50 Z, on the other hand, leaves the Bravo/286 behind. With the exception of the database tests, the Bravo/286's performance fits right in the middle, between the 8-MHz IBM AT and the 10-MHz PS/2 Model 50 Z for all the benchmarks.

Compatibility

With a company as mature as AST Research and an architecture as well established as that of the 80286 AT, compatibility should hardly be an issue. Every program I could get my hands on ran without a hitch.

The only glitch I noticed was with the VGA adapter running a not-well-behaved VGA demo program for an Intecolor monitor. When the program started playing around with the color palette, the display switched from 256 colors to shades of gray. AST is checking on the problem. Aside from this little anomaly, I had no other compatibility problems with this system.

An Economical Choice

The economy of the AST Bravo/286 is most visible in the pricing of its base (Model 1) configuration (512K bytes of DRAM, no floppy disk drive). Unfortunately, the options quickly add to the bottom line ($150 for a 1.2-megabyte 5¼-inch floppy disk drive, and $850 more for a 40-megabyte IDE hard disk drive), making the expanded system economically less competitive. However, you could certainly buy these options from a less-expensive soorce and install them yourself.

Its small size makes the diskless Bravo/286 a good choice for use as a LAN workstation. You'll just have to add video and network interface boards.

The AST Bravo/286 is a small, well-designed system that integrates many of the peripherals that you would commonly need in an AT system. It offers moderate performance in an economical package that is nonetheless made with the same care and quality construction that have given the AST Premium/286 and other AST systems good reviews in the past.

If you're looking for a high-performance super-AT, this is not your system. But if you want a well-made, economical, AT-class machine with the extras built in, the Bravo/286 might be just the machine for you. ■

Roger C. Alford is a project manager for Nematron Corp., a manufacturer of industrial computers and terminals in Ann Arbor, Michigan. He has written over 75 computer- and electronics-related articles and is the author of the Programmable Logic Designer's Guide *(Howard W. Sams & Co., 1989). He can be reached on BIX c/o "editors."*

Data to Go

Sysgen's removable hard disk cartridge system hooks to Macs or PCs

Don Crabb

Removable hard disk drives have been around for years as backup devices, but they have recently caught on for everyday use. Their performance has improved significantly in the past year, and they're available in both Mac and PC versions, thanks to the SCSI-standard interface.

Removable media schemes include removable drives, which have the spindle sprocket and read/write heads in the cartridge, and removable disk cartridge systems, which let you remove the disk platter from the drive mechanism. Typical of the latter is the Sysgen Maxi RD45 hard disk drive, which uses a SyQuest drive mechanism and 45-megabyte disk cartridges.

As a hard cartridge system, the Maxi is less fragile than removable drives, and additional cartridges are less expensive, since they contain only the platter. They're also quite fast: The Maxi has a 25-millisecond average seek time. The drive works with the Mac Plus or higher and the IBM PC, PS/2s, and compatibles (the PS/2 version was not available for this review). But Macs and PCs can't share the same cartridge; if you plan to use the drive on both platforms, you'll have to buy two cartridges.

The Maxi isn't cheap: The Mac version includes installation software and one cartridge for $1695. For the IBM machines, you'll also need a PC-bus interface ($195) or an MCA-bus interface ($250). Additional cartridges are $175 each. The Maxi compares well against removable hard disk systems, but it is more expensive than my portable Jasmine DirectDrive 140 ($1499). For backup purposes, it's considerably more expensive than slower Bernoulli drives or tape backup systems.

The Sysgen Maxi RD45 combines the speed of a fixed hard disk drive with the portability of a removable media system.

Each removable hard disk cartridge holds 44.4 megabytes of data when formatted. The clear plastic case houses a single platter suspended in the center of the case. The drive mechanism accesses the platter via a sliding window located on the side of the case. The drive is about as fast as many Mac SCSI disk drives; the PC versions are more than twice as fast as a standard 30-megabyte IBM PC AT internal hard disk drive.

The Maxi drive includes two SCSI ports and an external SCSI ID DIP switch that's convenient when you're plugging the drive into an existing chain of SCSI devices. The Maxi lacks internal SCSI termination but includes an external SCSI terminator that you'll have to add, depending on the place of the drive in a SCSI chain.

Testing to the Max

I tested the drive by connecting it to a color Mac II with 8 megabytes of RAM, a 1-megabyte Mac SE, and an IBM PC AT with 1 megabyte of memory. In all the tests, the Maxi drive was the only SCSI device I connected, and the test disk was always the start-up (boot) disk.

On the Mac, I installed System 6.0.2, Finder 6.1, and the other system software from the 6.0.2 System Tools package. I kept only the desk accessories, fonts, INITs, and cdevs that were supplied with the Apple system. I didn't install any other INITs, cdevs, DAs, or fonts, and I disabled the CPU's data cache for all the tests. I also installed version 2.56 of the Maxi software on the drive. For purposes of comparison, I've

continued

included benchmarks for Apple's Hard Disk 40SC 40-megabyte internal drive and Mass Micro's DataPakhd 120, which comprises a 120-megabyte drive along with a SyQuest 45-megabyte removable hard cartridge drive system in one box (see table 1).

On my AT running DOS 3.3, I installed the Maxi PC-bus (16-bit direct memory access [DMA]) SCSI adapter card in slot 3 and version 1.00 of the Maxi software. Table 2 shows a comparison of the Sysgen Maxi RD45 against the standard 30-megabyte IBM drive in my AT.

I ran virtually every Mac and DOS application I had on the drive—everything from Excel (both PC and Mac) to ParcPlace's Smalltalk-80 (Mac)—without any problems. The drive worked equally well when connected to the Mac and the AT.

One look at the benchmark tables proves that the Maxi is fast. With a 25-ms average access time, you'd expect that. But I didn't expect it to perform over twice as fast as the 30-megabyte internal drive in my AT. I attribute most of that increased performance to the Maxi's 16-bit SCSI DMA adapter. Sysgen says that this card blasts data out at sustained rates of almost 1 megabyte per second, with burst rates reaching 5 megabytes per second.

Table 1: *Benchmark results on the Macintosh. All times are in minutes:seconds. Each timing reflects the mean of 10 repetitions of each benchmark (N/A = not applicable).*

SCSI read (1 block/32 blocks); 500 seeks

	Mac II	Mac SE
Sysgen Maxi RD45	0:14.09/0:36.60	0:15.51/0:39.20
Apple Hard Disk 40SC	0:15.30/0:36.10	N/A
Mass Micro DataPakhd 120		
Fixed hard disk drive	0:18.97/0:37.78	0:21.35/0:41.90
Removable cartridge	0:14.07/0:37.75	0:18.50/0:40.77

Large file (5-megabyte) write/read

	Mac II	Mac SE
Sysgen Maxi RD45	0:26.10/0:26.14	0:39.20/0:38.03
Apple Hard Disk 40SC	0:26.14/0:23.46	N/A
Mass Micro DataPakhd 120		
Fixed hard disk drive	0:32.26/1:43.54	0:45.18/2:15.10
Removable cartridge	0:26.46/0:25.50	0:41.67/0:39.12

Table 2: *Byte disk I/O benchmark results as run on the IBM PC AT. All times are in seconds.*

	Sysgen Maxi RD45	IBM 30-megabyte internal hard disk drive
Hard seek		
Outer track	3.19	3.28
Inner track	3.18	3.30
Half platter	8.44	11.30
Full platter	10.32	16.59
Average	6.28	8.62
DOS seek		
1-sector read	5.15	11.66
80-sector read	18.45	24.33
File I/O		
Seek	0.15	0.22
Read	0.013	0.021
Write	0.014	0.022
1-megabyte		
Write	4.04	8.92
Read	3.55	8.16

Delicate Matters

While portable, the Maxi cartridges are still essentially platters, and you should treat them with care. If dropped to the floor, the cartridge would probably break. And unlike normal drives, which are sealed, a sliding window on each cartridge can let in potentially damaging dirt and dust. Under normal conditions, however, the drive movement blows dust particles off the disk, keeping the cartridge clean.

Sysgen claims that the cartridges are rugged enough (when transported in the supplied padded cases) to take along in your briefcase or ship cross-country. They are rated to survive impacts of up to 40 g's. I carried a full cartridge (with 40 megabytes of Mac files on it) in my soft-sided briefcase for about a month. It saw significant abuse (i.e., the case was bumped, jossled, and repeatedly x-rayed at airports) yet never failed to work properly; even the Mac Desktop remained pristine.

I also shipped this same cartridge from my office to my home and back again via Federal Express. I enclosed the cartridge in its padded plastic case, and then I put it into a standard cardboard overnight letter (the package went from my office in Chicago to the Federal Express hub in Memphis and back to my home). The cartridge worked fine after both trips, although the plastic carrying case was a little worse for wear.

In a month's worth of accelerated abuse and testing, the two cartridges I used worked fine. But be warned: Repeated abuse of a cartridge can have a cumulative effect on cartridge components.

Decisions, Decisions

Other vendors besides Sysgen incorporate the SyQuest drive in their removable hard cartridge systems, but the Maxi is

continued

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Sysgen Maxi RD45

Company
Sysgen, Inc.
556 Gibraltar Dr.
Milpitas, CA 95035
(800) 821-2151

Size
4¾ by 11 by 7¼ inches; 3½ pounds

Hardware Needed
Macintosh Plus or higher; IBM PC, PS/2, or compatible

Documentation
User's manual

Price
External hard disk drive (includes one 45-megabyte cartridge and a SCSI terminator): $1625
Internal hard disk drive (for PC and PS/2s only): $1325
Macintosh interface: $80
PC-bus interface: $195
MCA-bus interface: $250
Additional cartridges: $175 each

Inquiry 889.

the only drive with a 16-bit SCSI adapter for the PC. The real decision to make with regard to the Maxi is not whether you'll buy this particular drive, but whether a removable hard cartridge system is right for you.

The Maxi is convenient for backing up fixed hard disks, since it's reliable and fast. But the cost is high: $175 for a blank 44.4-megabyte cartridge isn't cheap. Compare that to $30 for a 38.5-megabyte DC-2000 streaming tape or $45 for a 60-megabyte DC-600 tape. Although both tape formats are much slower than the Maxi, and you can't use them as random-access system drives, they're a lot less expensive for archival storage. Also, the reliability of magnetic tape for long-term storage is well documented.

A better use for the cartridge might be to keep only critical system backups of important data and applications that need to be up and running immediately after a hard disk crash.

The Maxi is useful for day-to-day data storage, if you don't need more than 44.4 megabytes of disk space. But the Maxi's best application is probably in locations where security is a big concern, since you can remove Maxi cartridges and lock them away at the end of the day.

If you decide to use the Maxi to transport data between offices or on business trips, you'll have to make sure that a Maxi drive awaits you at your computing destination. This is a drawback over toting a small portable drive. I carry my Jasmine DirectDrive 140 with me when I go on the road; it plugs into any Mac SCSI port. It may be more fragile, but after a year of abuse, the drive still hasn't failed. Of course, the Jasmine drive is heavier to carry than a Maxi cartridge.

Personally, I need more than 44.4 megabytes of data on a single hard disk volume, so I can't use the Maxi. But your data needs might be different. And for the price of an interface kit and an extra cartridge, you can use the Sysgen Maxi RD45 in Macs, PCs, and Micro Channel PS/2s. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."

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EGA, 640 X 350, 21.8KHz, WordPerfect 5.0

Hercules, 720 X 348, 18.4KHz, ChessMaster 2100

Hercules, 720 X 348, 18.4KHz, Basic

VGA, 720 X 400, 31.5KHz, DOS Directory

VGA, 720 X 400, 31.5KHz, Lotus 1-2-3

VGA, 640 X 480, 31.5KHz, Publisher's Paintbrush

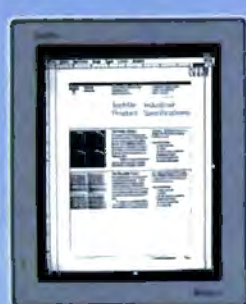
Non-interlaced, 1024 X 768, 49KHz, Windows 386

Full Page VGA, 800 X 1000, 60KHz, 16 Shades of Gray, Publisher's Paintbrush

Full Page VGA, 800 X 1000, 60KHz, AutoCad release 10

Full Page VGA, 800 X 1000, 60KHz, Scanned Grayscale Image

Full Page VGA, 800 X 1000, 60KHz, WordPerfect 5.0



Full Page VGA, 800 X 1000, 60KHz, PageMaker

Full Page VGA, 800 X 1000, 60KHz, Superfax

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Mastering the PCX Format

Add PCX compatibility to your graphical software using the PCX Programmer's Toolkit

Bert Tyler

The graphics programmer confronts a bewildering array of graphical file formats. The PCX Programmer's Toolkit, from Genus Microprogramming, supports one of the more prevalent—PCX. ZSoft developed PCX for its PC Paintbrush package. Ventura Publisher and PageMaker support it, as do virtually all fax and scanner products. So PCX compatibility is a handy feature to add to your graphical software.

I tested version 3.5 of the PCX Programmer's Toolkit on an IBM PS/2 Model 80 with its built-in VGA adapter. The PS/2 is connected to a LaserJet II printer, and it uses a Logitech C-7 serial mouse as a pointing device. The Toolkit directly supports virtually all the standard IBM CGA, EGA, and VGA modes. Only CGA mode 5 is missing. The Toolkit also supports Hercules monochrome mode and SuperVGA modes up to 800 by 600 pixels by 256 colors for the Paradise, Tseng Labs, and Video Seven chip sets. It also supports the most popular extended SuperVGA video modes. I was able to test all the standard IBM modes on my PS/2.

The Toolkit Utilities

The Toolkit comprises a set of standalone utilities that create and manipulate .PCX files, and a set of library routines that let you add the same kinds of functions to your own programs. The utilities were built from the supplied library routines, and they demonstrate the strengths and weaknesses of the library.

Unless you already have a collection of .PCX images to manipulate, the first utility you're likely to use is PCXGRAB, a TSR program that grabs the contents of your screen and saves it to disk when you press a preselected hot key. PCXGRAB can save both graphics and text screens. I tried it with every IBM graphics format supported by the Toolkit. I had no problems saving the various screen images.

I did run into minor conflicts with the F11 and F12 keys on the IBM Enhanced keyboard. With PCXGRAB loaded and intercepting keyboard activity, other programs, such as MS-Kermit and my own graphics programs, lost the ability to detect F11 and F12. Fortunately, few programs require the capabilities of the Enhanced keyboard, and PCXGRAB is easy to deinstall, so this wasn't a major problem. For particularly nasty programs that don't use the BIOS to perform video-mode changes—the manual cites AutoCAD—you can tell PCXGRAB to expect to find the screen in a particular mode.

After you've grabbed an image, you will want to display it with PCXSHOW. It can display stand-alone PCX files as well as PCX images stored in special PCX-format libraries. Options include specifying a region of the screen in which to display the image, and leaving the screen in graphics mode (useful for slide shows and demonstrations). I ran into a minor but annoying problem with PCXSHOW and monochrome images saved by PCXGRAB. Unless I forced PCXSHOW into the proper monochrome mode (by means of its /m command-line argument), monochrome CGA and EGA images appeared on my VGA system in odd colors—green and white in CGA 640- by 200-pixel mode, and brown and blue in EGA 640- by 350-pixel mode.

PCXPRINT was the most disappointing of the utilities. This program, which does what its name suggests, works only with monochrome images and (at least in version 3.5) only with LaserJet II and compatible printers. Moreover, the largest image I could print on my LaserJet II—using a 640- by 480- by 2-pixel image at the largest scaling (200 percent)—filled only about a sixth of the printed page. Images generated from anything other than a square pixel format, such as 640 by 480 pixels, appeared flattened; this effect was most pronounced with CGA 640- by 200-pixel and EGA 640- by 350-pixel images.

Although the manual says that the Toolkit supports IBM and Epson dot-matrix printers, that's not the case. A note in a READ.ME file on the distribution disk explains that dot-matrix printer support will be included in the next release, scheduled to be available in December for a nominal upgrade fee. Even so, there's no promise that the Toolkit will support color printers. Genus specifically recommends the use of programs like PC Paintbrush for printing PCX images in color. A Genus spokesperson acknowledged that the Toolkit's printer support was weak, and that the primary focus of its next version would be to add dot-matrix printer support and expand printed output to full-page images.

PCXCUT clips a rectangular chunk out of a displayed PCX image—you specify the region with cursor keys or the mouse—and saves it to a separate image file. PCXLOC displays an image along with the pixel coordinates of a keyboard- or mouse-driven cursor. It's a handy way to identify landmark locations within an image.

PCXLIB is an ARC-like utility for PCX files, with the added feature that the other utilities and the routines included in the Toolkit can manipulate images "in place" within an image library. PCXHDR interprets a PCX file's

continued

PCX Programmer's Toolkit 3.5

Company
Genus Microprogramming
11315 Meadow Lake
Houston, Texas 77077
(800) 227-0918
(713) 870-0737

Hardware Needed
IBM PC XT, AT, PS/2, or compatible; IBM CGA, EGA, VGA, Hercules, or compatible adapter; Paradise, Video Seven, or Tseng Labs SuperVGA chip set.

Software Needed
MS-DOS 2.1 or higher

Price
Toolkit: $195
Toolkit with library source: $495

Inquiry 885.

header. It reports the image's resolution, palette contents, and preferred video mode. PCXTRANS converts text screens saved by means of PCXGRAB into ASCII text format and vice versa. PCXFIX fixes up older PCX files that don't conform to the latest specifications. I tested all these utilities successfully, except for PCXFIX. I just didn't have old-style PCX files to convert.

The Library Routines

The library routines provide functions that assist in the manipulation of PCX files, libraries, and displays. Note that the supplied routines don't help you to create images from scratch (though they do support cutting and pasting from other PCX images). Figuring out how to draw a circle on the screen is still up to you or some other graphics package.

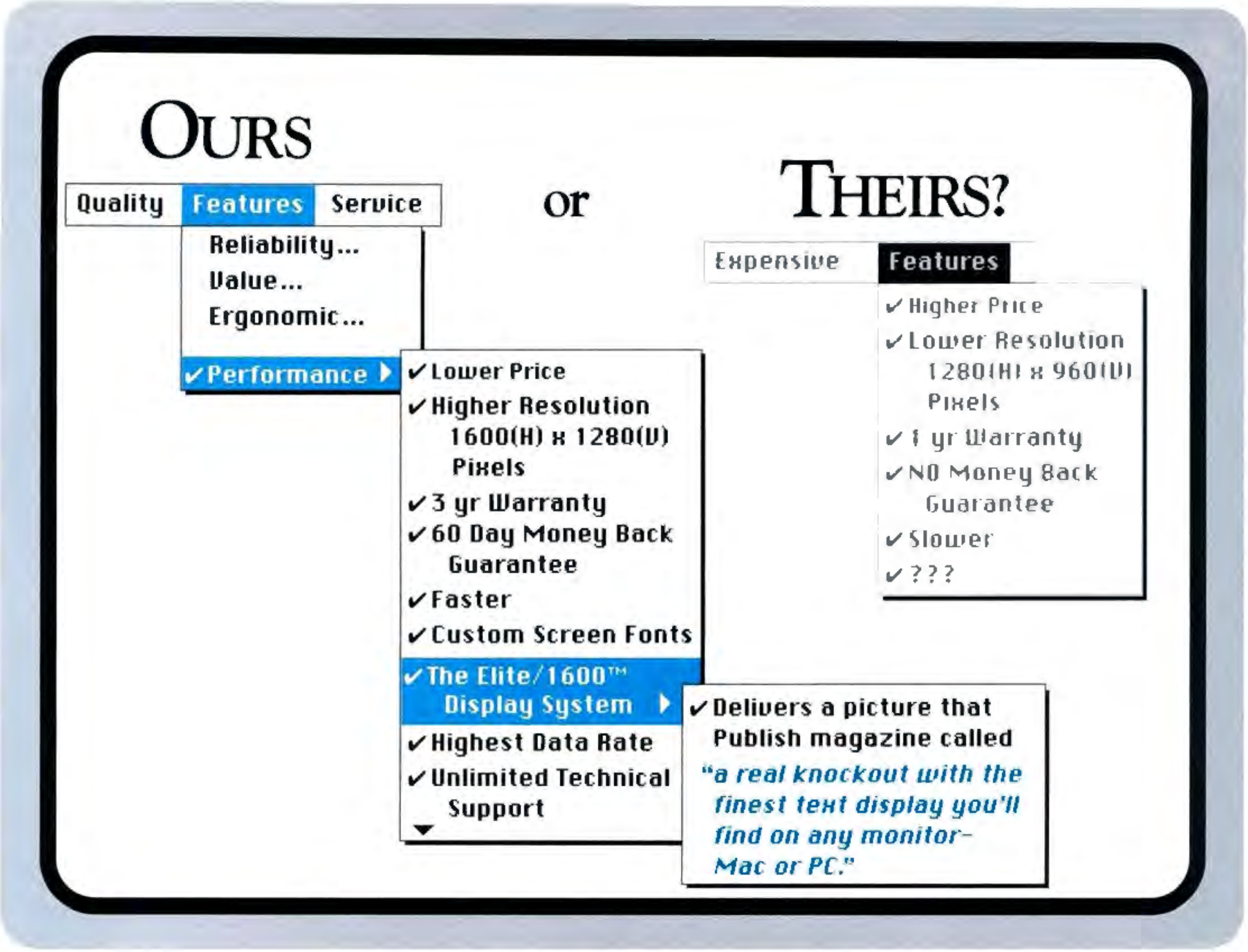
The routines enable you to display images, store and retrieve them from files and image libraries, and print them. In addition, the routines support image buffers and virtual memory buffers. Think of these as RAM-resident versions of PCX files. The buffers are compressed PCX images, and the virtual memory buffers are uncompressed images. These buffers—which may be stored in conventional or expanded memory—confer significant speed advantages.

A variety of query routines let you detect the presence of an MDA, CGA, EGA, MCGA, VGA, or Hercules video adapter. It can even detect the presence of a Paradise, Tseng Labs, or Video Seven SuperVGA chip set. You can also check for the presence and amount of free EMS or standard memory.

The libraries come with interfaces to C (Microsoft, Borland, and Lattice), Pascal (Microsoft and Borland), BASIC (Microsoft), FORTRAN (Microsoft), assembly (Microsoft and Borland), and the Clipper. I ran all my tests using Microsoft C 5.1. You don't owe Genus royalties if you distribute executables containing the Toolkit routines, but you can't distribute .OBJ or .LIB files that contain the routines, and you can't distribute the Toolkit's stand-alone utilities. For $300, you can get the library source code.

To test the Toolkit routines, I added PCX read, write, and print features to a Mandelbrot program that I wrote. The program already creates graphical displays in all the IBM-specific video modes, and it writes and reads an alternate file format (GIF), so that using the

continued



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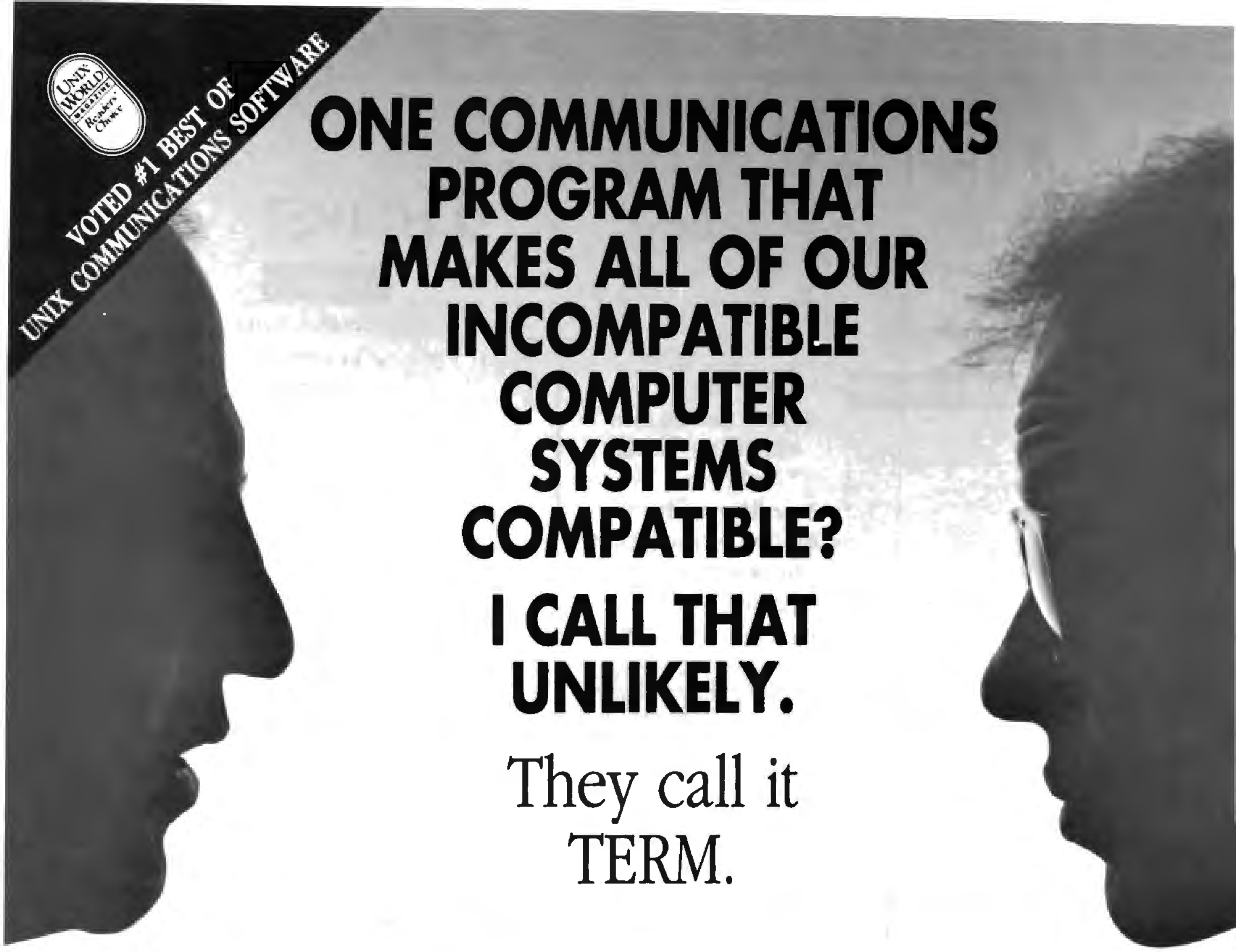

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Toolkit's routines to add PCX support was straightforward.

I liked the fact that I didn't have to use the Toolkit routines to initialize the graphics adapter. Although the Toolkit, of course, supports that, you can also just tell it what video mode the adapter is already using. That's handy in cases like mine, where you're simply adding PCX capability to an existing program, and it's vital if you're using another graphics package that must initialize the adapter.

Adding a PCX-save feature to my program took just eight lines of code. Half the job was to convert my internal video modes to the Toolkit's video-mode IDs. The feature worked on the first try. Putting in PCX-restore took longer, since my program needs information about the resolution of the incoming image. But I also got it working in short order, and then I tackled PCX-print. Considering that my program didn't have any print options to begin with, I was pleased to be able to implement PCX-print in just 10 more lines of code. Of course, the printer routines suffer from the same limitations as the PCXPRINT utility, so I had to settle for tiny and, in non-640- by 480-pixel modes, squashed printouts.

I wrote several additional utility programs while checking out the library routines and found the routines to be clearly documented and easy to use. The manual documents each routine separately, with short examples for each routine in C, Pascal, BASIC, FORTRAN, and the Clipper; that was invaluable.

Technical support is available by way of telephone, fax, CompuServe, and ZSoft's BBS. When I called technical support to ask about printer support, I talked to a courteous person who didn't know the answer right away but found someone else with the information in less than a minute.

I found the PCX Programmer's Toolkit to be intuitive and useful. The lack of dot-matrix printer support was annoying, but this problem may be resolved shortly. I would recommend checking on this item first if it's a priority for your application. Other problems, such as PCXGRAB's difficulty with the Enhanced keyboard, and PCXSHOW's inability to display monochrome images correctly, were minor, and I had no trouble working around them. If you want to add PCX support to your graphics programs, here's a convenient and inexpensive solution. ■

Bert Tyler holds a B.A. in mathematics and is an independent PC consultant. He can be reached on BIX as "btyler."

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Circle 33 on Reader Service Card (DEALERS: 34)

A HyperCard for the PC

Build and launch applications with HyperPAD's object-oriented, push-button approach

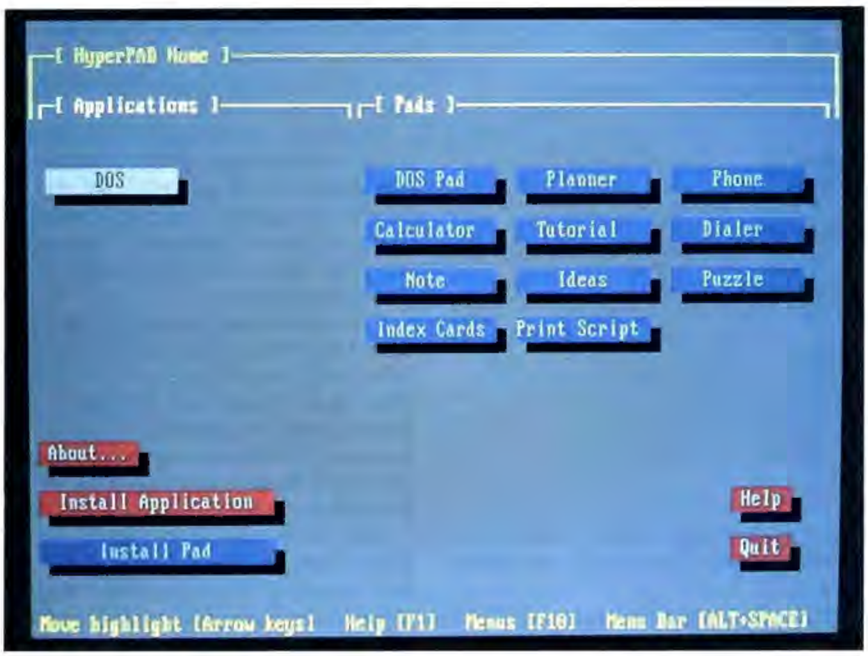
Bob Stepno

Following in the footsteps of Apple's HyperCard for the Macintosh, Brightbill-Roberts' HyperPAD for MS-DOS is an intriguing product that might attract a new generation of programmers.

Actually, HyperPAD is part toolkit for building front ends and tutorials, and part application package. As a toolkit, it is the most fun I've had since my folks gave me that Erector Set. As an application package, it's more useful than I expected.

Like HyperCard, HyperPAD shows you screen after screen of layered backgrounds, information fields, and buttons. Each screen is called a *page*, and files that contain the screens are called *pads*. (With HyperCard, you call each screen a card and each file of related cards a stack.)

If you like to streamline your DOS applications with batch files, shells, and front ends, and if you're curious about object-oriented programming, HyperPAD deserves your attention. It also makes quick work of building a tutorial or a prototype of a new application. It includes a screen-capture utility that quickly imports spreadsheet layouts, word processing menus, data-entry screens, and other displays from text-based applications.



The home pad can launch any of 11 built-in applications plus DOS utilities.

Object-Oriented Programming

HyperPAD's programming language, PADtalk, is similar to HyperCard's HyperTalk. For example, to put today's date in a field in HyperCard, you would use the following HyperTalk line:

```
put the long date into field "Date"
```

In HyperPAD, you just join "long" and "date" into one word (longdate) and end the line with a semicolon.

From the user's perspective, HyperPAD is object-oriented. Each button, field, background, page, or pad is an object. Each object has attributes, such as color, size, and shape, and it can have a program script that makes it do tasks. A button's script can make it run WordPerfect or play "Mary had a Little Lamb." With cut-and-paste editing, you can combine the scripts of several buttons to make one button play a tune while it launches WordPerfect. The editing buffer lets you clip text, buttons, or whole pages and then paste them in other pads.

A music pad lets you pick out notes on a text-based image of a piano keyboard, save or edit tunes, manipulate playing speeds and rests, and paste the result into your scripts with a Play command.

The scripts and attributes travel with their object, whether you drag the object from one corner of the screen to another or cut and paste your favorite button into all your pads. For example, while I was writing this review, all the pads in my HyperPAD directory had copies of a button called BYTE that started my word processor and loaded the current manuscript.

Nothing Fancy

As for working with graphical environments, HyperPAD takes an interesting

continued

HyperPAD 1.0

Company
Brightbill-Roberts
120 East Washington St., Suite 421
Syracuse, New York 13202
(315) 474-3400

Hardware Needed
IBM PC, AT, PS/2, or compatible with 384K bytes of RAM, two 360K-byte floppy disk drives or one 720K-byte floppy disk drive, and any color or monochrome display graphics board

Software Needed
DOS 2.1 or higher

Documentation
User's manual, quick reference card, installation booklet

Price
$99.95

Inquiry 884.

route around DOS's many graphics standards—it does practically everything with text.

HyperPAD's buttons are mostly words that are in boxes, words with shadows, words with color backgrounds, and words modified with IBM extended characters. For example, a notepad application distributed with HyperPAD uses the color attributes and line-drawing characters to paint a spiral-bound notebook on the screen. Another pad features a lined index card background, and yet another shows the ever-popular telephone index card, complete with notches at the bottom.

HyperPAD lacks bit-mapped images, diagonal lines, and curves. It could be prettier, but the advantage is that you can use anything developed in HyperPAD on a low-end PC with a monochrome monitor without so much as a Hercules graphics card. (For this review, I tested the program on a monochrome VGA-based IBM AT–compatible system and a monochrome AT&T PC 6300.) If you have a graphics machine, you can still use HyperPAD buttons to launch graphics-display applications. Brightbill-Roberts has also posted special monochrome versions of the sample pads on its BBS.

In another concession to the realities of DOS machines, HyperPAD lets you switch between a mouse and the keyboard. This means that you can build an application using a mouse on your PC and then take the application on the road in a mouseless laptop, using it with just the keyboard.

Built-in Applications

HyperPAD comes with a library of 25 sample pads. Calling an application is as easy as pushing a HyperPAD button and entering the DOS path. You can even give HyperPAD the parameters that you would normally enter as command-line options. After that, you give the newly created button a name (usually the application name).

By default, HyperPAD automatically starts at its home pad, which includes one application button labeled DOS and 11 buttons that launch pads for a schedule planner, phone directory, calculator, and other desktop-accessory style applications (see photo).

The planner and phone pads are similar to their HyperCard cousins. The first is actually a launching pad for several other pads—yearly and monthly calendars and a daily appointment log. Clicking on any half-hour entry in the appointment book opens a scrolling text field for that time period.

The phone pad is an address book, with a button linking it to a dialer pad that actually dials the phone for you (i.e., if you have a modem connected) and tells you when to pick up the receiver. Other phone-related buttons and pads help you time your calls and keep track of incoming and outgoing messages.

The DOS button runs COMMAND.COM, putting you back at the DOS prompt. HyperPAD "shrinks" to take up only 2K bytes of RAM, which leaves enough memory for you to run most DOS applications.

Separate from the DOS button is a DOS pad button, which may be the least successful of the sample HyperPAD applications. It tries to save you from the trials and tribulations of DOS commands, giving you push buttons for eight DOS operations: copy, move, delete, view a subset of a directory, launch a program, format (defaulting to drives A and B only), and make or remove a directory.

The DOS pad uses three scrolling fields or windows. One is for files, one for directories, and the other for disk drives. You can browse through the filenames on your disks in the 16-line Files window, but you can view only one directory at a time, and there is no facility for inspecting a file or performing other operations found in popular DOS shell programs. Strangely, HyperPAD lets you type over the filenames in the Files window, though doing so does not affect the files.

Not All Fun and Games

Error-detection is one of HyperPAD's weaknesses. For example, when I told it to format a 3½-inch floppy disk in an empty 5¼-inch floppy disk drive, HyperPAD sent the empty drive spinning into hyperspace for a while and then returned to the HyperPAD screen. There were no error messages saying I used the wrong type of drive or that I had an open drive door.

Coincidentally, the READ.ME file on the disk warns that if you try to print with the printer off-line, HyperPAD may give you a "disk drive door open" error message. However, I got no error message at all when I issued print commands with the printer off.

I also discovered that it was possible to lock up my computer by typing non-HyperPAD filenames after the program name at the DOS prompt. Normally, you can supply the name of the pad you want to run as a parameter when you execute HyperPAD from the command line. But whenever I gave HyperPAD an invalid parameter—even though it may have been a valid filename—it locked up my computer.

The system also locked up when I attempted to import delimited ASCII data files that were not as clean as HyperPAD wanted. The file-import routine requires quotation marks as well as commas between fields and allows no empty or missing fields. These requirements are not mentioned in the documentation. Also, I could not load an ASCII file larger than 600 records, but the company's technical-support person was unable to help me find the problem. The company says, however, that it is working on the problem.

Still, with a product that stresses ease of use and even trademarks the phrase "push-button computing," you should not have to push the hardware reset button because of an incorrect file type.

Nearly as bad, the imported data files became HyperPAD pads three to seven times the size of the originals. A 14K-byte file containing data about 100 newspaper editors, for example, turned into a 64K-byte pad. A 2K-byte ASCII list of names became a 14K-byte pad. A 7K-byte dBASE file became a 23K-byte pad.

continued

Circle 154 on Reader Service Card

The increased size may also account for HyperPAD's poor performance at locating text in the files—WordPerfect was much faster searching the original text file.

Helpful Ideas

Back at the home pad, the first buttons to investigate are help and tutorial. The help button launches the help pad, which is a 48-screen hypertext help system that is also available by pressing the F1 key in most application pads. The tutorial button launches the tutorial pad, which is a 36-screen document designed to look like an open spiral binder. Both provide good introductions to HyperPAD.

Although both the help and tutorial pads are little more than electronic page turners, they do show you how to use HyperPAD to create more-advanced interactive texts and demonstrations. For example, both pads have index or table of contents screens in which each subject heading is a button that links to a page elsewhere in the document. Using the same technique, any word on this page could be linked to a page of definitions for beginners, a more detailed discussion of the subject, or a list of related topics covered by other pads—and linked to them.

You can add your own notes field to either pad, or you can create a separate pad for notes and then build links to sections of the tutorial and help pads. Opening files, moving between pads, and building your applications are all managed neatly with a Macintosh-like system of pull-down menus.

An ideas pad features clip art and sample buttons for common commands such as Forward, Backward, Go to First Page, and Go to Home. But all the ideas aren't in the ideas pad. Each sample application is written in PADtalk, and the script for each pad, page, field, and button is available to any user via a command that overrides the access-level protection of a pad.

But don't expect much help from the manual. Although it has an alphabetical section of PADtalk elements, the HyperPAD manual does not have a detailed tutorial on how to write your own scripts. The manual even lacks a list and explanation of error messages.

I'd also like to see some documentation in the code of all those sample pads, which are hardly mentioned in the manual. (PADtalk allows Pascal-style comments.) Heavily commented code would be especially instructive on the more complex sample pads, such as the move-the-numbers box puzzle and the scientific calculator.

Caveats aside, I like HyperPAD. It lets you easily create and modify attractive and easy-to-operate user interfaces. Generally, HyperPAD works well for building tutorial systems and front ends for other software. In fact, using HyperPAD, you could make life easier for someone learning and using a new word processor or database manager.

It may not, however, offer the joys of graphics doodling and iconography you find in Apple's HyperCard. But it's the easiest system I've seen for experimenting in interface design and exercising your own opinions about the *right way* a program should work. ■

Bob Stepno is a journalist and systems humanist who has been working with computers since 1978. His master's thesis was on reading and writing with hypertext. You can reach him on BIX c/o "editors."

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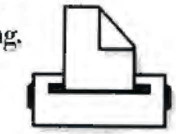
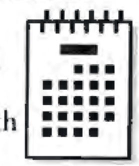


With cooperative processing, an OfficeVision user can have several computers sharing one task. A midrange computer might search files in a mainframe for constructing a graph that's displayed on a PC.

Each system does its part, but as a user you're completely unaware. You simply ask for the work to be done. How it gets done isn't your worry.

A single standard. Multiple solutions.



We can call SAA a standard, but that doesn't mean much unless software developers agree with us. And indeed they do.

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IBM

Arriba: The Painless PIM

Good Software shows that using a personal information manager needn't be an ordeal

Lamont Wood

Each entry in Arriba's phone list represents a folder that contains related notes.

Arriba offers something that is generally lacking in personal information managers (PIMs)—ease of use. Unlike with other PIMs, with this $195 PC package you can become productive almost immediately, thanks to its cookbook approach to information management. But should you itch to do so, you can break away from its recipes and come up with your own.

Arriba has, of course, problems and limitations. And it's not as polished as some of its big-name competitors. But if it gets what you need done with minimal hassle, you may not care.

Notes and Folders

It's inevitable to compare Arriba 1.0 with Lotus's Agenda (see "The Database Redefined," December 1988 BYTE). Both let you assemble your thoughts or your daily schedule in an intelligent notebook that sorts, arranges, and probes itself on command.

But using Agenda requires that you vault a series of conceptual hurdles and figure out what the programmers meant by the terms *note*, *item*, *view*, and *section*. Slowly, you learn to jot down your thoughts as items, expound them with appended notes, sort them by categories, and view them in sections. As you go along, you add categories, filters, and other functions, until finally you arrive at the application you need—it's like adding clay until you get a statue.

With Arriba, you load the software and immediately get three canned applications—a phone list, an appointment calendar, and a to-do list. Other formats let you create a variety of other common data files, or you can cook up your own formats.

Arriba lets you write notes about appointments, contacts, and so forth. Part of the note can serve as the title, somewhat corresponding to an Agenda item. You can search all the text in an Arriba note, and it can be 16K bytes long.

Where Agenda has sections and views, Arriba has folders and file cabinets. A file cabinet is the entire textbase, and the folders are the subject headings it contains. A folder can contain notes, other folders, or both. But there the products diverge. Agenda sorts items into views based on their contents and the specifications you give in the category manager. Agenda even lists the items in columns, with the matching text in the adjacent columns to the right or left, letting you sort by more than one specification.

Arriba is not as sophisticated; it mainly has the search command. You can give Arriba a search specification—complete with AND, OR, and NOT logical operators, parenthetic clauses, and wild cards—and it searches the notes of the current folder and its subsidiaries for the text. If it finds a match, it displays a screen with that note, with the matching text highlighted. Should there be more than one match, Arriba shows a list of the note titles, which you can browse through. You arrange the folder contents

continued

Arriba 1.0

Company
Good Software Corp.
13601 Preston Rd., Suite 500W
Dallas, TX 75240
(800) 272-4663
(214) 239-6085

Hardware Needed
IBM PC XT or compatible with 384K bytes of RAM and a hard disk drive

Software Needed
MS-DOS 2.0 or higher

Documentation
User's manual

Price
$195

Inquiry 883.

manually, whereas Agenda's category manager does it automatically.

Cookbook Recipes

The phone list is actually a mailing-list program. It displays a list of entries, each with a name, phone number, and company reference (see photo). But the entries are just the titles of individual notes, and each note has formatted data fields for an address, plus a field for general text (so you can make notations). Using the print command, you can print a personal telephone directory as shown on the screen, or you can print mailing labels.

If you have an auto-dialing modem, Arriba can dial the phone number in the entry for you. If you need to dial 9 to get through a local private branch exchange or wait for a second dial tone or add long-distance access codes, you use the Setup menu. You can even tell Arriba what your area code is so it will add 1 to any calls outside the area code and drop the area code while calling inside it—common-sense features you don't normally see. (What Arriba does not do, although it would be nice, is track the duration and destination of your calls, in case you need to charge them to someone else.)

You can dial any number that appears in any note, not just the phone list, by having the cursor on the line that contains the number and invoking the dial command. If you are in the phone list application, Arriba dials and then calls up the note associated with the number, so you can start typing notes regarding your phone conversation.

Meanwhile, calling up the calendar gives you a screen window with a three-month calendar display, laid out in typical fashion, with the current month on top and the current day highlighted.

Pressing Return brings up a display showing a list of time slots (every half hour is represented), and along the bottom of the display is a chart showing how much of the day is scheduled. If, for instance, you put the cursor on 9:00 a.m. and press Return, Arriba gives you a data input window that asks you for the starting and ending time or the duration of the appointment and a brief description. If the appointment lasts 90 minutes, the next two lines displayed will have ditto marks added to them, and the chart will show highlights between 9:00 a.m. and 10:30 a.m. You put the cursor on the new appointment and press Return again. You can then add a note to that appointment to remind yourself of what will be discussed.

You can search the contents of the note—and all the notes in the calendar, for that matter. Short work with the search command can, for instance, show which day you had that "court appearance" concerning "Smith."

You can page through the months, for example, from January 1980 to December 2037. Arriba accepts a wide range of time inputs (e.g., 330 will be seen as 3:30 p.m.), and you can input the current date and time with function keys. But it falls far short of Agenda, which can make sense of things like "a week from Thursday." In fact, Arriba seems to know nothing about the days of the week—this is troubling, especially if you do most of your scheduling on a daily basis.

The to-do application is a simple listing of items you need to do. There are fields for description, date due, person assigned to, and priority.

Further Cooking

Arriba does not limit you to its defined applications. You can add your own folders with your own formats for the data. Here, again, it provides recipes—Arriba comes with 10 data-file formats to choose from. These include a format for auto-expense records, business-expense records, a calendar (for writing applications like the canned calendar file), contact management, a daily journal, a property locator, real-estate tracking, a phone list, and two to-do lists.

You can also create an entirely new form, to your own specifications. Doing so requires a little more expertise and planning, since you have to specify the field lengths for your data elements and decide which ones will appear in the note titles. In fact, it's a lot like ordinary database programming, except Arriba handles many of the details. For instance, you can move the data fields around on the screen, as you would move text with a word processor; the subsequent data input window shows the inputs as you arranged them.

Like Agenda, Arriba has no provision for mathematical calculations—you can't add up the numbers in particular fields. You can only fill them in, search them, read them, and edit them—or dial them, if they happen to be phone numbers.

Other Entrées

You can run Arriba as a 137K-byte TSR program. But it has no facility for importing data from whatever was on the screen previously.

The TSR mode will not work with a program that intercepts keyboard input. Also, if you pop it up atop a program using a graphics screen, Arriba will work fine, but when you go back to the original program, you'll have only garbage on the screen and you may have to reboot. (Alas, Arriba is hardly the only TSR program that does this to you.)

You can also load Arriba normally and escape to DOS. Once there, you can execute simple DOS commands such as DIR and COPY—although anything else is likely to produce a "cannot load program" error message. Typing Exit returns you to Arriba.

Arriba lets you import ASCII files into a note and export a note as an ASCII file. It also has a function that exports the entire contents of a folder to a "file," but in this case a "file" turns out to be another Arriba textbase (a collection of folders under one name). Arriba will not handle any file types other than ASCII—a shortcoming, since many PIM packages make a point of handling popular word processing formats. For example, if you currently keep your phone list in a word processing file, you are likely to encounter difficulty importing it into Arriba.

The 16K-byte limit on notes, which at first seemed copious compared to Agenda, is actually a problem when you want to import large amounts of data. Arriba just loads its 16K-byte maximum, cuts off the rest, and gives you an error message. I tried importing a phone list of about 750 people only to find out that Arriba could only handle about 200 per folder. Basically, it's up to you to cut the data into smaller chunks—a tedious additional chore.

continued

Within a textbase you can, as you'd expect, copy material from one note to another—swiping a phone number, for instance, from the phone list to an appointment note.

As for performance, Arriba is quite responsive. No matter what you're doing, the screens pop up like flashbulbs (at least they do on my 16-MHz AT-clone); file imports are almost as fast, provided they're the proper size.

In general, getting between screens is only a matter of two or three keystrokes. Repeatedly pressing the Escape key eventually brings you back to the main menu, so you're not likely to ever get lost. Pressing Escape to "back up," however, can be a problem. When inputting a note, for example, the Escape key still means "escape," and I had to learn the hard way that you need to press the Save key when you're through typing a note. Otherwise, the search command frustratingly refuses to find anything—since escape preceded save, there's nothing in the notes.

The user's manual that comes with Arriba is adequate, if unexciting. But it is irrelevant anyway since everything you might need to know about Arriba is in an enormous (367K-byte) help file. You can invoke the help command at any time and get a somewhat context-sensitive help screen. F10 loads the help file as a textbase. You can then invoke the search command and get the help topics you need. Searching for "export and ASCII" will get you a list of the seven help notes that contain the two words. You would see that one of them is titled "exporting note text to an ASCII file" and call it.

No matter what you're doing, Arriba screens pop up like flashbulbs.

Proper Diet

Arriba, like Agenda, provides a simplified database language—with additional calendar and phone functions—suitable for managing personal information. The simplification puts mathematical analysis out of the picture. But for those of you whose PCs have replaced your filing cabinets, you can easily do what you could always do before you computerized—browse through your material.

But Arriba manages to avoid a problem that Agenda typifies. Too often, software evokes an appreciative "golly, this is neat" reaction from the user as he or she surveys the sophisticated complexity of the new package, just prior to abandoning family and friends for whatever time it takes to master its intricacies.

Eventually, somewhere on the other side of the learning curve, the user may return to the original job and actually become more productive (i.e., before some new software comes along).

Software doesn't have to forsake simplicity for functionality, and users need not be programmers. Arriba sets an example. ■

Lamont Wood is a freelance writer and computer consultant living in San Antonio, Texas. You can reach him on BIX as "lwood."

Reviewer's Notebook

Reviewer's Notebook is a compilation of brief reviews and updates to previously published evaluations. BYTE will publish Reviewer's Notebook each month on a space-permitting basis.

PixC Leaves Windows Overhead in the Dust

Windows without the operating system overhead: The idea is great. As a hardware implementation of windows for SCO Xenix and MS-DOS, PixC makes this idea a reality for 80386 AT-bus PCs.

PixC includes a 1536- by 950-pixel monochrome monitor, a video-control board, and a three-button mouse. A four-port serial board for connecting to other machines is a $400 option. The window manager and programs are embedded on the video board, which has an Intel 82786 window chip and 3 megabytes of video RAM. You can display as many as six windows on the screen at a time. Each window has function icons for sizing, positioning, scrolling, cloning, closing, and cutting and pasting.

I used four windows: one PC window (the Xenix equivalent of an MS-DOS console), a window through one of the serial ports to a Unix minicomputer, and two windows into Xenix on the local machine. I also ran VP/ix in the PC window, which, like tbe standard console, handles 12 virtual terminals of its own.

My job requires me to maintain a minicomputer, to program in 80386 Unix/Xenix, and to transfer files to and from MS-DOS. PixC let me work simultaneously in all these environments on the same screen, each window a full 80 columns (optionally 132) by 25 rows. This did not slow down my computer, because PixC operates transparently, using its own hardware.

PixC can simultaneously run six windows without slowing down the host.

But PixC has some limitations (the manufacturer says that it is working to resolve them). First, the PC window is 25 rows, while all others end at 24 rows. Thus, it is inconvenient to run another PC in any of the other windows.

Second, the serial ports don't extend their communications to the system bus; they only communicate internally with the video board. So although I created a window to an external machine without taxing the local system, I had no way for the local system to communicate with the external machine on the same line. This weakness extends to the use of the mouse. To use the screen mouse within an application, you need to run a cable between the fourth PixC port and a system serial port—a loss on both accounts.

Overall, PixC is economical and easy to use. I learned the display quickly due to the intuitive nature of the windows and because the actions and icons were consistent with other common (and more-expensive) systems. In fact, the most difficult part about writing this review was finishing it. Now I'll have to send the PixC back, and I will surely miss it.

—Ben Smith

PixC Display System
International Software Corp.
528 Commons Dr.
Golden, CO 80401
(303) 526-0388
$2995 with system-software interface
$495 for each additional interface
Inquiry 886.

Inconsistency Mars Budget-Priced Scanner

At $899, The Complete Page Scanner provides some of the features of flatbed scanners, such as Hewlett-Packard's ScanJet, at about half the price. But in terms of image quality and overall performance, it compares to the cheaper hand-held models.

The product offers 4-bit, 300-dot-per-inch, full-page scanning for the IBM PC, PS/2 Model 30, and compatibles. Unlike flatbed scanners, it uses three rollers to pull pages past a scanning window. You can select resolutions of 200 or 300 dpi, choose two halftone settings, and pick three dithering patterns: bayer, spiral, and mesh. The scanner supports 16 gray scales.

Menu-driven SmartScan software, which is included, converts images into various file formats, such as TIFF, PC Paintbrush+, Dr. HALO, Windows Paint, and GEM. It also imports and combines graphics and text files so you can merge them with scanned images and store them as one file.

I easily installed the interface card and software into my AT clone in about 15 minutes. From the main menu, I found the configuration screen, where I selected page size, orientation (portrait or landscape), and scanning resolution.

I tested the scanner with BYTE's scanning template and a variety of line art, halftones, and continuous-tone images. For comparison, I scanned the same elements with an HP ScanJet. I printed the scanned images with an HP LaserJet Series II.

After experimenting with scanner adjustments, I generated some clean copies, but my results were inconsistent. Black stripes appeared at the top corners of printouts, or stray pixels dotted the page. Dithered images showed less contrast than with the ScanJet, but the quality was adequate for newsletters.

Unacceptable, however, were the size distortions. Images scanned and printed at 300 dpi shrank 4 percent to 288 dpi horizontally and 10 percent to 270 dpi vertically. The manufacturer claims that the software shrinks images so 8½- by 11-inch scans fit 8- by 10-inch formats—the maximum for some laser printers. To print the image correctly, you must store it in your PC and then import it into another application, such as PageMaker.

The Complete Page Scanner is economical for some applications.

The manufacturer designed The Complete Page Scanner to work with The Complete Fax board and The Complete OCR/Page software. Unfortunately, the SmartScan software doesn't integrate these products. To use the scanner with the fax board, you scan the image from within SmartScan and save it as a fax image file. Then you send the image with The Complete Fax software. A similar procedure is necessary to run The Complete OCR/Page software.

Overall, the scanner lends itself to low-end desktop publishing applications where high-quality images and accurate sizes aren't required. Otherwise, you might as well spend the extra money on a flatbed scanner. *—Robert Mitchell*

The Complete Page Scanner
The Complete PC
521 Cottonwood Dr.
Milpitas, CA 95035
(408) 434-0145
$899
Inquiry 888.

Trim Mac IIcx Still Packs Power

Do you need a 68030-based Mac for high-powered, Information Age processing? The Mac IIx and Mac SE/30 both have their problems. The Mac IIx demands a healthy chunk of desk space, and the 9-inch, built-in monitor on the Mac SE/30 is too small for many tasks. Now there's the Mac IIcx, which is essentially a trim Mac IIx with only three expansion slots (see "Apple's New Compact Mac IIx," May BYTE).

The Mac IIcx's CPU box is smaller than either the Mac IIx's or the IBM PS/2 Model 50's. Yet the Mac IIcx accommodates several monitors that are larger than the Mac SE/30's, but still fit on top of the CPU.

I evaluated a system with 4 megabytes of RAM, an 80-megabyte hard disk drive, and a Portrait Display monitor and video board. The BYTE benchmarks rated the Mac IIcx as fast as the other 68030-based Macs (see table 1).

Software-compatibility tests showed some problems. For example, Adobe Illustrator 1.6, which behaved passably on the Mac IIx, crashed on start-up with the Mac IIcx. (Adobe says that a redesigned version now runs on the newer Mac.)

Apple revamped the Mac CPU layout for the IIcx, with good and bad results. On the plus side, the hard disk access light now glows when the IIcx performs a lengthy I/O operation. Also, the interrupt and reset switches sit in the front where you can easily get at them.

However, problems center on the plastic lip that surrounds the ends of the NuBus boards. This lip reduces the area available for cable connectors. Also, the video cable socket for the SuperMac Spectrum/24 video board rides high on its card end and nearly collides with the plastic lip. Connecting a monitor to the Spectrum/24's video socket required major surgery on the cable connector to bypass this lip. If you plan to recycle NuBus boards from another Mac system into a IIcx, check for this problem.

Overall, the Mac IIcx is a nice compromise with more expandability; it has a larger screen than the Mac SE/30, and it requires less space than the Mac IIx. You're certainly not sacrificing any processing power by using it.

—Tom Thompson

Macintosh IIcx
Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
Base price: $4669
System as reviewed: $8767
Inquiry 887.

continued

Table 1: *The BYTE benchmark tests for 68030-based Macintoshes show that the trimmed-down Mac IIcx can keep pace with its Mac cousins. The major differences are in CPU performance and hard disk speed, where the Mac IIcx's 80-megabyte hard disk drive (also used in the Mac SE/30) outmatches the 40-megabyte hard disk drive on the Mac IIx test unit.*

	Mac IIx	Mac SE/30	Mac IIcx
CPU	3.81	4.61	4.61
FPU	1.00	1.16	1.15
Disk	2.56	3.01	3.65
Video	2.35	2.33	2.58
Applications	13.7	17.0	17.97

Note: Indexes show relative performance. For all indexes except FPU, a Mac SE = 1; for FPU, a Mac II = 1. For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

Lisp Dialect Taps Mac Riches

Programmers new to the Mac need to immerse themselves in the Byzantine ROM Mac Toolbox, where the machine's richness resides. MacScheme+Toolsmith 2.0 can help that process, especially if you're a Lisp aficionado.

MacScheme is an interpreter and compiler of Scheme, the Lisp dialect that turns functions into object-oriented programming modules and lets programmers use suspended computations called *continuations*. Toolsmith integrates MacScheme with the Mac Toolbox.

The development system provides an event-driven, multitasking environment that's well suited to object-oriented programming. To create a document window, for example, I entered `(define window (make-window 'text))` at the MacScheme prompt. An empty window appeared and behaved like any Macintosh window.

Behind the scenes, MacScheme performed some fascinating things. The `make-window` value was a Scheme function built to object-oriented programming specifications outlined in MacScheme. As such, it responded to a variety of window-related commands. When I typed `(window 'operations)`, the window listed the things it knew how to do, including activating and deactivating itself, displaying its width and height, and editing text.

This message originates from two sources. MacScheme can trap Macintosh system events pertinent to its own interface and convert the others to messages

MacScheme+Toolsmith offers a multitasking environment on the Mac.

that it sends to Scheme objects, such as windows and menus. Second, user-written Scheme code can also send messages to the same objects. Therefore, I could close the window by clicking in its close box or by typing `(window 'close)`.

This arrangement has interesting ramifications. I found the interaction with a live Mac interface to be instructive. Also, because MacScheme encapsulates the event loop that is normally at the heart of programs written in Mac high-level languages, it supports an object-oriented style of programming. I didn't need to manage raw system events; instead, I concentrated on building objects that could act independently.

MacScheme predefined a set of high-level window, menu, and text-editor objects; these worked in conjunction with event handlers that mediated between Macintosh system events and the MacScheme high-level objects. The objects and event handlers gave me an effective environment for building Scheme programs that use the Mac interface.

The product's multitasking facility supported the development of Scheme programs made up of concurrent tasks. Yet MacScheme didn't interfere with MultiFinder, which manages icons and controls the Clipboard and Scrapbook. Both the development system and the stand-alone applications built with MacScheme ran under MultiFinder.

The question is, does MacScheme's rapid prototyping, object-oriented programming, and multitasking capabilities make it a compelling option for Mac developers? For some, the answer is no. Like all Lisp systems, MacScheme levies a significant run-time burden. For example, the sample text editor included with MacScheme is noticeably less snappy than the Think C equivalent. Of course, not every Macintosh program requires the blazing speed expected of commercial software. For those who can accept that, I recommend MacScheme as an aid to interactive Macintosh exploration and as a flexible object-oriented programming environment. *—Jon Udell*

MacScheme+Toolsmith 2.0
Lightship Software
P.O. Box 1636
Beaverton, OR 97075
(503) 643-6909
$395
Inquiry 889.

Better than Cache in the Bank?

Wouldn't it be great if you could wave a magic wand and make your hard disk drive run twice as fast? A screwdriver can do the same thing for you, if you use it to add Western Digital's SpeedKit caching controller to your computer. Five minutes was all it took to dramatically improve my old drive.

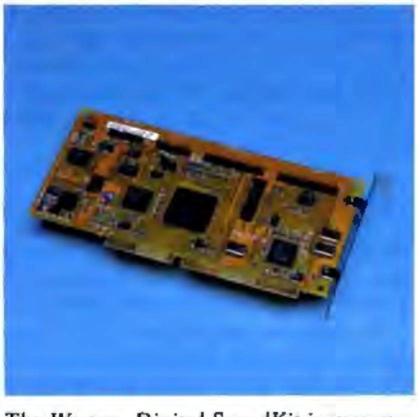
The SpeedKit is a $225 replacement hard disk drive controller for your 80286- or 80386-based AT compatible. This short card has a built-in memory cache that holds up to 13 sectors of data, and a data transfer rate fast enough to handle a 1-to-1 interleave. The SpeedKit is designed for ST-506 standard hard disk drives.

The SpeedKit performs a "look-ahead" during reads, storing up to 13 sectors of data in its memory. If you read sequential data from the disk, the controller provides it quickly from memory.

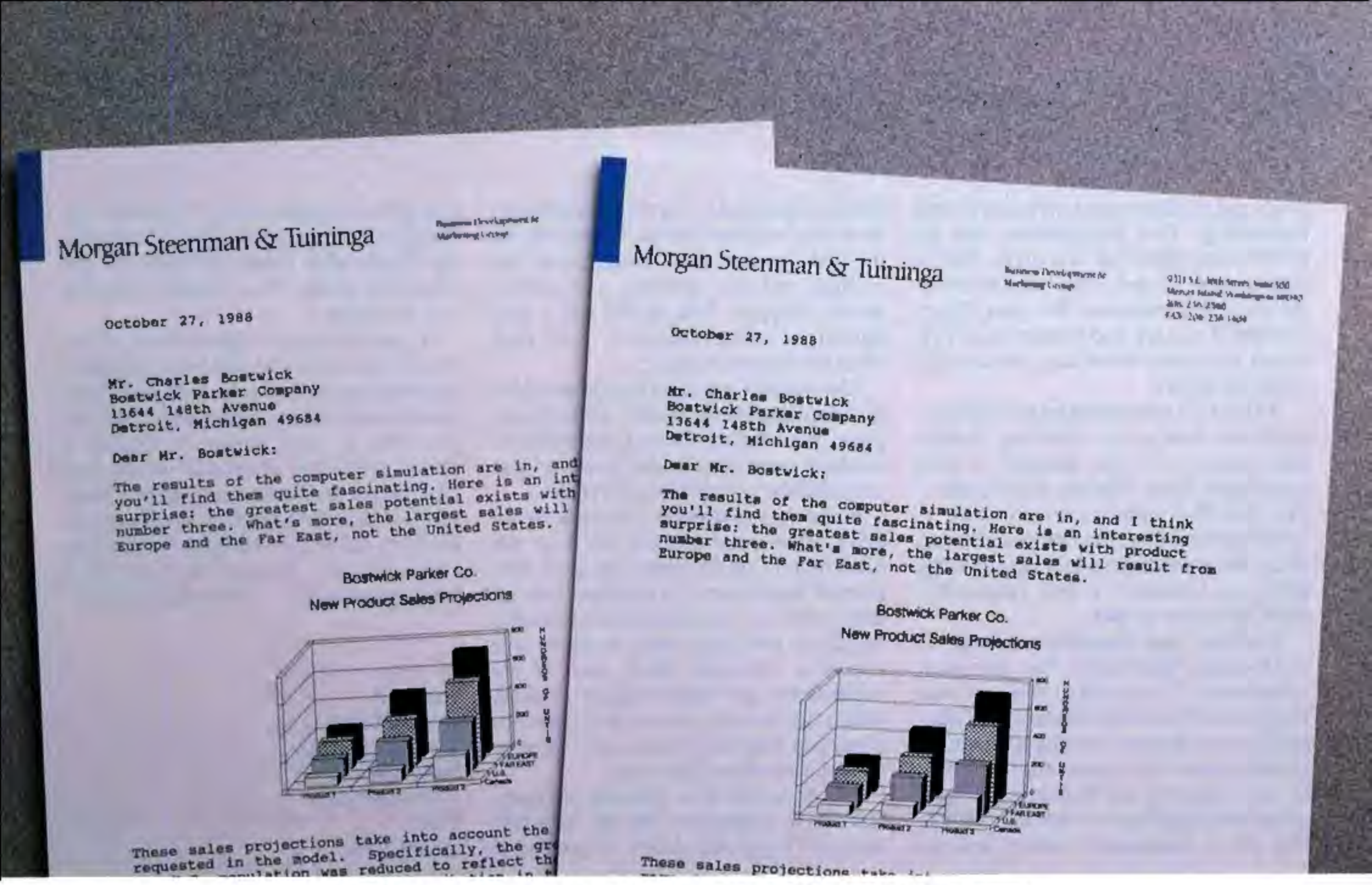
I installed the SpeedKit in an 80386-based clone with a 70-megabyte MiniScribe 6085 hard disk drive. The controller I replaced was the Western Digital WD1003-WA2. After installation, the machine booted on the first try.

To take full advantage of the board, you need to do a low-level reformat of the hard disk drive at a 1-to-1 interleave. The WD1003 normally runs the MiniScribe with an interleave of 3 to 1 or 4 to 1. Western Digital provides WDFMT, which requires that you know how many

continued



The Western Digital SpeedKit improves hard disk performance.



CAN YOU SPOT THE $700 DIFFERENCE?

One of the nearly identical samples you see above was printed with the HP Laserjet Series II. The other is from the Mannesmann Tally* MT905. Both are reprinted here exactly as they came out of the printers.

But what might surprise you is the rather dramatic difference in the manufacturers' suggested retail prices.

The Mannesmann Tally laser is $700 less. Yet it offers the same high quality output, lowers operating costs 25 percent, and prints at six pages per minute.

The MT905 comes with the same resident type fonts as HP, accepts standard HP font cartridges, and lets you choose optional memory upgrades from one to four megabytes.

MT905 Specifications

- Technology: scanning laser.
- Print Speed: 6-pages per minute.
- Resolution: 300 x 300 dpi.
- Emulations: HP Series-II. [optional emulations: Epson,* IBM* Proprinter, & Diablo 630.]
- Standard I/Os: Serial & parallel.
- Memory: 512K. [upgrades: 1, 2, & 4 megabytes.]
- Typefaces: Courier medium & bold, line printer, accepts standard HP font cartridges or any downloadable font in HP-format, 6-resident fonts + 2 font cartridge slots.
- Paper Handling: 150-sheet input & output bins. Manual feed handles single sheets, envelopes, transparencies, and labels.
- Workload: 4,000 pages-per-month.
- Suggested Retail: $1,995.

For more convenient paper handling, the universal paper cassette holds letter, legal, and international sizes, plus up to 15 standard envelopes. You can choose face-down output to keep long documents in the right order. And the manual feed lets you print labels or transparencies.

So any way you figure, the answer still comes up the same. The Mannesmann Tally laser looks perfect. And so does the price.

For the name of your nearest dealer, call the toll-free number listed below.

MANNESMANN
TALLY

1-800-843-1347
Ext. 360

Circle 171 on Reader Service Card (DEALERS: 172)

heads and cylinders your drive has before formatting. This information may be posted somewhere on the drive, but in many cases, it's not. You need to know the correct parameters for your drive, because if you try and format more cylinders than your drive has, you can severely damage it.

WDFMT's screen and lack of clear instructions were a bit unsettling. Rather than trust the screen defaults, I used SpeedStor from Storage Dimensions. The SpeedKit worked perfectly with it. After reformatting, the raw transfer rate of my drive doubled from a typical 243K bytes per second to a very respectable 496K bytes per second.

Windows and PageMaker flew. A 112K-byte PageMaker file that previously took 15 seconds to save was now whisked to disk in about 8 seconds. Other applications showed varying amounts of improvement—from none at all to twice as fast. The best performance increase came from applications that use one file laid out in consecutive sectors and accessed sequentially. Typical overall performance increased about 30 percent. As the disk became more fragmented, the caching was less effective and performance dropped. You should use a disk optimizer and defragment your disk often for best performance.

The manual has excellent instructions for installing the SpeedKit controller in place of a Western Digital controller. If you have some other brand, however, you may find the installation a bit trickier.

Make sure that when you connect the drive cables, you connect pin 1 on the drive to pin 1 on the controller card. The manual would have you believe that all disk cables have identifying red stripes—but this is not always true. Look at your controller first and check each of the cables *before* you remove them to find out which side is connected to pin 1. Otherwise, you may trash your drive by connecting the cables improperly.

The SpeedKit also provides a floppy disk drive controller for the standard types of floppy disk drives. If your hard disk drive controller doesn't control your floppy disk drives, you'll have to disable the floppy disk drive controller on the SpeedKit board. The manual explains how to do this.

If your computer began its life as one type of machine and has been upgraded to something faster, your hard disk drive now probably seems a bit sleepy. Perhaps you tried to save money by buying a slower hard disk drive and would now like better performance. Either way, take a look at the SpeedKit. Getting more out of an old drive is cheaper than buying a new machine. Besides, who can't use a little extra cache? *—Howard Eglowstein*

SpeedKit
Western Digital Corp.
2445 McCabe Way
Irvine, CA 92714
(714) 863-0102
$225
Inquiry 948.

In Search of a Faster 80287

The world of floating-point coprocessors is one of desire. If you don't have one, you want one. When you've got one, you want a faster one.

Enter the IIT-2C87, a pin-for-pin, instruction-for-instruction replacement for the 80287 coprocessor. The designers of the 2C87 have hot-rodded the chip. It looks like an 80287 to the CPU, but it executes floating-point operations in fewer cycles.

I pitted the 2C87 against an 80287 using BYTE's floating-point benchmark tests; both FPUs were running at the same clock speed inside an 8-MHz AT. All the tests ran without a hitch. The 2C87 doesn't seem to suffer from any compatibility problems.

The Livermore Loops test showed the 2C87 performing at nearly twice the rate of the 80287: 0.045 million floating-point operations per second versus 0.024 MFLOPS. On the LINPACK benchmark, the 2C87 chip performed about 1.7 times faster than the 80287. This agreed closely with our low-level FPU benchmarks, which showed the 2C87 to be, on average, 1.8 times faster than the 80287.

Inside a normal 80287, you will find a set of eight 10-byte storage locations that you can access either independently (as though each were a register) or in a group (as though the entire set were a push-down stack). If you take a look inside the 2C87, however, it reveals 32 10-byte locations, in four banks of eight each. You can access banks 0 through 2, but the coprocessor reserves bank 3 for its own use. When you apply power to the 2C87, its internal bank pointer is automatically set to bank 0. But special op codes that only the 2C87 recognizes allow you to switch the bank pointer to bank 1 or 2.

During normal operation, the 2C87 operates as though it is aware of only the currently active bank. In this case, the 2C87 is indistinguishable from a souped-up 80287: There's no way to operate on values in separate banks simultaneously.

With one exception.

The 2C87 has one more special instruction, which gives it the appropriate mnemonic F4BY4. It allows you to multiply a four-element row vector in bank 0 by a 4×4 matrix in banks 1 and 2 in one fell swoop. This may sound like a quirky instruction to add to a coprocessor, but it's not. If you are doing intense graphics operations in three dimensions—three-dimensional CAD, for instance—a fast matrix multiplication operation of the sort that F4BY4 provides is a godsend.

I executed a demonstration program that rotated a simple polygon through 360 degrees, one rotation per degree (each rotation required a matrix multiplication on eight points). The 80287 finished the job in about 345 seconds, while the 2C87 was done in only 179 seconds. Although I expected a better showing from the 2C87, a nearly 2-to-1 performance boost is nothing to sneeze at.

Integrated Information Technology has not yet set a single-unit price for the 2C87, though I was told that it should cost about the same as an 80287. IIT's engineers said that they had contacted compiler and CAD package developers, hoping to convince those companies to create special libraries that will recognize a 2C87 and make use of its added capabilities.

If you've got to have an FPU in your AT, paying 80287 prices and getting twice the throughput looks like a deal to me. *—Rick Grehan* ■

IIT-2C87
Integrated Information Technology, Inc.
2540 Mission College Blvd.
Santa Clara, CA 95054
(408) 727-1885
10 MHz: $189 each in lots of 1000
20 MHz: $239 each in lots of 1000
Inquiry 856.

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.

Introducing DESQview 2.2

And now, DESQview 2.2 adds capabilities, performance, and compatibility enhancements you've been asking for:

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.

More bang; less bytes

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.

Our story gets better and better

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 EDITORS' CHOICE

TECH Professional Solutions Award 1989 Best Operating Environment

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BYTE

September 1989

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SUPPLEMENT

Standards
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LAN Standards: Do You Need Them?

Jonathan Schmidt

As a technology matures, standards encourage its broad acceptance

LANs were developed to serve personal computers with the economics of shared resources. Connected machines could share expensive printers and hard disks. Now it is often the case that microcomputers are installed to serve the purposes of the LAN. LANs are more and more the actual "computer" of choice to solve data-processing, office automation, manufacturing, and control problems.

Early LANs were often nothing more than alternatives for the popular "printer sharing boxes" except that they could also share a hard disk. When LANs served personal computers, the big question was "Is the LAN transparent to all desktop applications?" That was back in the days when other familiar questions were "Is this particular personal computer IBM PC-compatible? Can it run Flight Simulator and Lotus 1-2-3?"

Today, the question is this: "Is the LAN compatible with LAN products?" *LAN products?* LANS are now real ends unto themselves, no longer used as a means to the individual computer's ends. LANs are now installed for their own purposes, not to aid the economics of the computer's installation. Real LAN products are designed to facilitate the end purposes of the LAN: database engines, System Network Architecture (SNA) gateways, and servers of all types.

As with personal computers, it's not good if LANs don't conform to the standards that let you use the popular added-value products designed for them. Also, the synergistic support industry is more highly motivated to invest in product development when there is a large base of compatible users to absorb the products.

LANs are layered, and products for LAN users range from wires and connectors to MS-DOS applications. Proponents of particular solutions, promoted as candidates for standards, range from Datapoint with ARCnet, Xerox with Ethernet, and IBM with Token Ring at the wire end, to Novell, Microsoft, and, of course, IBM at the higher levels. Adding to the richness of offerings is the emerging participation of OS/2, Unix, and the Macintosh.

Standardization

Standardization is a two-edged sword. In the infancy of a technology, it can stifle advancement. Later, however, as personal computers have shown, it generates widespread competence, familiarity, and an explosion of value-adding products.

Luckily for LAN users, early standardization did *not* occur. The industry is now in the final stages of a frenzied development of a wide variety of network species that are competing for a place in the world—a cretaceous period for networks, so to speak.

Some consolidation and effective standardization have occurred. LAN hardware is mature. It has assimilated existing hardware technology and is awaiting future developments to make the full speed of fiber-optic technology and even higher-speed modulation and propagation media accessible.

The "war of the wires" of several years ago is over. A brief tour through issues of BYTE of the early 1980s (when which "LAN" you used referred to the type of hardware, not to Novell or Banyan) will bring it all back, as in these caricature quotes: "Token Ring is too fragile and expensive," says an Ethernet spokesperson; "Ethernet is too unreliable and unpredictable," says a Token Ring spokesperson; "ARCnet is the best," says an ARCnet spokesperson. And there were (and are) Orchid and Omninet, too. LANs were coming from universities, telephone companies, copier companies, computer companies, modem companies, and some apparently through spontaneous generation.

Now 90 percent of the market is consolidated around Token Ring, Ethernet, and, yes, nearly 2 million ARCnet nodes as well. Today, the competition is dedicated to bringing users these survivors with lower cost, higher reliability, and easier wiring with coaxial, twisted-pair, and fiber-optic connections available on all of them. All three are mature, easy to install, reliable, fast, and dropping in price. And the huge numbers of users of these LANs have forced the LAN system vendors to accommodate each of them.

The choice of wiring of any new network is now often decided by an existing installation already dedicated to one of the three. Or, accommodation of the selected computers may determine your wiring choice: Token Ring for IBM, Ethernet for Unix or VAX, or ARCnet for commercial data-processing installations or factory-floor integration. In any case, choosing among these mature and comparable disciplines solely on the basis of the price/performance ratio is difficult.

LAN Protocol Standards

LAN protocols are in a high state of flux. Competing interests, from international standards to IBM to defense systems, all have different agendas. Most LAN users with no one else to talk to on special protocols don't need them and don't use them. Besides, there is an interesting back door that takes care of the problem in many instances.

Immediately above the hardware layer in most networks, you usually find a protocol that handles communication across the LAN (e.g., TCP/IP). But, of course,

continued

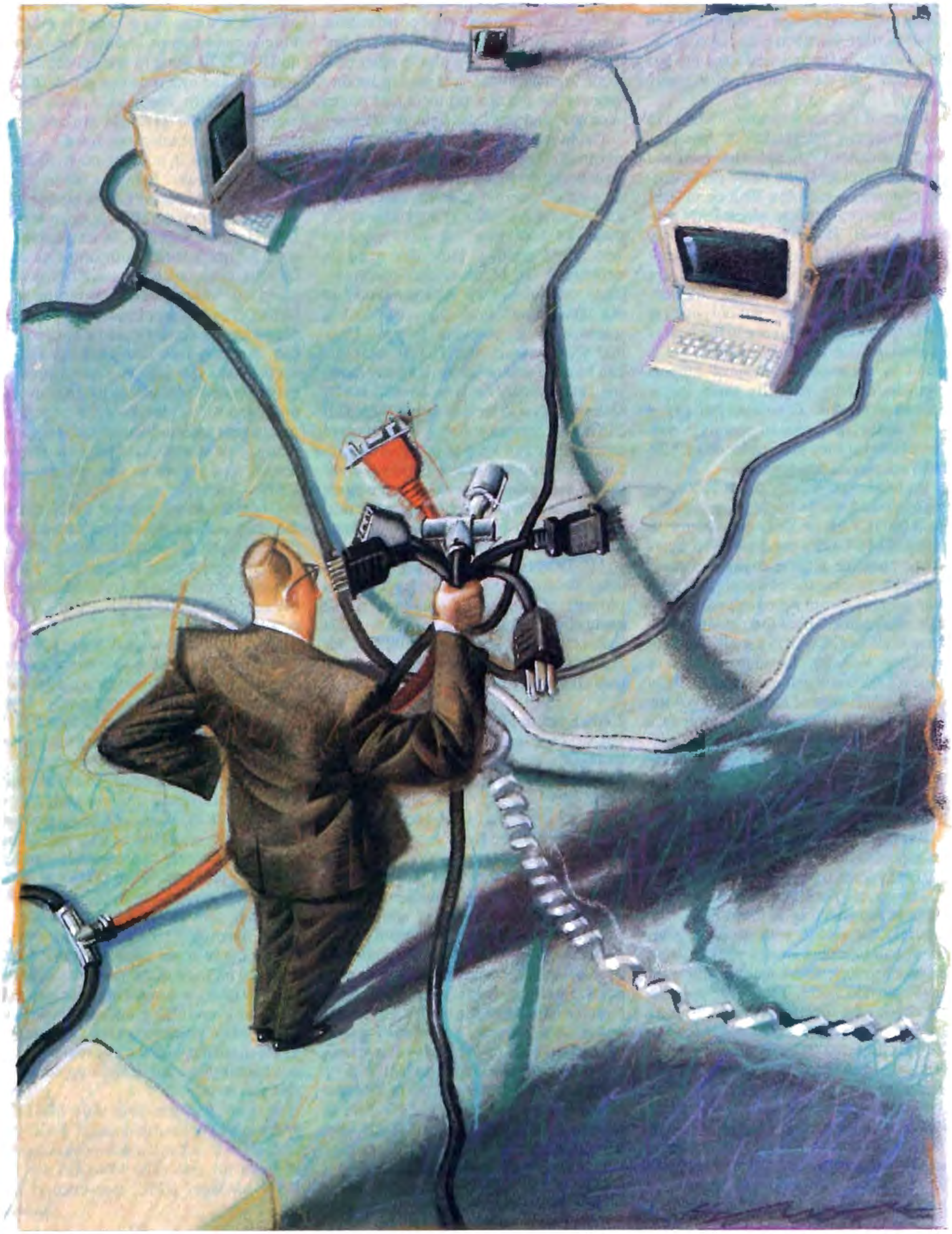

ILLUSTRATION: SALLY WERN COMFORT © 1989

there is also Open Systems Interconnection (OSI), XNS, variants of XNS (such as Novell's IPX), and myriad simple protocols optimized for restricted use within a particular hardware environment. Some are fully layered, and some are just part of a full stack. But does it really matter?

It does if you are seriously planning to use a *complete* integration of your personal computer LAN and other facilities *soon*. Involvement with other participating computers, such as a VAX or an IBM mainframe, can dictate which LAN protocol is used. This factor becomes especially important if a wide-area network is involved. TCP/IP proponents are pleased to point out that this "internetwork suite of protocols" not only is here today (an obvious reference to the lack of implementation of the OSI model) but is aided by an awesome array of support products and by virtually every major computer vendor. However, you pay a price today in terms of memory consumption that may just render other MS-DOS operations impossible.

Protocols, especially those following sophisticated, fully implemented stacks such as TCP/IP or OSI, can eat up so much of MS-DOS's precious 640K bytes of memory (or require expensive cards for implementing the protocol) that popular memory-hungry programs are unusable. Remember, both the network software itself and MS-DOS are also in there gobbling memory. In addition, lots of code means that it gets executed, and that implies time—lots of time to do even the simplest network operations. Faster PCs and memory-unshackled operating systems (such as OS/2 and Unix) will bring this problem to an end and offer up the delights of a broadly applicable protocol to PC LAN users.

But there is the hazard of adopting the "protocol of the month." What do you do next year when nobody remembers it?

The great innovative microcomputer support industry, as it often does, has come to the rescue with protocol gateways: software that causes your existing protocol to look like whatever you want to the outside world. That's one purpose for choosing a specific protocol, isn't it? Do you want your ARCnet LAN to look like an Ethernet TCP/IP network to an HP system in another department? Do you want it to look like an IBM Token Ring SNA network to your mainframe? Both at the same time? No problem, and you don't have to touch your network, which has been humming along just fine for several years. Nor does it require subjecting your entire network to a particular protocol to achieve this circus on interconnection. Just install one of the many gateways on the market, and you are set. Often you get better performance than you would if the network were completely homogeneous with the other protocol. And next year, just plug in another gateway for the new protocol that reigns supreme, and you'll be right up to date.

Gateways, however, are not for every purpose. They can't always use other internetwork facilities and, as Banyan can do with its internal TCP/IP, can't act as an IP router for other TCP/IP users. But they can link your networks together with X.25 so they look like a single networked set of users and resources. They can join every microcomputer to the IBM mainframe. They can link a microcomputer network to your Unix and VAX systems with TCP/IP. All this can be done without disturbing any existing functionality on your current LAN. Gateways can keep you going with full MS-DOS memory for your sensitive users. They can keep your network performance up until newer personal computers and operating systems come along that can handle protocol overhead as well as computing. In short, they can keep your personal computers unshackled.

MS-DOS is a *personal computer* operating system for *personal computing*. Its purpose often must be preserved to the exclusion of expeditions into new areas that offer magnificent possibilities for the future but can harm the immediate usefulness they offer.

LAN System Standards

LAN system standards are just beginning to rapidly evolve. Pioneers like Novell developed and proved the efficacy of basic mechanisms. In a repeat of the IBM PC evolution, IBM and Microsoft have incorporated these facilities directly into their operating systems. This time, however, their designs acknowledge this rapid transformation and take evolution and the resulting administrative hassle of updates into account.

Although early LANs were dedicated to sharing expensive hard disks, now LAN interface cards often cost more than the hard disks. So what's the appeal of the LAN, anyway? The whole is greater than the sum of the parts—the microcomputers are working together.

In Data Processing 101, one of the first precepts you learn is "one fact in one place." In simple terms, if you have several copies of a customer list, they will probably never be identical. With a LAN, you can assign one machine the responsibility for maintaining the list, and everyone can access that machine when it's time to work on the list (shades of timesharing on minicomputers). Don't just share data, share other resources. Plug in one gateway, and everyone can be an IBM 3270. Plug in one asynchronous gateway, and everyone can get on BIX or call a BBS (*n* users at a time for *n* modems on the gateway) without their own modems or telephone lines.

That's how it is right now. Shared, synergistic power. But more is coming.

Current-generation LANs almost universally provide the IBM/Microsoft MS-DOS-defined NetBIOS. In simple terms, it's a lot like a Hayes-compatible modem in your personal computer. It's now a standard whereby your program tells NetBIOS to connect to another program or task on the network, and it does so if it can. A whole new world has opened up for products that just plug into a running network and provide value for everyone—gateways, database management machines, internetwork bridges, print management systems, plug-in shared power, and power to the *n*th for your LAN of *n* users.

Once the other popular LAN manufacturers such as Novell and Banyan produced NetBIOS-emulation facilities (3Com doesn't need to "emulate"; it licenses the core LAN from Microsoft), the support industry exploded in plug-in power for LANs.

OS/2 was announced with a better "NetBIOS" than NetBIOS: named pipes. Named pipes do everything NetBIOS does and more—and more easily. With announcements from Novell that it will support this facility, the stage is set for another explosion in development.

Exciting new structures can be built with multitasking and named pipes. With MS-DOS, it was one program running on one machine at one time. One machine was only the gateway, a rather complete program. With OS/2 and Unix providing named pipes, parts of your program, called *tasks*, can migrate to other machines on the network where they may be more appropriate. An I/O task can migrate to the machine with the laser printer; a computing task can migrate to a really big and fast machine; and a communications task can migrate to the machine with the channel on it and not bother you until something comes in that you want.

You say that you have only MS-DOS and can't have multiple tasks? Well, you can, if OS/2 or Unix machines take some of them for you. The MS-DOS for the LAN Manager (OS/2 networking) lets

continued

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you run multiple tasks from your MS-DOS machine as long as the others run on an OS/2 or Unix LAN Manager somewhere else on the network. There is now a true basis for remote procedure calls, the Xanadu of early network theorists.

Gradually, LAN System Standards

Microsoft has carefully been building this networking into all its operating systems; even Xenix comes with it. Recent versions of MS-DOS and OS/2 have networking modules, licensed separately, that obey the carefully designed behavior created by Microsoft to automatically network together users, resources, and even procedures. The delight of this design is that it is both upward compatible and downward compatible. This compatibility means that fully functional parts of your network, when operating with an older version of MS-DOS and its network, don't have to be uprooted to install an OS/2 server for newer OS/2 users. In fact, in most cases, you can install the OS/2 server without turning the network off. And to top that, the resources on the OS/2 server can be accessed by the old MS-DOS users as soon as it is brought up. Microsoft networks have a negotiation built in, with newer versions always able to talk the more basic "language" of older versions, thus assuring hassle-free evolution. That design would certainly have been welcome when users were forced to upgrade MS-DOS versions on stand-alone PCs.

With both Hewlett-Packard and AT&T independently announcing that they are producing Unix systems to obey this same Microsoft LAN Manager networking language, the stage is set for a truly generic LAN. It is capable of absorbing not only accessories from the support industry, but also workstations, file and print servers, and facilities of all types on a wide variety of operating systems.

For LANs that support only MS-DOS, the standards picture is very bright indeed. All Microsoft-based LANs—including those from IBM and 3Com, Microsoft "clones" such as PowerLAN and Network O/S, and the majority of proprietary LANs such as NetWare, VINES, and LANtastic—fully support the MS-DOS LAN mechanism for communications (NetBIOS) and record locking. Thus, applications in general should find these LANs accommodating.

OS/2 is another matter. OS/2 was designed with the network as an integral part—it's a *networking* operating system and needs no network operating system to support it. Vendors whose products are based on the premise of a network operating system that sits on top of the computer's operating system will continue developing features to demonstrate that they do add value. Microsoft, no doubt, will strive to make sure that OS/2 and MS-DOS don't need them.

The frantic pace of LAN development is continuing. Novell and Banyan have both indicated intentions to provide some degree of emulation for most of the current OS/2 networking mechanisms with a steady series of announcements over the past year. And it is no trivial detail that this "LAN Manager" is also IBM's LAN language. After witnessing the evolution of the PC, this indeed may be the most important fact. ■

Jonathan Schmidt is chief technical officer of Performance Technology in San Antonio, Texas. He can be reached on BIX c/o "editors."

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The Glue for Internetworking

William Stallings

TCP/IP binds together LANs and networks of LANs

As more and more personal computers hook into LANs, more and more LANS are in turn being connected to form WANs (wide-area networks). To move beyond the simple disk server and printer server applications of the typical LAN requires a powerful communications architecture. The most popular such architecture is based on the TCP/IP suite of protocols.

The Department of Defense (DoD) created TCP/IP as part of the experimental packet-switched network ARPANET, and it has since become a military standard. But TCP/IP also has been quietly building a following in the commercial arena—ironically during a time when the industry has focused a great deal of attention on the International Organization for Standardization's Open Systems Interconnection (OSI) model. Currently, over 200 vendors provide TCP/IP products, making TCP/IP the most widely available and most widely used set of standardized computer-communications protocols.

Five core protocols make up the TCP/IP architecture, although the entire set carries the names of only two: Transmission Control Protocol (TCP) and Internet Protocol (IP). TCP/IP has four layers: network access, internet, transport, and application. The network-access layer contains the protocols that provide access to a communications network such as a LAN. The TCP/IP suite includes no unique protocols at this layer. Rather, it supports whatever protocol is appropriate for a particular network (e.g., Ethernet, IEEE 802, or X.25).

The internet layer consists of the procedures required to allow data to traverse multiple networks. Thus, it must provide a routing function. The IP functions within network hosts and routers (a router relays data between networks using an internetwork protocol). (See "When One LAN Is Not Enough," January BYTE.) The IP connects multiple LANs within the same building or at different sites through a wide-area packet-switched network.

The TCP at the transport layer provides the logic for ensuring the reliable delivery of data exchanged between host systems. It's also responsible for directing incoming data to the intended application.

Finally, the application layer contains protocols for specific user applications. Each type of application, such as file transfer, requires a protocol that supports that application. TCP/IP includes three such protocols: Simple Mail Transfer Protocol (SMTP), File Transfer Protocol (FTP), and TELNET.

Operational Issues

Figure 1 shows a typical TCP/IP network configuration. Some sort of network-access protocol, such as Ethernet, connects computers to a network. This protocol enables the host to send data across the network to another host. IP resides in all end systems and routers. It acts as a relay to move a block of data from one host, through one or more routers, to another host. TCP resides only in the end systems; it keeps track of the blocks of data to ensure reliable delivery to the appropriate application.

For successful communication to occur, every entity in the overall system must have a unique address. Two levels of addressing are needed. Each host on a network must have a unique global Internet address. And each process within a host must have an address that is unique within the host; this allows the host-to-host protocol (TCP) to deliver data to the proper process. The latter addresses are called *ports*.

Suppose that a process associated with port 1 at host A wants to send a message to a process associated with port 2 at host B. The process at A hands the message down to TCP with instructions to send it to host B, port 2. TCP hands the message down to IP with instructions to send it to host B. Note that IP does not need to know the identity of the destination port. It needs to know only that the data is intended for host B. Next, IP passes the message to the network-access layer (e.g., the Ethernet logic) with instructions to send it to router X (the first leg on the journey to B).

Controlling this operation requires transmitting control information as well as user data (see figure 2). When TCP receives a block of data from a process, it appends control information as the TCP header, forming a TCP segment. The peer TCP protocol entity at host B will use this control information. The following are examples of items that are included in the header.

- Destination port: When the TCP entity at B receives the segment, it must know to whom it should deliver the data.
- Sequence number: TCP numbers the segments that it sends to a particular destination port sequentially so that if they arrive out of order, the TCP entity at B can reorder them.
- Checksum: The sending TCP includes a code that is a function of the contents of the remainder of the segment. The receiving TCP performs the same calculation and compares the result with the incoming code. A discrepancy results if there has been some error in transmission.

TCP then hands over each segment to IP, with instructions to transmit it to B. IP must then transmit these segments across one or more networks and relay them

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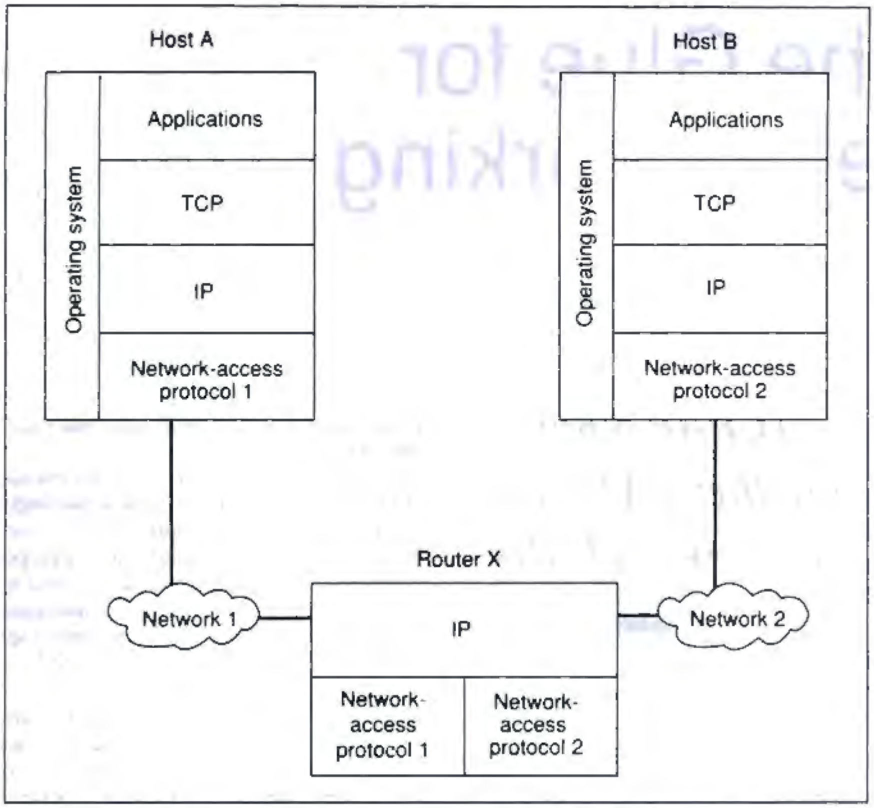

Figure 1: *This simple configuration demonstrates how you might internetwork two hosts via TCP/IP.*

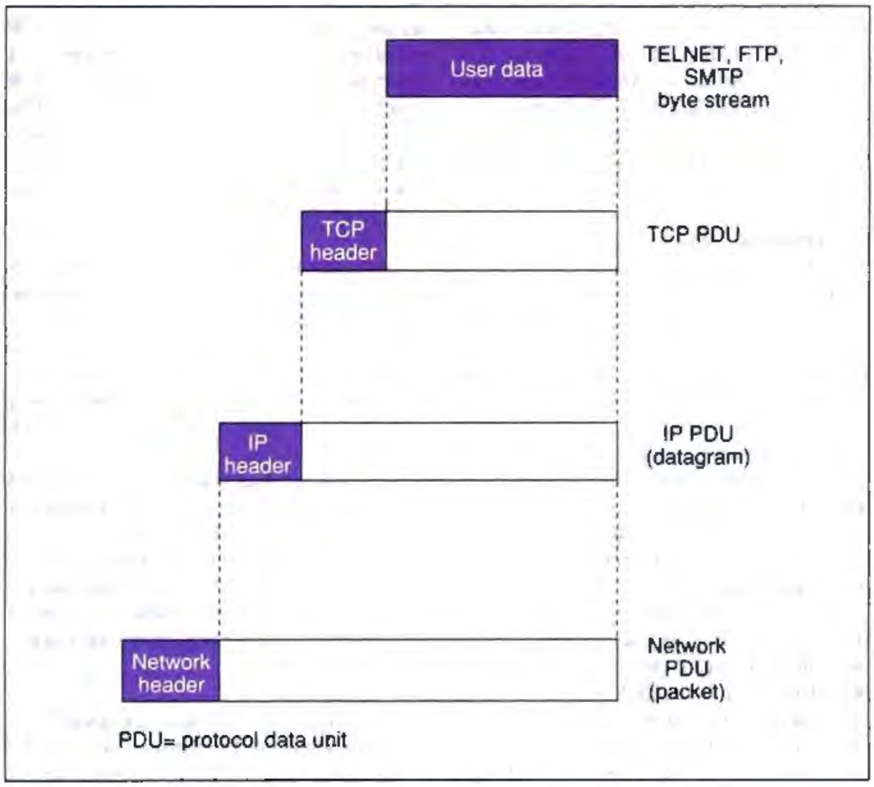

Figure 2: *The levels of protocol header information in a TCP/IP packet.*

through one or more intermediate routers. For this purpose, IP appends a header of control information to each segment to form an IP datagram. One item stored in the IP header is the destination host address (in this example, B).

Finally, IP presents each datagram to the network layer for transmission across the network to router X. The network-access layer appends its own header, creating a packet, or frame. The packet header contains the information, such as the destination address, that the network needs to transfer the data across the network.

Router X strips off the packet header and examines the IP header. Based on the address information in the header, the router's IP module directs the datagram out across network 2 to B. To do this, it must augment the datagram with a network-access header.

When B receives the data, the reverse process occurs. At each layer, B removes the corresponding header, passing the remainder on to the next higher layer, until the original data arrives at the destination process.

Applications

As mentioned earlier, TCP/IP's three application protocols are SMTP, FTP, and TELNET. SMTP provides a basic E-mail facility. Its features include mailing lists, return receipts, and forwarding. The SMTP protocol doesn't specify how to create the messages; it requires some local editing or native E-mail facility. Once a user has created the message, SMTP accepts it and uses TCP to send it to an SMTP module on another host. The target SMTP module uses a local E-mail package to store the incoming message in the recipient's mailbox.

FTP sends files from one system to another under user command. It accommodates text and binary files and provides features for controlling user access. When a user wants to engage in file transfer, FTP sets up a TCP connection to the target system for the exchange of control messages. These allow the user to transmit an ID and password and to specify the file and file actions desired. Once the system approves the file transfer, it sets up a second TCP connection to handle the data transfer. FTP transfers the file over the data connection without header or control information overhead at the application level. When the transfer is complete, the control connection signals completion and is ready to accept new file transfer commands.

TELNET provides a remote log-on capability that lets a user at a terminal or personal computer log onto a remote computer and function as if he or she were connected locally to that computer. TELNET was designed to work with simple scroll-mode terminals. The protocol actually has two modules: User TELNET interacts with the terminal I/O module to communicate with a local terminal. It converts the characteristics of real terminals to the network-standard virtual terminals and vice versa. Server TELNET interacts with an application, acting as a surrogate terminal handler so that remote terminals appear as local to the application. Terminal traffic between User and Server TELNET is carried on a TCP connection.

Microcomputer Connections

Figure 1 shows the simplest architecture for interfacing a host system to a network using TCP/IP. The TCP/IP protocols sit above the network-access protocol, which is unique to the particular network. The host operating system supports all these protocols. This approach is common for large computers but is of questionable value for microcomputers. TCP and IP are complex protocols that perform a considerable amount of processing, and they impose a burden on the host in terms of memory consumption, processing time, and the number of interrupts.

Figure 3 shows an alternative approach that uses a communications coprocessor board. All the protocols up through TCP (i.e., TCP, IP, and network access) reside on the board, and only the application-level protocols (SMTP, FTP, and TELNET) reside in the host CPU. This approach relieves the CPU of the communication processing burden, enhancing efficiency. Also, the board can be procured from a different vendor than the supplier of the host system, allowing greater flexibility when you're selecting equipment to attach to the network. Currently, a number of vendors offer such boards for the most popular microcomputer buses.

Figure 3 also indicates the need for some sort of interface protocol, referred to in the diagram as a host-to-front-end protocol (HFP). To see the need for an HFP, consider the operation of an application in figure 1.

If an application protocol such as FTP is to transmit a block of data, it invokes TCP with a SEND command. The TCP standard doesn't specify how to implement this command; this is up to the implementer, who can invoke it as a procedure or subroutine call or as some sort of trap in the operating system that generates a message to TCP. The implementer will choose a technique that optimizes some parameter, such as performance or code size. Indeed, the standard must not dictate the interface between TCP and the application protocols so that the implementer remains free to design the most efficient solution.

However, when TCP is running on the coprocessor board and the application protocol is running on the host system's CPU, a mechanism is needed for transmitting commands and their associated parameters between the application protocol in the host to TCP in the coprocessor board. This is the function of an HFP. The HFP formats the application command and its parameters into a standardized message to be sent to the front end. If the host and front-end systems are from the same vendor, the details of the HFP are of concern only to the implementer, but if they're from different vendors, a standard for the HFP is desirable. Unfortunately, no such standard exists. In a personal computer LAN environment, the de facto standard that fills this role is NetBIOS.

NetBIOS

NetBIOS, the standard interface for networking IBM PCs, PS/2s, and their compatibles, has become the dominant mechanism for personal computer networking. Normally, the personal computer makes use of the BIOS in ROM. This comprises a set of drivers that provide simple hardware support for standard equipment on the PC (e.g., drivers for printers and disk controllers). NetBIOS is the equivalent of the BIOS, but for the network interface.

NetBIOS enables PCs on a LAN to establish connections between themselves and to communicate directly without having to go through a central host computer, file server, or other device. It lets applications talk directly to the network, instead of talking to DOS, which in turn talks to the network operating system. Implemented on a circuit chip that resides on the network communications board, NetBIOS provides fast service because it bypasses the PC's operating system.

The NetBIOS specification defines a set of system calls that allow an application on a PC to gain access to applications on other PCs on the same LAN. To carry out a certain operation, the application loads various processor registers with given values and performs a software interrupt. The application issues an interrupt 5Ch to access the network interface board directly and use NetBIOS.

continued

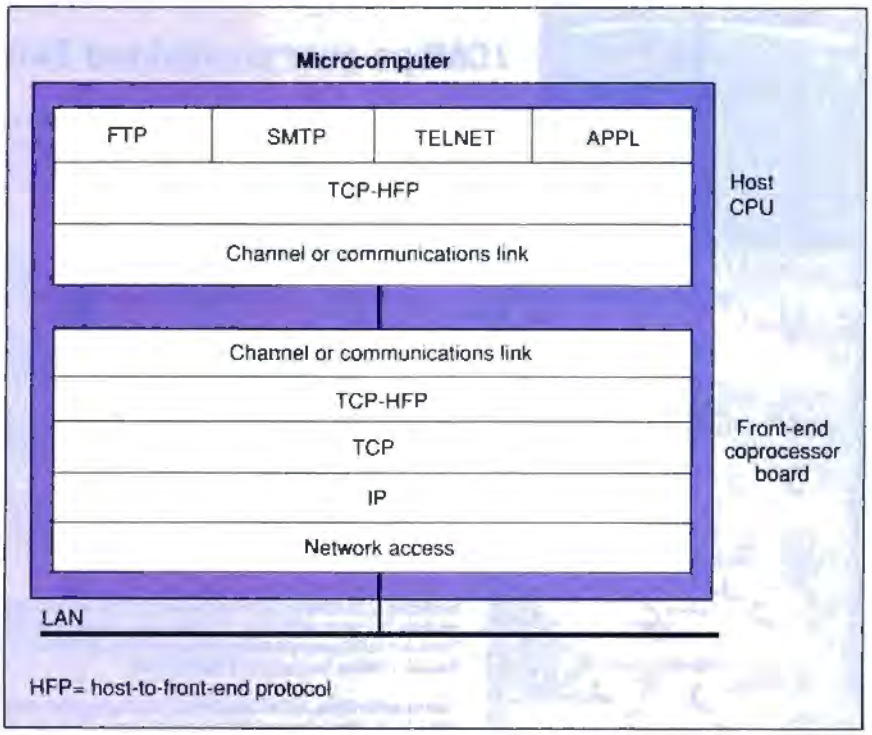

Figure 3: *When implementing TCP/IP on a microcomputer host system, using a host-front-end coprocessor board is a way of taking some of the processing burden off the CPU.*

The NetBIOS scheme has been hobbled by one major factor: its inability to span incompatible networks. Fortunately, the DoD has developed a merger of TCP/IP and NetBIOS that overcomes this limitation.

NetBIOS Over TCP/IP

In the past several years, many vendors have independently developed products that let NetBIOS applications run in a TCP/IP environment. These vendors were already offering TCP/IP networking products and wanted them to be able to interoperate with the growing number of NetBIOS applications. All the products used NetBIOS as the HFP between the applications on the host and TCP on the network. Unfortunately, all these different implementations would not work with each other. To solve this problem, the DoD issued the RFC 1001/1002 specification, which defines the interaction between NetBIOS and TCP. The products now coming into the marketplace conform to this specification.

The most difficult problem in integrating NetBIOS and TCP/IP is handling names. In the NetBIOS world, communicating entities (applications and servers) all have names, which users obtain via a simple announcement scheme. If you want the name FileManager001, you broadcast your claim to that name to everyone else on the LAN; if no one objects, that becomes your name. In an internetworking environment, this scheme presents two problems. One occurs when you connect two formerly separate networks, and two devices on the different networks have the same name. The second problem is that broadcasting in an internetwork almost always is forbidden because it would quickly overwhelm the communications links. To overcome this problem, the DoD developed a mapping between NetBIOS names and internetwork names and adapted the existing Internet name protocol to facilitate name creation.

The RFC 1001/1002 specification provides for three forms of NetBIOS: B-nodes, P-nodes, and M-nodes. B-nodes are restricted to communications on a single LAN and use a broadcast type of naming protocol, similar to the unadorned NetBIOS. Therefore, a B-node doesn't implement TCP/IP. P-nodes make full use of TCP/IP and can communicate with other P-nodes on the same LAN and with P-nodes on other networks to which they're connected. M-nodes have mixed functionality and can communicate with both B-nodes and M-nodes.

If you run NetBIOS over TCP/IP, you can communicate with any other system that implements NetBIOS over TCP/IP—as long as it supports the NetBIOS interface as defined in the RFC 1001/1002 specification. For example, you can't access files from a Unix system that supports TCP/IP but not NetBIOS. But because so many systems, especially Unix systems, support TCP/IP, and because it is relatively easy to add NetBIOS support to such systems, the possibilities for networking these machines are substantial. ■

William Stallings is president of Comp-Comm Consulting in Pride's Crossing, Massachusetts. This article is based on material in his Handbook of Computer Communications Standards, Vol. III: DoD Protocol Standards, *2nd ed. (Howard W. Sams, 1988).*

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LAN-Aware DOS Programs

Multiuser design: issues and strategies

Barry Nance

Most DOS programs rely on DOS disk services and thus will work with a LAN that emulates those services. But the remote disk that a LAN provides is also a shared disk. Unmodified single-user programs tend to fare badly in the multiuser LAN environment. Data files are updated haphazardly; one user's configuration options are overwritten by someone else; the software crashes at mysterious times; users collide when they access files; performance suffers when dozens of users simultaneously load programs and data files.

LAN-aware software recognizes and understands shared disks, shared printers, and shared files. The software anticipates and correctly handles concurrent accesses and concurrent updates to files. It flexibly allows different drive letters and directory paths. It provides configuration options for each user. It is compatible with any LAN that supports the sharing and access mechanisms that have been part of DOS since version 3.0. In this article I'll discuss ways in which you can transform a single-user DOS program into a multiuser, LAN-aware DOS program.

Testing the Waters

For your development work, you'll need access to a LAN with a DOS 3.x-compatible network operating system that can share files, lock records, recognize network drives, and obtain machine names. (Or you can emulate a LAN using the freely distributed program described in the text box "Testing LAN Software Without a LAN" on page 228.) If you'll be doing advanced network programming using NetBIOS, you'll want the network operating system to provide a NetBIOS emulator that's compatible with the IBM NetBIOS standard.

You should also upgrade to DOS 3.3 if you haven't already done so. The networking support in earlier versions of DOS suffered from omissions and bugs. Why not go all the way to 4.0? For the same reason—too many bugs. When you're doing development work, operating system bugs are the last thing you need. Get version 3.3.

The environment your program will find itself running in should correspond to your development environment. So the first thing your program should do is check the version of DOS. If it discovers a version earlier than 2.0, it should definitely tell the user to upgrade. If the version is 2.x, it should probably do the same. Although Novell's networking support for DOS predates the support added by IBM/Microsoft in DOS 3.0 and thus will work with DOS 2.x, your program shouldn't rely on that peculiarity.

Turbo C and Microsoft C both place the DOS version in the global variable `_osmajor`. In Lattice C, it's `_DOS[0]`. In Turbo Pascal, use the function `DosVersion`. With Microsoft Macro Assembler, use the `GetVer` macro found in DOS.INC.

Next, your program needs to check for the presence of a LAN. One approach, illustrated in listing 1, is to try to exercise SHARE, a DOS utility that attaches itself to the DOS multiplex interrupt 2Fh and enables file sharing. If you find a pre-DOS 3.0 version, though, don't use this method or you'll crash the machine.

You can also look for NetBIOS. Interrupts 2A and 5C (not to be confused with DOS function call 5C) are the entry points for NetBIOS services; here's how you check for NetBIOS:

```
regs.h.ah = 0;
int86(0x2a, &regs, &regs);
if (regs.h.ah == 0)
  puts("NetBIOS not
       installed.");
```

Note, though, that NetBIOS is not a required feature of a LAN.

A DOS IOCTL call (function 44h, subfunction 9) is yet another way to detect a LAN; it tests whether a drive is local or remote. To use it, put the number of the logical drive in the BX register (1 = A:) and do the call. If bit 12 of the DX register is a 1 following the call, the drive is a network drive. Do this for all possible drives (C through Z), as shown in listing 2.

There's one problem with the IOCTL method. It can't discriminate between a network drive and a CD-ROM drive. Both look like remote drives to DOS. There's a set of MSCDEX (Microsoft CD-ROM extension) function calls that can help here. Interrupt 2F is the entry point for the MSCDEX functions. Function 15h, subfunction 0, returns in BX the number of drives mapped to CD-ROM devices. If BX is 0 after this call, don't worry about CD-ROMs. If it's non-0, though, things can get complicated. CX will be the first CD-ROM (e.g., 3 = D), but there may be multiple CD-ROM drives. Function 15h, subfunction 0Bh, checks if a drive is a CD-ROM drive, and subfunction 0Dh gets a list of all the CD-ROM drive letters. Unfortunately, only the newer version (2.0) of MSCDEX.EXE supports the additional query subfunctions 0Bh and 0Dh. If your application detects a CD-ROM—there aren't many of them in use yet—the best course might be to ask the user to tell you which drives are CD-ROMs.

Of these tests, I've found that the test for SHARE is necessary to ensure that file sharing is enabled and that the test for network drives is a reliable means of detecting a network.

Identifying the User/Workstation

Your program will need to distinguish the machine it's running on from other workstations on the network. To do this, use DOS function 5E00 to get the net-

continued

Testing LAN Software Without a LAN

If you don't have a LAN but want to do LAN programming, or if you have a LAN and want a controlled file-sharing and record-locking environment for testing purposes, you can use a program called NETWORK to simulate a LAN. NETWORK supports the following features:

- Machine name requests
- Sharing-retry-count/delay IOCTL calls
- Network drive identification
- File sharing between your computer and a separate pseudo-workstation (for testing access mode, sharing mode, and inheritance)
- Record locking/unlocking between your computer and a separate pseudo-workstation

While your application is running, you can call up NETWORK and tell it to open one of your files just as if NETWORK were a separate workstation. Your application can use any combination of access mode, sharing mode, and inheritance, and it can lock and unlock records.

Editor's note: *NETWORK is available on disk from BYTE (see page 5 for details). It can also be downloaded from the "listings" topic of the lans conference on BIX. After logging onto BIX, join lans/listings and download NETWORK.DOC and NETWORK.EXE. The same files are available on floppy disk from the author. Please specify 5¼-inch or 3½-inch format. Send your name, address, and $15 (check or money order) to cover shipping and handling to Barry Nance, 47 Cider Brook Dr., Wethersfield, CT 06109.*

work name of your program's machine.

```
char machine_name [16];
regs.x.ax = 0x5e00;
regs.x.dx = /* for small
      model */
 (unsigned) machine_name;
int86(0x21, &regs, &regs);
if (regs.h.ch == 0)
  puts("No machine name.");
```

If the machine name was never set, this function returns 0 in the CH register. Otherwise it returns a 15-byte name in ASCIIZ (null-terminated) form; Pascal programmers will have to do a little jiggling to set the length of the string. The name will be padded on the right with spaces to fill out the 15 bytes. With some LANs, such as Novell's, the machine name is optional. I'd recommend that your application require users to set the machine name. It's a piece of information your application can use to good advantage—for example, to create user-specific configuration files.

File Locking

Beginning with DOS 3.0, you specify how you want to share a file when you open it. There is also a function for creating a new file that guarantees that some other workstation won't be able to create a file of the same name at that same moment (DOS function 5B).

When you open a file, either by calling DOS directly or by means of facilities provided in your programming language, you can specify three kinds of properties: access mode, sharing mode, and inheritance. If your language doesn't let you specify these, you'll probably need to code some assembly routines that let you call DOS directly.

You specify the inheritance flag, sharing mode, and access mode by setting the AL register prior to the open, as shown in listing 3. The inheritance flag is significant only if you are planning to spawn other programs; it indicates whether or not a child process can access the file.

The access and sharing modes work hand-in-hand with the read/write attribute stored in the file's directory entry. Access mode tells DOS (really, the network operating system) whether you intend to write to the file. If you don't need to write to the file, opening it with a read access mode gives you two advantages: There can be multiple readers, and, if the file's directory attribute is read-only, workstations can buffer the file locally.

Sharing mode lets you control how other workstations can open the file once you've opened it successfully. For example, an open call that specifies deny-read/write mode succeeds if no other workstation has the file open and, if successful, confers exclusive control of the file. Of special interest is the deny-none mode. It allows multiple workstations to open the file and defers control of concurrent reads and writes to the record-locking functions discussed below.

Compatibility mode, generally, is an exclusive mode. It's set automatically when a file is created (rather than opened) or when you use file control blocks instead of file handles. You should avoid setting compatibility mode yourself when opening files. You should also avoid using file control blocks in LAN-aware software.

When you create a file with either the regular DOS function (3C) or the new one (5B), you are given exclusive access to the file. If you want to share it with another workstation, you'll have to close the file and then open it with a suitable sharing mode.

Record Locking

Most of the sharing modes allow you to keep other workstations from accessing a file for the entire time that it's open. However, if you open the file in deny-none mode (and all other workstations have it open in the same mode), you can truly share the file among all users. Concurrent updates become possible, so you'll want to protect a file (or certain records within it) from collisions resulting from simultaneous I/O. DOS function 5Ch—lock/unlock a file region—provides for this. With it, you can lock (or unlock) a given range of bytes in the file, starting at a specified file position (position 0 is the first byte). Listing 4 shows how to lock a range of bytes.

If a collision occurs when you read or write a record, DOS returns an error code to you and the I/O you requested does not take place. If you expect heavy traffic and frequent collisions, there is a DOS IOCTL call (440B, set sharing-retry-count/delay) that you can use to fine-tune the way DOS handles collisions before returning an error to you. With this call, you specify how many times DOS should retry the operation and how long it should wait between tries. The defaults are delay = 1 and retries = 3, where one delay period is a simple (MOV CX, 0; LOOP $) instruction sequence.

In Turbo Pascal, to set the delay period to two loops and tell DOS to retry six times before calling it quits, you would specify

```
Regs.ax := $440b;
(* Set 1 Delay period =
```

continued

Listing 1: *Detecting a LAN—the SHARE.EXE method.*

```
In C (most compilers):

if (_osmajor < 3)
     printf("Can't check for SHARE.\n");
else
    {
    regs.x.ax = 0x1000;
    int86(0x2f, &regs, &regs);
    if (regs.h.al != 0xff)
       {
       printf("SHARE.EXE (file-sharing support) is not loaded.\n");
       exit(1);
       }
    }


In Turbo Pascal:

If OS_Major < 3 Then
   Begin
     Writeln('Can''t check for SHARE.');
     End
Else
   Begin
     Regs.ax := $1000;
     Intr ($2F, Regs);
     If Regs.al < > $FF Then
        Begin
          Writeln('SHARE.EXE (file-sharing support) is not loaded.');
          Halt;
          End;
     End;
```

Listing 2: *Detecting a LAN—the DOS IOCTL method.*

```
remote_drive_present = 0;
for (i = 3; i <= 26; i++)
    {
    regs.x.ax = 0x4409;
    regs.x.bx = i;
    int86(0x21, &regs, &regs);
    if ( (regs.x.dx & 0x1000) == 0x1000 ) /* drive remote */
         remote_drive_present = 1;
    }
```

```
   2 Loops *)
Regs.cx := 2;
(* Double the default number of
   retries *)
Regs.dx := 6;
MSDOS(Regs);
```

Suppose you have a homegrown B-tree file-access method (each data file has a corresponding index file) that you want to enhance so that it can handle multiple users. When workstation A rewrites a data record, do you have to lock the index file even though you're not updating the index? Yes, because workstation B may want to add a new record (and a new index entry) at the same moment, and B will try to lock both data and index files. In fact, to prevent deadlock, it's important that you successfully acquire *all* necessary locks before proceeding with the actual I/O operations on a set of related files.

Ideally, you want your file-access method to function in either a single- or multiuser environment. The following is an outline of the changes you would make:

1. Detect the presence of the LAN in your initialization logic. Set sharing-retry-count and retry-delay.
2. Open files in a sharing mode if you're running on a LAN.
3. If the file contains a control record, read it on each access; don't try to store it in memory between accesses (this work station is not the only one that will update the control record).
4. When doing I/O to the data or index files, acquire a lock on the entire file (length in SI:DI = FFFFh:FFFFh) for the duration. Why the entire file? Because nodes in an index can be split by additions or coalesced by deletions. And even if you're only doing a read operation, another workstation may want to split a tree node at the same moment.
5. Make sure that the lock has been successful before doing any further I/O on the file.
6. Unlock the file region when you're through.

User Locking

When the application retrieves one or more records, displays them on the screen, and begins accepting keyboard input from the user, it's intuitively clear that physieal record locking is an inadequate method of collision protection while input data is being entered. Physical record locking is useful only for those moments when actual I/O is being performed on a file. It's unfair to other users to physically lock records in a file during keyboard-entry time, and there's no guarantee that users will actually fulfill their intention of updating those records.

The solution is to implement a user lock facility at the application level. Such a facility makes use of a centralized control file on a file server, in which records representing user intentions and fulfillments are placed. This scheme makes it possible for the application, running on several workstations, to coordinate with itself.

The control file might look like the following:

Field	Purpose
User ID	Machine name of user doing an update
File ID	File the user intends to update
Key	Identifies the record(s) that are affected by the update
Transaction	Code identifying the type of update
Date/Time	Date-and-time stamp
In-progress	1 while update is in progress; 0 when finished

When a user signals an intention to enter new or changed information, the application does the following:

1. Physically locks the control file.
2. Looks to see if it's OK for the user to proceed (i.e., checks to see if there's an entry in the control file that shows that another user already has something in progress).
3. If there's a conflict, unlocks the file and returns a "not available" indication. (If the date/time stamp is quite old, the record may be obsolete. These will need housecleaning and should not cause conflicts.)
4. If it's OK, inserts an entry in the

continued

Listing 3: *Access mode, sharing mode, and inheritance.*

```
< 8 7 6 5 4 3 2 1 >          (bit 4 always 0)
  |     |     |__|
  |     |        |______ Access: 000 = read, 001 = write, 010 = read/write
  |     |
  |     |_______________ Sharing: 000 = compatibility mode
  |                               001 = deny read/write (exclusive)
  |                               010 = deny write
  |                               011 = deny read
  |                               100 = deny none (fully shared)
  |
  |_____________________ Inheritance: 0 = inheritable; 1 = not inheritable
```

Listing 4: *Locking a range of bytes.*

```
regs.h.ah = 0x5c;
regs.h.al = 0;              /* 0 to lock; 1 to unlock */
regs.x.bx = file_handle;    /* returned by open() */
regs.x.cx = 0;
regs.x.dx = 499;            /* CX:DX = position in file */
regs.x.si = 0;
regs.x.di = 100;            /* SI:DI = byte count to lock */
int86(0x21, &regs, &regs);
if (regs.x.flags & 0x0001 == 0x0001)    /* Carry Flag check */
   puts("Could not lock record.");
```

control file for this user, unlocks the file, and proceeds with the update.

Then, when the user finishes by causing the data to be written to disk (with appropriate physical locks on the records/files as the I/O takes place), his or her entry in the control file can either be deleted or, if an audit trail is desired, copied to a separate file and then deleted. Deletion can take the form of marking the control file record as "finished" and therefore available for reuse.

If one workstation discovers that the control file has an entry from another workstation that prohibits a given update at this time, it's relatively simple to tell the user to try again later. But what happens if a physical lock needs to be established and DOS returns "Access Denied" to the application? No matter how you tune sharing-retry-count/delay, you still must account for the possibility that a locked region of a file may become inaccessible because of a network operating system bug, server problem, or other odd problem.

My suggestion is that you implement your own automatic retry logic, to augment the sharing-retry-count/delay settings. But if, after a time, a lock still cannot be acquired, you should abort the current process as gracefully as possible. Close any open files and inform the user at the workstation that a significant error has occurred that will require the attention of a system administrator. It may even be necessary, for example, to broadcast a message telling all the users to log off so that the servers can be restarted.

Final Tips

From a multiuser point of view, one of the most devastating things that a program can do is store configuration data back inside the executable file itself. This scheme has two problems: First, you can't store individual configurations; second, you can't make the executable file shareable and read-only. Don't do this.

Wherever possible, avoid the temptation to write code that is specific to a particular network operating system. If you decide, for example, to use Novell's Transaction Tracking System—a facility for grouping sets of database updates into atomic operations—be aware that you'll have to substitute your own such facility to make your software available to non-Novell users.

Identify each file—including executable files—in your application and specify, on a file-by-file basis, the kinds and the extent of sharing that your application will provide. Test your collision handling as thoroughly as possible. If you follow these suggestions, your programs should run happily in a networked environment. ■

Barry Nance works in the R&D department at Programming Resources Co. in Hartford, Connecticut. He can be reached on BIX as "barryn."

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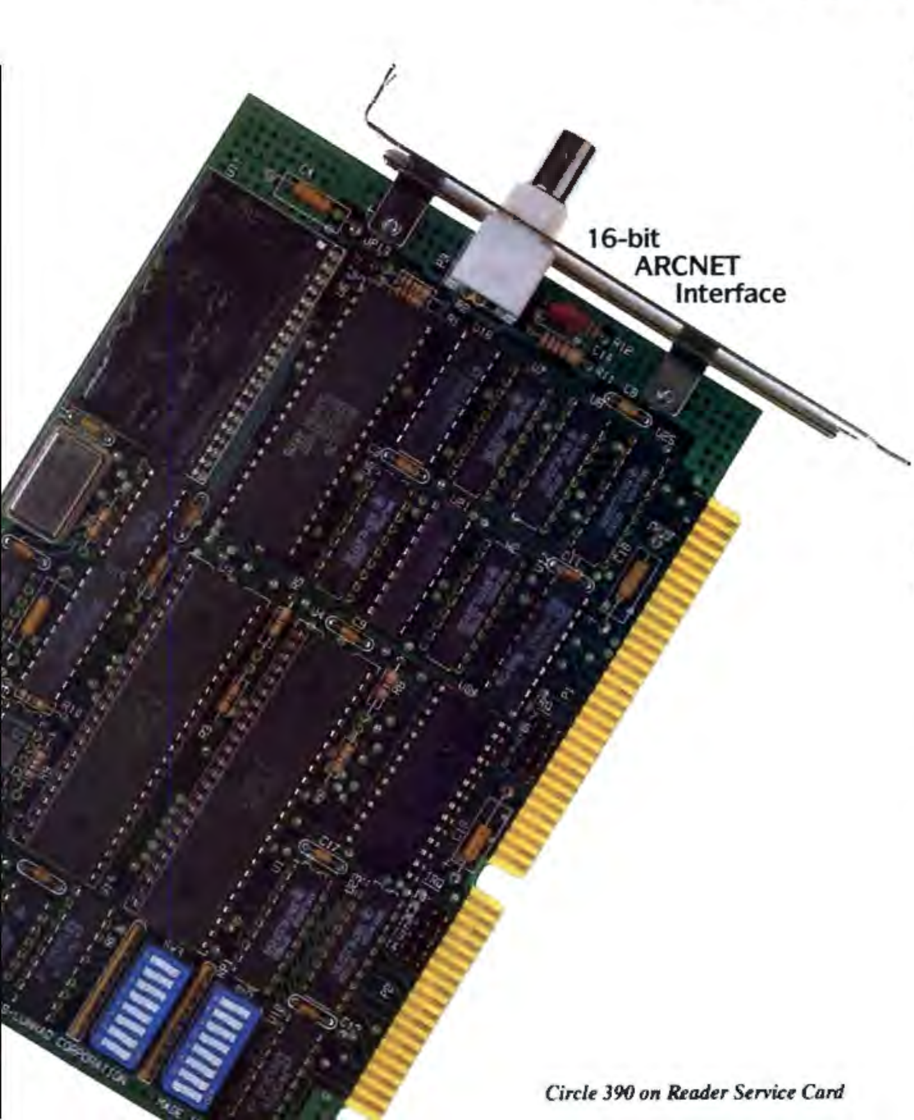

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Building Heterogeneous Networks

L. Brett Glass

Practical advice on the formidable task of networking dissimilar systems

Creating a heterogeneous network—a network consisting of machines made by more than one vendor—is one of the most common and challenging problems confronting personal computer buyers today. Computer manufacturers support different sets of network standards; many (most, in fact) even seem to try to limit users' choices to discourage them from using other vendors' hardware. In this article, I'll address the problems I'm most often called upon to solve in my consulting practice—those that relate to choosing physical media, protocols, and software for a multivendor network.

Choosing a Physical Medium

One fundamental choice you'll have to make when planning a multivendor network is the physical medium to use. Each major standard has something to recommend it. Ethernet, for instance, has the widest support among different vendors. Token Ring has the largest number of new installations in IBM PC-compatible systems and can span larger physical distances, but it's more costly; adapters are still in the \$400 to \$600 range. ARCnet, which uses chips and hybrids that are farther down the "learning curve," has the best cost-to-bandwidth ratio of the greater-than-1-megabit-per-second LANs. And Apple's LocalTalk, an order of magnitude slower, is one of the cheapest; it runs off the Mac's existing serial ports, and an adapter card for an IBM or Sun is relatively simple and inexpensive.

In some cases, your choice of medium may be limited by the selection of peripheral cards or software available for one of your machines. IBM, for instance, has been slow to support Ethernet in its zeal to promote its own Token Ring. But Token Ring cards aren't available for many other brands of computers, so—in response to consumer demand—IBM is grudgingly providing Ethernet drivers in system software such as OS/2 Extended Edition 1.2. (Ironically, you still have to buy a card from a third party, such as Western Digital, to use this software.) When it arrives, Fiber Distribution Data Interface (FDDI) will be a good choice for harsh environments and high data rates, but because the standard is not yet complete, the equipment you buy today may not be compatible with the final version.

Finally, your choice may already have been made for you. Your building may have existing coaxial cable or twisted-pair wiring, and the cost of installing more wires may be prohibitive. Fortunately, many network standards now support several different kinds of media. ARCnet, for example, is available on twisted-pair and 92-ohm coaxial cable, and Ethernet can be used with thick coaxial cable, thin coaxial cable (Cheapernet), and twisted-pair (10BASET).

It's often possible to convert wiring for use with a different network standard by using a device called a *balun*. A balun (the word is a contraction of "balanced" and "unbalanced") allows equipment intended for twisted-pair media to run on coaxial cables or vice versa. Thus, if your building is wired for Token Ring, you may still be able to use Ethernet equipment on that wiring.

Picking a Protocol Suite: Open or Proprietary?

The next (and hardest) choice you'll need to make is what suite of protocols and whose software to use on your network. Network protocols fall into two broad categories: proprietary standards, developed and sold by a single vendor or a small group of vendors, and "open" standards, supported by many companies and usually standardized by industry groups such as CCITT, IEEE, ANSI, and ISO.

In the microcomputer world, the open standards most worthy of note are TCP/IP and the ISO protocol suite, which is still under development. Because the latter is not yet finished or widely implemented, TCP/IP is likely to be the best choice in this group until the middle of the next decade.

Among the proprietary protocols, Novell's IPX controls the lion's share of the IBM PC-compatible market, while others (including IBM) provide networks based on MS-Net, NetBIOS, APPC, and/or LU 6.2. Apple's AppleShare (provided as part of the system software) and Sun's TOPS are popular on the Macintosh. Both these vendors seek to provide connectivity to several different kinds of machines; however, since only they (or their licensees) can do a port to different hardware, you may be left waiting for software or upgrades. In some cases, hardware and software gateways to networks that speak other protocols are available from third parties or from the vendors themselves.

Peer-to-Peer or Server-Based?

Another important consideration you'll need to address when designing your network is whether you want a peer-to-peer network (in which any machine can share resources with any other) or a server-based network (in which only servers share resources). Each has its pluses and minuses.

One common problem of server-based networks has to do with turning machines off and on. As long as the server is up, it doesn't make any difference if one user shuts off or reboots a machine. The same action on a peer-to-peer network

continued

could disrupt other people's work. On the other hand, a single-point failure at a server in a server-based network can bring an entire office full of workers to a screeching, expensive halt.

Server-based networks have advantages from a security standpoint. If your server is secured (say, in a locked room) and protected by passwords from illicit access, it's hard to steal data from it. But in a peer-to-peer network, users may be able to snoop on one another—and it may be easier to obtain physical access to a machine that contains critical data. It's also easier to perform backups if most, or all, of the information that needs to be backed up is kept on a server.

The choice between server-based and peer-to-peer networks is critical in a multivendor environment because many vendors offer *only* client or server software for certain kinds of hardware. TOPS, for instance, offers peer-to-peer connectivity between Macintoshes and PCs but only server capabilities for Suns. Other companies offer NetBIOS implementations for minicomputers and mainframes but allow them to act only as servers despite the usual peer-to-peer nature of NetBIOS networks. Novell offers only server-based networks.

As if things weren't complicated enough, you'll find that some of the server-based network packages require dedicated servers while others do not. Proponents of server-based networks claim that having a dedicated server provides performance advantages, but in fact it's not clear that this is so. A dedicated server may be able to devote a lot of computing power to its one job, but the combined contributions of several nondedicated servers may prove superior.

Filenames and Formats: Smoothing Out the Differences

One especially important problem you'll need to deal with in a heterogeneous network is how—or whether—it can handle the differences between various operating systems' filenames and formats. Table 1 shows three examples of file-naming conventions. A filename in IBM's PC-DOS has up to eight characters followed by an extension of up to three characters; Unix filenames allow up to 256 characters, and Macintosh names up to 32. Each operating system allows and prohibits different characters in filenames; thus, accessing a file on a different kind of machine may require you to type a filename that's "illegal" on your system. What's more, the characters used to indicate a directory ("/" in Unix, " \ " in DOS, and " < " and " > " in TOPS-20) may be prohibited on other machines. Most network software attempts to solve these problems—either by maintaining multiple names for each file or by performing algorithmic translation—but alas, few of these schemes are graceful. And if a server supports n naming conventions at once, n separate directories or $2n^2$ conversions will potentially be required.

File formats present yet another obstacle to connectivity. Sharing files with another machine isn't much use if you can't read them, yet even the formats of simple text files differ from machine to machine. On the IBM PC, Atari ST, DEC-20, and VAX side, each line ends with a carriage return and a linefeed. Unix and the Amiga use a linefeed only; the Mac uses only a carriage return. The results can be confusing: When I recently tried to open a DOS text file from MacWrite on a networked Mac, I discovered a strange "block" character (which turned out to be a linefeed) at the end of each line. To complicate matters still further, Mac files have two "forks"—a data fork and a resource fork—which essentially make them two files in one.

Fortunately, some software products, such as Microsoft Excel and WordPerfect, ease these differences by supporting a single file format across all architectures. (Some even support other vendors' formats; Macintosh Excel, for example, can read files produced by Lotus 1-2-3 on an IBM PC.) But in the majority of cases, you'll need a way to convert your files, and the conversion process may cause information to be lost. For this reason, it may be impractical to share the same copy of a file between two genres of machines; you might have to work on, say, a spreadsheet on only one machine and send text file output across the network to others.

Table 1: *Examples of operating-system naming conventions for files, directories, and folder names. Note the diversity that must be accommodated when you try to share files among dissimilar systems. (Courtesy of TOPS)*

Operating system	Conventions
DOS	Up to 8 characters, optional 3-character extension; no blank spaces; cannot use " / \ [ ] : ¦ < > + = ; , * ?
Unix	Up to 256 characters; blank spaces OK; cannot use / Avoid $ ' * ? ! # { } [ ] " ( )
Macintosh	Up to 31 characters; blank spaces OK; cannot use colons

Peripheral Access, E-Mail, and Mainframe Gateways

Most LANs provide ways to share peripherals, but sharing devices in heterogeneous networks can pose special problems. For instance, you probably won't be able to print Macintosh graphics on an IBM Graphics Printer attached to an IBM PC even if the two can share the printer via the network. Likewise, an IBM PC program can use a PostScript driver to print graphical output on an Apple LaserWriter and a C. Itoh ProWriter driver for the Apple ImageWriter, but it probably won't be able to use a QuickDraw printer. Fax cards may not understand graphics file formats intended for a machine they don't plug into directly. And shared modems aren't supported across some networks.

Often, you can get network software from the same vendor who wrote your network software; some, such as TOPS's InBox, span more than one kind of machine. Still, the protocols used by almost all E-mail systems are unique to the vendor that provides them. However, only TCP/IP's SMTP (Simple Mail Transfer Protocol) and the emerging CCITT X.400 standard are likely to be available from many vendors; if you're building a heterogeneous network, it pays to insist on having such a protocol available.

One of the most asked-for features in heterogeneous LANs is a way to get to the big behemoths: software that will let you emulate a 3270 or other mainframe terminal and transfer files back and forth. Fortunately, almost every computer and/or network vendor addresses the problem—some with special hardware for each machine, and some with gateways that concentrate data from LAN workstations at a central server before passing it on to the mainframe.

Some Real-World Products

In the sections that follow, I'll discuss the specifics of some popular network offerings and point out some key advantages and disadvantages relating to heterogeneous networks. While this isn't intended to be a review or even a comprehensive survey, the products I'll mention

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are representative of what's available in the marketplace as a whole.

• *AppleShare*—AppleShare is Apple Computer's own server-based network protocol. It lets Macintoshes share files on an AppleShare server via either EtherTalk (AppleTalk on Ethernet media) or LocalTalk (AppleTalk on twisted-pair). Peer-to-peer communications are possible using lower-level AppleTalk protocols, but peer-to-peer file sharing is not supported.

Apple—like many other companies with proprietary protocols—is now beginning to release implementations for other vendors' hardware. AppleShare client software will soon be available for IBM PCs; server software is available for the VAX family running under VMS.

Third parties have also written AppleShare implementations (e.g., Novell; see below); others have created hardware gateways that let AppleShare clients access servers on other kinds of networks. Notable among these units is the GatorBox from Cayman Systems, which translates AppleShare requests into NFS requests and transmits them to an NFS host. This lets any machine running the NFS protocol act as an AppleShare server.

• *NetWare*—Novell's NetWare holds about 50 percent of the IBM PC LAN market. In the IBM world, NetWare uses two proprietary protocols, called IPX (Internet Packet Exchange) and SPX (Sequenced Packet Exchange), that are somewhat similar to Xerox's XNS protocols.

NetWare has always supported a wide variety of media, including ARCnet, Ethernet, and the Token Ring. The Novell server software is also quite elaborate and includes provisions for disk mirroring, backup, and E-mail. But until recently, NetWare ran *only* on the IBM and its clones. This changed with the advent of NetWare for VMS, which lets a VAX running under VMS act as a NetWare server.

Last December, Novell announced NetWare for the Macintosh. (Developed in cooperation with Dayna Communications, this product is also marketed as DaynaNet, a less expensive solution that offers fewer options.) And earlier this year, Portable NetWare, a version of NetWare designed to be ported to many machines, made its debut. Numerous ports are reputed to be under way to systems manufactured by such companies as Data General, NCR, Prime, Unisys, Northern

continued


USSMSG10: MAINFRAME 0013: Enter Applicaton
E-Mail
USSMSG2: R70302 E-MAIL COMMAND UNRECOGNIZED
E-Mail PLEASE!
USSMSG2: R70302 E-MAIL COMMAND UNRECOGNIZED
E-Mail PRETTY PLEASE!!

Telecom, and Sun Microsystems.

Novell's networks are server-based, rather than peer-to-peer, networks. Each network must have at least one server (although a few versions allow it to be nondedicated), and only resources attached to the server can be shared.

Novell's VAX offering is a server-only implementation. PC users can share files on the VAX, use the VAX's printers, log onto the VAX with a terminal emulator, and even use a VAX's DECnet connection to access other VAXes. The VAX, however, cannot access files or peripherals on PC-based NetWare servers.

> *NetWare supports a wide variety of media, including ARCnet, Ethernet, and Token Ring.*

NetWare also supports the Macintosh, but with some limitations. PC-based servers running version 2.15 or higher of NetWare can act as AppleShare servers as well as IPX servers; Macs and PCs attached to the server can use the same files. The server can also control an AppleTalk printer (such as a LaserWriter) and allow clients on both the AppleTalk and IPX sides to access it. It's also possible to use a NetWare network to carry AppleTalk packets from one AppleTalk network to another; AppleTalk packets are encapsulated in IPX packets and routed through the Novell network.

NetWare makes no attempt to translate files between Macintosh and PC; if the formats are not compatible, it's the user's responsibility to find a way to convert them. Filenames are handled with a dual-directory approach; separate directories are maintained for each file system, and changing the name of a file on the PC side may not cause it to be changed on the Mac side (a special utility is needed to do this). The resource forks of Macintosh files are invisible to DOS.

Unfortunately, the PC-to-Mac connectivity is not complete. PC clients cannot use the NetWare server as a gateway to access files on an AppleShare server, nor can they communicate directly with Macintoshes. But for many uses, the connectivity Novell does provide is more than adequate.

Novell's offerings will doubtless expand to cover a wide variety of media on many manufacturers' machines; where they now exist, they offer clean, prepackaged solutions to many networking problems. However, since NetWare is based on a proprietary standard, there's no way to go to a third party or implement it yourself, and you will probably not have a choice of implementations for a given machine, as you might with a nonproprietary protocol. Finally, if you own large numbers of machines that will probably not be supported soon (e.g., Amigas or Atari STs), you may be forced to choose another solution altogether.

• *TOPS*—The brainchild of Nat Goldhaber and Michael "Flash" Pflumer, TOPS is a network operating system specifically designed for heterogeneous LANs. (The acronym TOPS, which stands for Transcendental Operating System, reflects this.) Their company, originally called Centram, was bought by Sun Microsystems, which runs it as a separate division.

TOPS is built on the AppleTalk protocol suite and uses the standard media supported by AppleTalk: LocalTalk cabling and Ethernet. In systems equipped with special hardware (a card called the FlashCard for the PC or an add-on called the FlashBox for the Mac), TOPS can also run FlashTalk, a sped-up version of LocalTalk.

Unlike NetWare or AppleShare, TOPS is a peer-to-peer network. Any computer can "publish" files and peripherals for use by others and can "mount" resources that other stations publish. TOPS supports two types of media: Apple's LocalTalk cabling system (with an optional fast protocol that requires special hardware) and Ethernet. Because the lower layers of the TOPS protocol suite are the AppleTalk protocols, Media Access Control (MAC)-layer bridges designed for AppleTalk (like the Kinetics FastPath) will work properly with TOPS. However, while Macintoshes equipped with a copy of TOPS can access AppleShare servers, ones that don't can't access a TOPS server.

Currently available are full-blown versions of TOPS for the IBM PC and Macintosh and a server-only version for the Sun. These are the only versions TOPS itself produces. However, third-party TOPS server software is available for VAXes running VMS and Unix, and

continued

We think that NetCommander is a better low-cost LAN alternative than any of these competitors.

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BayTech Model 24
Data Manager 4 × 4
FocalPoint Plus
Bytelink
Western Telematic INC-64

Buffalo SL
The Logical Connection
Equinox Alternet
Alliance
Rose Master Switch
Commix 32

Of course, you are entitled to a second opinion:

PC MAGAZINE
EDITORS' CHOICE
July 1989
NetCommander NC-16

"The clear choice for a highly complete and flexible system goes to the NetCommander NC16 from Digital Products. Aside from handling the usual tasks of device sharing and file transfers, this system also offers virtual disk drive capabilities that work well, and it can even provide such unique features as IBM 3270 access and automated tape backup. Its maximum speed of 115,200 bits per second gives it excellent throughput performance for large networks...."

"Data Switches: A Low-Cost LAN Alternative"
July 1989 PC Magazine

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Novell is readying a driver that will let TOPS users access a Novell server.

What if you want to access files on some other type of machine from a TOPS workstation? One way is to use a third-party TCP/IP package that can coexist with TOPS. Two such products are TOPS Terminal (developed at the University of Oregon) and NCSA Telnet (from the National Center for Supercomputing Activities). Another way is to use a Sun running both TOPS and NFS (a file-sharing protocol that runs under TCP/IP) as an NFS gateway. If the Sun publishes a resource to which it has gained access via NFS, that resource becomes available on the TOPS network. It may also be possible to run TOPS on an IBM PC concurrently with other network software, thereby turning the PC into a gateway, but you'll have to experiment to see if this will work in your system.

• *NetBIOS*—The IBM PC NetBIOS (see "Understanding NetBIOS," January BYTE) is actually an Application Program Interface (API) rather than a network standard. This means that there is no written standard for the format of the packets that travel across the physical medium (although some are emerging; see below). You must generally run the same manufacturer's NetBIOS at every station on a segment of a LAN to ensure that the nodes can talk to one another.

Many brands of network software, such as NetWare and TOPS for the IBM PC, provide NetBIOS emulation, which lets programs written for the NetBIOS API run on these networks. But NetBIOS was really intended for use in peer-to-peer networks based on MS-Net; the IBM PC LAN Program and CBIS's Network OS are two such products. MS-Net uses NetBIOS (which operates on the MAC and Session layers of the OSI model) and adds an Application-layer protocol called SMB (Server Message Block). This combination allows transparent sharing of files and peripherals among MS-DOS machines.

Because the lowest layers of NetBIOS implementations differ, there are three ways to use NetBIOS in heterogeneous networks. The first way is to use a NetBIOS implementation that's painstakingly reverse-engineered to use the same low-level protocols as IBM's products. The second way is to buy a NetBIOS for the PC together with matching software for the non-PC machine (e.g., a VAX); the matched set of programs will, presumably, be designed to communicate correctly. Another way is to use the newly emerging "NetBIOS over TCP/IP" standard. This standard, set forth in two Internet documents (RFC 1001 and RFC 1002), presents a standard way of translating NetBIOS calls into TCP/IP transactions. Because TCP/IP is a nonproprietary protocol available on many machines, the latter solution is appealing; many organizations are embracing this standard and writing their own applications that communicate with PCs using TCP/IP over NetBIOS.

• *TCP/IP*—A protocol suite developed for use on a government and research network called the Internet, TCP/IP is the most widely implemented nonproprietary network protocol. It's the most common protocol at universities, which often have computers from hundreds of different vendors on the same network. TCP/IP networks at trade shows such as InterOp and UniForum, comprising many vendors' machines, have been assembled in a matter of days. [Editor's note: *For more about TCP/IP, see "The Glue for Internetworking" on page 221.*]

Unlike the products I've already mentioned, TCP/IP doesn't usually come as a "plug-and-play" solution. You will probably have to buy a version for each type of machine you want to connect from a different vendor, and you'll need to know how the protocol works in order to get the network up and running. But the extra diligence required to assemble a TCP/IP network pays off; you'll be able to connect virtually any machine that supports networking to any other.

TCP/IP packages typically come with several standard applications. These include TELNET, which lets you log onto a remote machine through the network; FTP (File Transfer Protocol), which lets you transfer files to and from another machine; and SMTP (Simple Mail Transfer Protocol), which transfers E-mail. You can share files via Sun's NFS and perform interprocess communications via Berkeley "sockets" or Sun's RPC (Remote Procedure Call) interface. The protocol suite also contains routing and gateway protocols that let you connect your LANs to WANs; not all proprietary systems are designed to grow to this level of complexity.

TCP/IP is available on virtually every machine that runs Unix. There are several implementations for the IBM PC under DOS (from FTP Software, Wollongong, Excelan, Sun, and others), and even one (KA9Q, written by Phil Karn of Bell Labs) that's freely redistributable and comes with source code. IBM, known for its lack of support for protocols it does not control, has announced TCP/IP products for its mainframes. There's even an Amiga version of TCP/IP, which has been used to good effect by scientists at SLAC, Stanford's linear accelerator.

Several universities (e.g., Stanford) and a few commercial sources (Kinetics, InterCon, and others) have developed implementations of TCP/IP for the Macintosh. Apple already has a TCP/IP product called MacTCP, and sources on the Internet report that Apple has acquired the rights to a compatible NFS implementation developed at the University of Michigan. Kinetics' FastPath can bridge AppleTalk and TOPS networks to Ethernets running TCP/IP; Cayman Systems' GatorBox can also do this and can provide a hardware gateway between AppleShare and NFS.

Assess Your Needs

There's no hard-and-fast solution to the problem of heterogeneous networks; designing them, installing them, and keeping them running requires patience, skill, and expertise. Which solution should *you* choose? The answer depends, of course, on your individual situation.

If you think your long-term needs will be met by a prepackaged solution, by all means use it; it may save you hours of shopping, mixing, and matching. But if no one package covers all the machines you want to connect, it will be well worth your while to look at more "universal" protocols such as TCP/IP, which enjoy widespread, if uneven, support from many vendors throughout the industry. ■

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Database Trends

There's a world of difference between where databases have been and where they are going. Databases are the major source of information in a computer system. Whether that information is your personal tax records, a small business's inventory, or a major corporation's sales activity, it is stored in some kind of a database. How that database should be organized and structured is a matter of considerable debate.

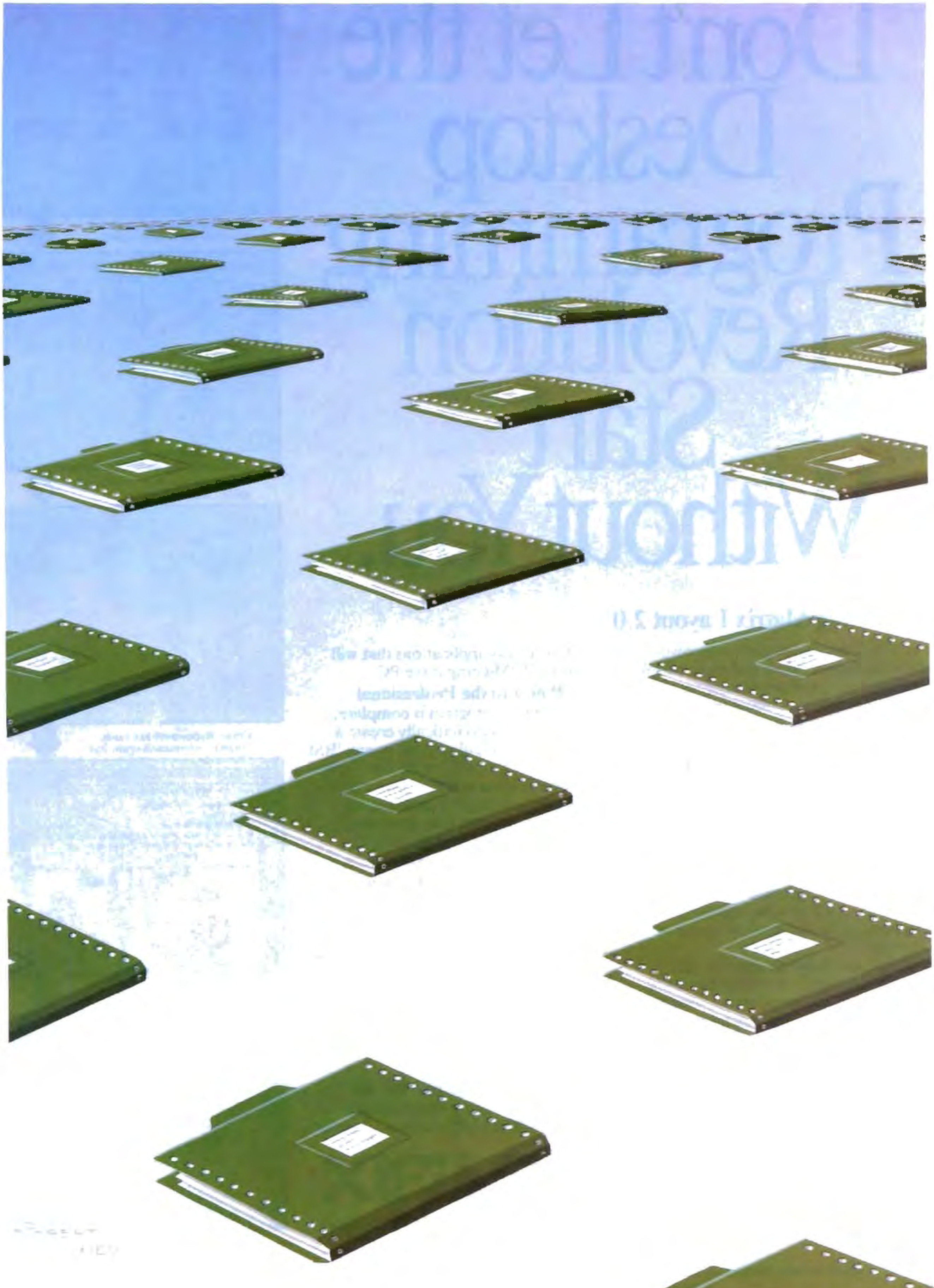
This month's In Depth section discusses the current trends in the microcomputer database world. In "A Brave New World?" Fabian Pascal discusses the changes that have been occurring recently with databases and delves into the popular relational model and Structured Query Languages.

In the past, most microcomputer databases have been of the stand-alone variety. Recently, however, with the popularity and proliferation of LANs, the problems of database incompatibilities among different microcomputers have become more pronounced. Two major approaches to the database on a network have been developed. In "Serving Up Data," Mark L. Van Name and Bill Catchings describe one of these approaches: the database server. In "Sharing the Wealth," Ralph Davis describes the other: the distributed database.

Where are databases going in the future? Basic changes in technology may lead us into uncharted waters. One area where the mapmakers are already at work is object orientation. While still on the drawing board, object-oriented databases are becoming more real every day. In "A Family of Models," Joseph Dawson describes some of the forms those databases may take.

And where is the In Depth section going in the future? As you read this, we are considering topics for In Depth coverage for the second half of 1990. So I'll turn that question around. Where do *you* think this section should go? What topics should we cover? What are your major concerns in computing? What do you want or need to know about? Please contact me at BYTE, One Phoenix Mill Lane, Peterborough, NH 03458, or on BIX as "janetaz."

—Jane Morrill Tazelaar
Senior Technical Editor, In Depth



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A Brave New World?

Exploit the relational power and the graphical, multitasking, and connectivity facilities of new database environments

Fabian Pascal

Progress comes at a price. Fundamental changes are occurring in database management as they are in the entire personal computer environment. And as new developments proliferate in both arenas, the interaction between the two becomes more and more unpredictable. Where this volatility will end is unclear. What is clear, however, is that when the dust settles—if it ever does—the ensuing database market will be much different than it has been in functional scope, in the types of demands placed on vendors and users, and even in the structure of the industry.

Databases are the basic corporate information source. Data is generated by and used in financial and manufacturing transactions, decision support tools, text and graphical documents, desktop publishing applications, and so on. Regardless of its purpose and origin, however, multiple users must be able to share a lot of the same accurate, consistent, up-to-date information efficiently and securely, no matter what it is or where it is. It is the task of database management systems (DBMSes) to facilitate this function.

Tradition hasn't equipped database management programs to fulfill this task effectively, no matter how easy they are to use. Corporate data suffers from incompatibilities across different computing platforms and even within the personal computer environment itself. There is a proliferation of different products, most of which were originally designed to work in stand-alone mode. They must properly address integrity, security, concurrency, and recovery issues, improve the power/ease-of-use ratio, minimize maintenance burdens, and maximize performance, especially over networks. Moreover, a variety of nondatabase software packages store and manage their own disparate data in different and unintegrated formats.

It's Tradition

Data management software has, to a large degree, been constrained by the 8088/DOS environment with its RAM (640K bytes) and disk (32 megabytes) limitations, single-user and single-tasking capabilities, and relatively sluggish processing speed and disk access. With the advent of the 80286 processor, enhancements and ways to work around these limitations have been devised. But these aren't fundamental changes. Moreover, the user interface is character-based and command-oriented.

But while the environment imposed limitations, database technology itself also caused many weaknesses in and incongruities between products. In fact, many popular so-called DBMSes are not

continued

DBMSes at all: They are *programmable filers* at the core, leaving most of the job of *managing* databases to the users and providing only unproductive tools to aid in the task.

First, except for the simpler tasks in accessing and manipulating data, you can't ask for the results you want directly. Frequently, you must create procedures (detailed sets of steps) that the system must follow internally to obtain those results. Moreover, where you want to perform a data operation—retrieval, update, or deletion—on multiple data records, you must iteratively loop the system over the records one at a time, keeping a count, until completion. In short, traditional database access usually requires some degree of programming skill.

Second, a great deal of the procedural detail consists of explicit references to internal storage structures, addressing mechanisms, and so on, which are irrelevant to logical database tasks. Thus, where traditional systems fail to support physical data independence for applications, they involve you in machine complexities and performance considerations, which most people are ill-equipped to handle and shouldn't have to bother with anyway.

Third, traditional database systems lack a theoretical foundation. Without the systematic functional guidelines that theory could have provided, products were developed ad hoc. The ensuing proliferation of different solutions to a general set of problems is a direct consequence. The products are proprietary: Despite some similarities, each one approaches the same data tasks in its own unique way.

Table 1: *The set of features composing the original relational model. Notice particularly the five types of integrity constraints that ensure data accuracy and consistency.*

A. Structural features
R-Tables
- Base (stored)
- View (virtual)
- Query (derived)
- Snapshot

Domains

Columns

Keys
- Primary (PK)
- Foreign (FK)

B. Integrity features
- Entity integrity
- Referential integrity
- Domain integrity
- Column integrity
- User-defined integrity

C. Manipulative features
Basic operations
- Assignment
- Project
- Restrict
- Product
- Union
- Difference

Derived operations
- Join
- Intersect
- Divide

Extended operations
- Outer
- Maybe
- Domain override

But Is It Practical?

Without objective criteria, you can't validate the functional correctness and completeness of products like these (see reference 1). As a result, you end up having to fill the gaps with programs of your own and accepting disruptive revisions that may result in backward incompatibilities. This is also why consistent product comparisons are difficult, and thus scarce. Data managers are often evaluated either against each other or against long arbitrary lists of features (see reference 2).

Often, you need technical personnel to mediate between end users and their data. Because the natural language of the end user differs from the procedural machine-oriented tools that traditional products provide, the communication between them is time-consuming, inefficient, and frequently ineffective. Procedural application development is difficult and error-prone.

When implementation details change, as they must for a variety of reasons, their exposure in applications imposes maintenance burdens. And because such details tend to vary across platforms, portability and distributivity of data and applications are limited. In fact, data sharing has been achieved with LAN file servers, which ship files around for DBMSes residing elsewhere on the network to process locally. This approach can be inefficient when the requesting applications need only a few records. Moreover, with this approach, integrity, security, concurrency, and recovery can be difficult to manage.

Similarly, connecting microcomputers to other platforms has been limited to host links. Data files of different formats were transferred back and forth for processing and storage, accompanied by more or less explicit conversions and the problems that come with the resulting data redundancy.

Various attempts have been made to overcome these limitations within the constraints of the personal computer environment. Some products insulate applications from certain physical details (e.g., the use of indexes). However, the one-record-at-a-time approach inhibits this capability. In this approach, the overall purpose of the data operations isn't obvious to the database system, and, thus, it can't optimize them. In addition, there is neither information about its current state nor the intelligence on which to base optimizing decisions.

The Relational Model

In 1969, mathematician E. F. Codd, while at IBM, developed a relational theory of data, which he proposed as a universal foundation for database systems (see reference 3). His relational model, based on the set mathematics of relations and first-order predicate logic, covers the three aspects of data that any DBMS must address: structure, integrity, and manipulation.

Originally, the relational model was presented as a set of features (see table 1) whose meaning and implications, while obvious to Codd, were misunderstood or distorted by others. Therefore, he supplemented them with the now-famous Fidelity Rules (see table 2) to guide the implementation and evaluation of relational DBMS software. [Editor's note: *These are known as the 12 Fidelity Rules although there are 13 of them. They intentionally start with Rule 0.*] Since then, he has refined, clarified, and extended the model in many ways, but the initial features and rules remain as valid as ever.

A relational DBMS presents databases to the user as collections of tables—and nothing but tables. But these tables must obey a certain discipline. They must have unique rows (whose storage addresses or ordering are not necessary to access their data), and their cells must be single-valued. The DBMS (not the user) must ensure that all database tables comply with these requirements. When they do, it can apply mathematical operations

Table 2: *The 12 Fidelity Rules (as emphasized by the author). Codd wrote these rules to clarify the features in table 1 (see reference 20).*

0. Foundation Rule
Any system that is advertised as or claimed to be a relational DBMS must
- *manage* the database
- *entirely* through its *relational* capabilities.

1. Information Rule
- *All* information

in a relational database must be represented
- *explicitly*
- at the *logical level*
- in *exactly* one way
- by *table values.*

2. Guaranteed Access Rule
Each and every data value in a relational database is
- *guaranteed* to be
- *logically* accessible

by resorting to a combination of
- *table name*,
- *column name*, and
- *primary key value.*

3. Missing Information Rule
- Missing value *indicators*
- *distinct* from
  - empty character strings
  - strings of blank characters
  - 0, or any other numbers

must
- *represent* and
- support in *operations*
- at the *logical* level
- in a *systematic* way
- *independent* of data type

the *fact* that values are missing for
- *applicable* and
- *inapplicable*

information.

4. System Catalog Rule
The description of the database is represented
- at the *logical level*
- *dynamically*
- like *ordinary data*

so that authorized users can apply
- the *same* (relational) *language*

to its interrogation.

5. Comprehensive Language Rule
No matter how many languages and terminal interactive modes are supported
- at least *one language*

must be supported that is expressible as
- *character* strings
- per some *well-defined* syntax

that supports
- *interactively*
- *by program*
  1. *data definition*
  2. *integrity constraints*
  3. *data manipulation*
  4. *views*
  5. *transaction boundaries*
  6. *authorization privileges.*

6. View Updatability Rule
The DBMS must have
- a *way* of determining
- at view *definition time*

whether a view can be used to
- *insert* rows,
- *delete* rows, or
- *update which columns*

of its underlying base tables and store the results
- in the system *catalog.*

7. Set Level Updates Rule
The capability of
- operating on *whole tables*

applies not only to retrieval, but also to
- *insertion*,
- *modification*, and
- *deletion*

of data.

8. Physical Data Independence Rule
- *Application programs* and
- *interactive operations*

should not have to be modified whenever changes are made in
- *internal storage* or
- *access methods.*

9. Logical Data Independence Rule
- *Application programs* and
- *interactive operations*

should not have to be modified whenever
- *certain types* of changes
- involving *no loss* of information

are made to the base tables.

10. Integrity Independence Rule
- *Application programs* and
- *interactive operations*

should not have to be modified whenever changes are made in
- *integrity constraints*
- defined by the *data language* and
- stored in the *catalog.*

11. Distribution Independence Rule
- *Application programs* and
- *interactive operations*

should not have to be modified whenever data
- is first *distributed* or
- *redistributed*

on different computers.

12. Nonsubversion Rule
If a DBMS has a low-level (procedural) language, that language should *not* be allowed to
- *subvert* or
- *bypass*
- *integrity* constraints or
- *security* constraints

expressed in the high-level relational language.

and strict logic to them, as if they were "relations." This eliminates traditional deficiencies and offers significant practical benefits.

The tabular structure is simple and familiar. It is general enough to represent most types of data; it is independent of any internal computer mechanisms; and it is flexible, because you can readily restructure tables vertically, horizontally, or both ways, through either splitting or joining.

In fact, because table manipulation always yields results that are tables themselves, unlimited nesting of operations is also possible for relationally disciplined tables. Data manipulation by relational DBMSes consists of a well-defined, complete set of mathematical operations (see reference 4). If the DBMS supports the five basic operations and some useful combinations (see figure 1), data access no longer needs to be procedural.

At a high level, you can specify a data request as a result table, in terms of the operations that must be performed on other tables to derive it. The system then transparently translates these logical requests into an efficient internal-access strategy. A relational DBMS can use information about the database (e.g., statistics) in its *catalog* (a set of tables dynamically maintained by the system) to optimize the logical operations.

The relational approach requires the system to enforce *centrally* (i.e., in the database) strict and comprehensive integrity constraints (the five types of integrity are listed in table 1) to ensure data accuracy and consistency. Thus, a relational DBMS relieves you of developing

continued

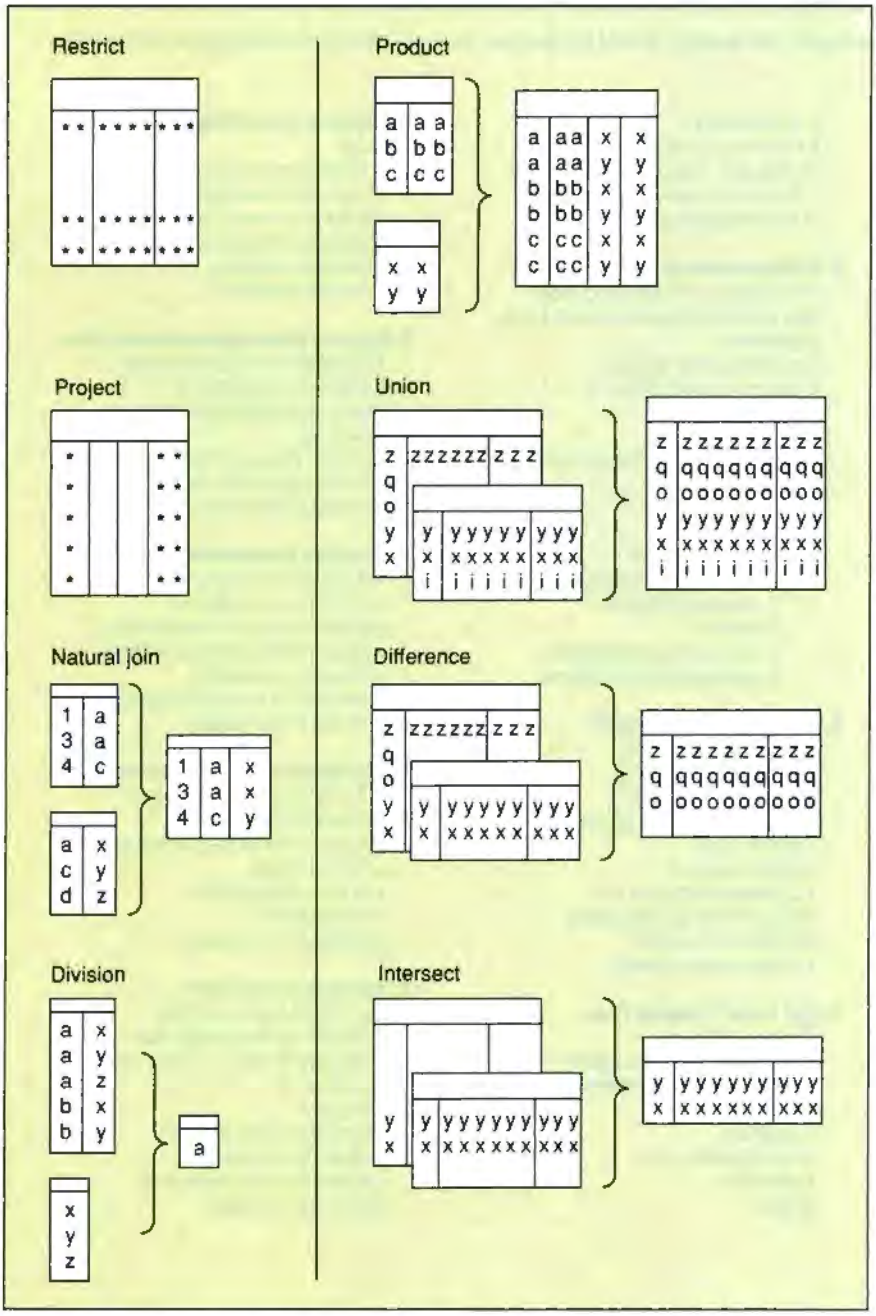

Figure 1: *Table manipulation yields results that are tables themselves. Thus, if the DBMS supports the operations shown here, data access need no longer be procedural.*

or maintaining integrity code in your applications and offers a level of productivity and reliability superior to that of traditional systems (see reference 5). In addition, the relational model also requires support of logical units of work (or multistatement transactions), as well as self-recovery from operational failures that can corrupt the database.

But for the practical benefits of the relational model to materialize, its structural, integrity, and manipulative features must be incorporated in the DBMS engine (or back end). The features are highly interdependent, and the lack of any one feature affects the support of the others. You can't provide all the intended benefits by arbitrarily implementing only some of the features or by simply adding an interface to nonrelational engines. The fidelity rules were devised to clarify this important point.

The mathematical and logical basis of the relational foundation makes it a natural candidate for a database standard. A standard based on the relational model would yield the best of both worlds: The products that complied would offer both relational fidelity and standard compatibility. The underlying database functions would be the same for all products, regardless of whether they are standalone or multiuser or what kind of front-end tools and applications they have. In addition, front-end tools such as spreadsheets and word processors could then all operate on databases, not on disparate files.

Structured Query Language

The only concrete expression of the relational model that has gained industry acceptance is Structured Query Language; SQL is now part of IBM's Systems Application Architecture (SAA) strategy. Four SQL dialects have been incorporated into IBM's DBMSes: DB2 (MVS), SQL/DS (VM), SQL/400 (OS/400), and Database Manager (OS/2 Extended Edition). Subsequently, SQL has been adopted as a standard by ANSI, the International Standards Organization, the Open Software Foundation, X/Open, and Federal Information Processing Standards. Some microcomputer implementations have been around for quite a while (see reference 6), but now there is a real stampede. Despite the rush to SQL, however, most of its pros and cons (especially for the microcomputer environment) are poorly understood (see reference 7).

SQL is a language for interacting with relational databases, *not* a full application development language. First, this keeps the well-defined, set-oriented database foundation distinct from the less precise, procedural character of existing programming languages. Second, it avoids creating yet another general-purpose language that, by trying to be everything to everybody, becomes too complex to master and invites compromises. Third, it eschews the lengthy political process that would be required to extend standard procedural languages such as COBOL and FORTRAN with relational database functions.

Using SQL

SQL statements are embedded in programming languages, where they retrieve sets of rows from the database, stepping a cursor through them one at a time and passing each to host-language variables for further processing. The

continued

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Table 3: *Current versions of SQL lack important functions. For example, both the SQL standard and IBM's DB2 dialect of SQL comply only partially with the 12 Fidelity Rules.*

	ANSI	IBM
0. Foundation Rule	P[1]	P[1]
1. Information Rule	Y	Y
2. Guaranteed Access Rule	N	P[2]
3. Missing Information Rule	N	P
4. System Catalog Rule	N	Y
5. Comprehensive language Rule	P	P
6. View Updatability Rule	N	P[3]
7. Set Level Updates Rule	P	Y
8. Physical Data Independence Rule	Y	Y
9. Logical Data Independence Rule	P[4]	P
10. Integrity Independence Rule	P	P[5]
11. Distribution Independence Rule	?	I
12. Nonsubversion Rule	?	Y

Y = full support
N = no support
P = partial support
I = intended support
? = unspecified

[1]Reflected in rules 1-12.
[2]Key support, but allows duplicate rows.
[3]Only simple views updatable.
[4]Due to [3].
[5]Partial entity, referential integrity.

source code containing SQL is preprocessed to translate the embedded SQL statements into optimized database calls specific to the host language. Then the source code is compiled and executed in the regular way. Embedded SQL can be *static* (where the SQL statements are known and, therefore, can be preoptimized and precompiled) or *dynamic* (where the SQL statements are specified by users at run time and thus are optimized and compiled then).

Application Programming Interfaces (APIs) to SQL engines are also provided for programming languages. Here, the host language passes the SQL statements as string variables to the DBMS for execution, and the receiving program loops over the resulting sets in the traditional way.

The attraction of these approaches is that you can use SQL within familiar, standard (and thus portable) languages. However, the interface between procedural and set-level technologies is cumbersome and defeats many of the relational intentions.

There are attempts to make SQL more of a development language, either by extending it with programming constructs or by making dialects of SQL an integral part of a 4GL. These combinations are usually somewhat smoother, but standardization and portability are limited.

SQL is also incorporated in front-end tools other than programming languages, which, from a microcomputer perspective, is a more palatable alternative. Thus, in forms-based systems, you can inlay SQL statements in the forms. Or you can hide SQL altogether with menu-, prompt-, or form-driven capabilities such as query-by-example, query-by-form, or graphical interfaces. These guide you in specifying the table operations underlying SQL, leaving the system to generate and execute the appropriate SQL statements transparently. This approach requires good mapping between relational functions and these tools. This is the direction for the future, but most developers prefer, as an easier first step, to migrate whatever tools they already have to SQL engines. SQL's imperfections (see reference 8) and its questionable implementation in some products (see reference 9) do not help.

Fidelity vs. Compatibility

Weaknesses in the SQL language itself cause some of this variation and the consequent implementation problems. The ANSI standard was initiated after many SQL dialects had already been implemented. In their current versions, the standard and commercial dialects are relationally incomplete (table 3 shows, for example, that the standard and the DB2 dialect comply only partially with the 12 Fidelity Rules). They also lack important functions and suffer from redundancy, arbitrary restrictions and inconsistencies, failure to obey simple rules of arithmetic, and on and on (see references 10 and 11).

The standard concentrates on syntax, leaving important aspects such as semantics, catalogs, data types, the programming interface, and concurrency control to the developers. The ANSI committee continuously revises the standard, but a large committee of vendors, each with vested interests in their own existing nonrelational systems or SQL dialects, cannot design a correct and coherent language. Consequently, most SQL developers extend their dialects beyond the standard to offer missing or advanced functionality (see reference 12). Meanwhile, the laxity of the standard is exploited by staking claims of compatibility for products that are not genuine SQL implementations (see reference 13). Some even claim relational features that are not truly so (see reference 14).

This creates significant difficulties for those who want to interface their tools to SQL DBMSes, and for those who must decide which products to choose—the exact problem the relational approach was intended to solve (see reference 15). Nevertheless, the fact remains that, however imperfect or incomplete, SQL is a relational data language whose dialects, although different in many ways, have more in common than (as well as advantages over) the proprietary, procedural data languages in existence (see reference 16).

Connectivity vs. Portability

It is the relational nature of SQL that has propelled it as the language of choice for connectivity. Its high level, set orientation, and support of physical data independence make possible many of the current developments in the database arena. Cooperative processing (as in the client/server approach), distributed databases, and parallel processing are all facilitated by relational technology.

Cooperative processing and database distribution among networked heterogeneous computers become possible not only because workstations can now communicate in a standard language with different remote database servers. These things are also possible because database functions, including integrity and security, are now centrally, relationally,

continued

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effectively, and efficiently managed by those servers.

Only the data required by authorized applications is shipped over the network as sets, improving performance, preserving data reliability, distributing the processing load, and eliminating explicit import/export conversions. True distributed DBMSes will even decide which participating DBMS should perform an operation on distributed data, to optimize overall performance. Consequently, tools and applications running on microcomputers will be able to operate transparently on databases residing on any platform, reducing the importance of portability.

The trend toward SQL is accompanied by technological changes separate from database matters.

It's a mistake to assume, however, that SQL's only value is as a standard connectivity language to link microcomputers to minicomputers and mainframes, and that it should be ignored in stand-alone or single-user PC environments (see reference 17). Easier-to-use tools and applications with forms, iconic, or object orientations can better exploit the relational features underlying SQL (see references 18 and 19). These can directly manipulate relational data as sets, rather than one row at a time, as with procedural tools. Because there is better affinity between these high-level development techniques and relational database functions, there is a great deal of synergy between these separate but simultaneously emerging technologies.

The Price of Progress

Progress, however, comes at a price. The trend toward SQL is accompanied by technological changes separate from database matters. There is continuous progress in hardware: 80386, 80486, RISC, parallel processing, WORM (write once, read many times), CD-ROM, and erasable optical storage. As a new, multitasking operating system with a graphical user interface and large memory addressability, OS/2 is being positioned to take advantage of these advances and to offer easier interaction with the machine. There are also many new sophisticated microcomputer connectivity facilities (e.g., LAN Manager, LAN Server, and APPC).

While the ensuing environment no longer holds back DBMSes, it imposes certain burdens on developers and forces users to cope with multiple conceptual changes. These changes can easily overwhelm relational benefits. Moreover, the move from stand-alone, single-user systems to shared environments involves complexities that are unavoidable and similar to those experienced at the minicomputer and mainframe level.

Issues such as concurrency, security, and data and network administration, which are inherently complex and were ignored in traditional microcomputer database systems, must now be properly facilitated by database software and understood and managed by microcomputer users. Anything that can be done under these circumstances to simplify, systematize, and standardize at least the database management component is a critical improvement—hence the value of relational technology.

Misconceptions and Changes

A major obstacle to the acceptance of the relational model lies in the various misconceptions about the technology prevailing today. Some of the most common are as follows:

1. A relational DBMS is one that handles multiple files at a time.
2. The relational approach is theoretical, and, therefore, it has no practical relevance for users.
3. New technologies, such as object-oriented or semantic databases, are making the relational approach obsolete.
4. SQL is useful only for connecting microcomputers to minicomputer or mainframe data.
5. A SQL interface can offer full relational benefits while preserving compatibility with existing applications.
6. Relational DBMSes require that you learn and use SQL directly. This is more difficult than using traditional databases.
7. If a DBMS provides easy-to-use icons, menus, and screens, then you shouldn't care about the underlying database technology.
8. You can get the same full-relational

continued

benefits by mixing and matching any front-end tool with any SQL back end; the latter are simply becoming a commodity.

One example of the results of these misconceptions is an attempt I saw to retrieve 100 records from a database by issuing 100 separate SQL statements, each retrieving one row. Another example is discounting DBMS enforcement of integrity rules because "I do that myself anyway."

The relational approach is fundamentally different and shifts the burden of managing the database from users to the DBMS. Therefore, there are limits to the ability to extend traditional products or migrate existing applications to SQL DBMSes *as is* and still benefit from relational advantages. In addition, it's unlikely that the DOS environment will be able to support the increasing sophistication of DBMSes as their relational fidelity is enhanced.

Where Are DBMSes Going?

What is badly needed is an improved, fully relational SQL standard that leads, not follows, the market. There must be new kinds of tools that truly exploit both relational power and the graphical, multitasking, and connectivity facilities of the new microcomputer environment, without falling into the "mainframization" trap. And the complexities of connectivity shouldn't overwhelm database management simplicity.

There are already signs that these fundamental changes in technology are restructuring the industry. A handful of SQL servers will emerge, with most other traditional DBMS vendors turning into front-end tool and application providers. There will be strategic alliances between technologies such as hardware, SQL, graphics and object orientations, communications, and so on, because no one vendor can hope to address all these elements in an optimal way. The emphasis will be on corporate rather than personal systems, and it will probably take several years until beneficial results will materialize for informed users.

Expect the first generation of front ends for SQL DBMSes under OS/2 to be mainly extensions of existing products. Take the opportunity, during this period, to educate yourself for the new DBMS world. It will be braver than what it was, but probably not as brave as it should be. And it will take knowledge, not merely experience, to exploit the implications. ■

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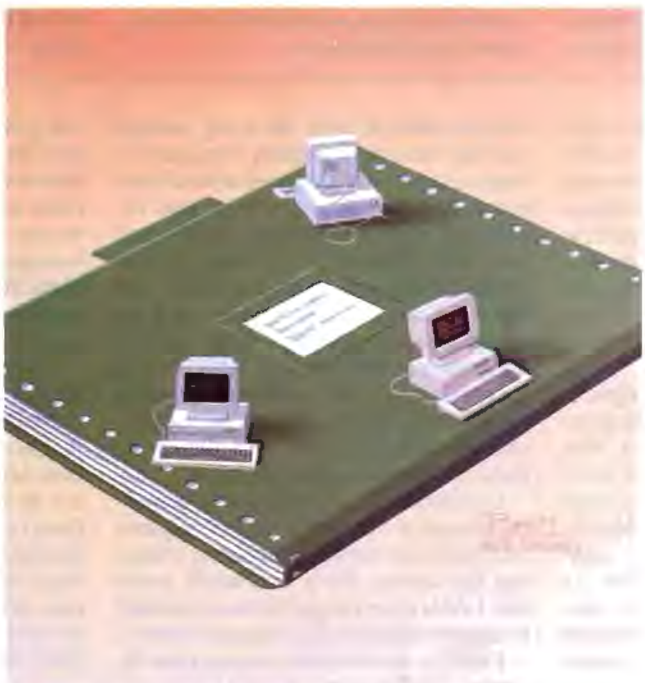
Serving Up Data

Can centralized data preserve the independence of individual users?

Mark L. Van Name and Bill Catchings



The database server offers many advantages over traditional stand-alone microcomputer database systems. Supporting multiple simultaneous users is perhaps its biggest asset, but the centralization of data on a LAN has other advantages as well.

By storing a single copy of each piece of information, the database server cuts down on data redundancy and inconsistency. Compare this with an office that uses several stand-alone systems: If you store the same data—employee names and addresses, for instance—at each of the sites, a change to any data item at one site creates an inconsistency. Having only a single copy of the data that everyone shares eliminates redundant copies. When there is a change, all users have access to it.

An Evolutionary Compromise

Essentially, the database server is an evolutionary compromise between the current stand-alone microcomputer database systems and the centralized database systems found on mainframes and minicomputers. Microcomputer databases have traditionally supported a single user on a single machine. The microcomputer handled your entire workload, from database requests to front-end applications to screen I/O. If you wanted to share data with someone else, you either had to swap data disks or take turns using the same system.

By contrast, centralized mainframe and minicomputer database systems let many users share the data on a single machine simultaneously. The central computer did all the database and application processing, and you sat at a dumb terminal.

The client-server architecture melds these two approaches. It uses a central server machine that handles all the hard-core database processing. Like the minicomputer and mainframe systems, the server maintains a single copy of the database and makes it available to all users. The server does not, however, run the actual database applications or other front-end programs. Those tasks stay with the individual microcomputers, which become clients of the central server. Each microcomputer executes its own application programs and handles its screen and keyboard I/O. When an application needs data from the database, it uses a local client library to create a database request and send it across the LAN to the server. After the server retrieves the desired data or performs the requested operation, it sends the data back over the LAN to the client.

While this architecture spreads the processing between the client and server machines, it does not spread the data itself. Database systems that store their

continued

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The Tie That Binds

Most database servers support SQL (pronounced "sequel"), a language that has long been the de facto standard for relational database systems. With an evolving ANSI standard and the support of IBM behind it, SQL is likely to be the dominant database language for servers for some time.

Inside SQL

The attraction of SQL is that it lets database applications issue multirecord requests to the server. The four primary SQL data-manipulation verbs—SELECT, INSERT, UPDATE, and DELETE—can all work on groups of records at a time. An application can, for example, issue a statement like

```
SELECT NAME FROM EMPLOYEE WHERE
CITY = "St. Louis"
```

to retrieve the names of all employees who live in St. Louis. The statement goes to the server as a single request, and the server then performs all the processing necessary to retrieve the appropriate records.

While the server could ship all the selected records back to the client, such a transmission would pose a problem for most applications, because conventional programming languages are designed to work with only one record at a time, not with groups of records. Consequently, ANSI SQL's programming interface provides operations that let clients retrieve the desired records one at a time. This approach obviously increases network overhead and runs counter to the notion of manipulating groups of records at once. Extensions to some versions of SQL enable programs to retrieve groups of records in a single call.

SQL also provides COMMIT and ROLLBACK functions that let programs manage transactions. In addition, SQL is a data-definition language with which you can define databases. It offers commands for defining database tables and fields, as well as the security controls on those items.

Flies in the Ointment

While SQL is unlikely to be supplanted, the language is not perfect. One problem is that no two versions—including the three from IBM—are exactly alike.

SQL also lacks features that many critics consider important parts of the relational model. For example, it offers no direct support for *primary keys*—groups of one or more fields that must be unique in every record of a given type. You can use SQL to enforce primary-key constraints, but there is no enforcement of the concept built into the language. This is particularly onerous because many different kinds of applications use unique record identifiers.

Still the Winner

Despite this and other problems, SQL is clearly the database server language of choice today. All the major announced database servers support SQL. Both its technical virtues and the market forces behind it make SQL likely to retain that crown for many years.

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data across many different systems and manage the integrity of that collection of data are known as distributed database systems. A single, centralized database server faces a simpler task than a distributed database system because it doesn't have to worry about coordinating the data in multiple locations.

The Server's Demands

The server does, however, place significant demands on some underlying technologies. First, it requires a host with enough power to handle a multiuser database. While older microcomputers, such as the IBM PC XT and the early Macintoshes, lack the power to support complex servers, newer machines offer far greater processing capabilities. In fact, machines built around Intel's 80386 and Motorola's 68030 CPUs provide power rivaling that of minicomputers.

Some network vendors, such as Novell, are also opening their LANs to minicomputers, so the database server on a microcomputer LAN could well be a minicomputer. The server could also be a mainframe; IBM, for example, plans to make its OS/2 Extended Edition Database Manager capable of retrieving data from a mainframe DB2 database.

The processors alone, of course, are not the whole performance story. Servers demand hard disks big enough and fast enough to support databases as large as those once relegated to minicomputers and mainframes. They also require operating systems such as Unix and OS/2 that take full advantage of the power of their advanced processors and disks. These operating systems provide the multitasking and memory space that advanced database systems need. While it's possible to build a database server on top of DOS, the limitations of one process at a time and 640K bytes of memory make DOS a poor server platform.

In addition, the LAN must be powerful enough to handle the load of requests and responses between the many clients and the server. Many commonly available LANs offer the performance needed to support multiple simultaneous users.

Finally, the database system must be able to handle multiple users while providing reasonable levels of performance, security, and integrity. Because minicomputer database systems have already had to face these problems, many of today's servers have their roots in the minicomputer world. Oracle and INGRES offer servers based on their minicomputer versions; Sybase built one of its first versions of the Sybase/Microsoft/Ashton-Tate SQL Server for the VAX.

It's too early to tell how important a role OS/2 will play in this area. It does provide the kinds of services that these systems require and is thus poised to become an important platform for database servers. Currently, OS/2 cannot take advantage of some of the advanced features of the 80386 processor, such as hardware memory swapping. Vendors and users eagerly await an 80386 version of OS/2.

Despite this drawback, however, many vendors have announced OS/2 database servers. IBM has even indicated that its own OS/2 Extended Edition Database Manager will eventually be able to act as a LAN database server. Oracle from Oracle Corp., the SQL Server from Sybase/Microsoft/Ashton-Tate, SQLBase from Gupta Technology, and several others are available today. These products and others like them may give OS/2 the raison d'etre it so sorely needs.

Basic Server Services

One reason most servers are based on minicomputer database systems is the complexity of the tasks the servers must handle. Many current database systems lack the structure and capabilities necessary to support multiple users. A multiuser system creates demands rarely encountered in stand-alone environments.

A database server must be transparent

continued

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In the Real World

NetWare SQL is a database server from Novell. It can run on any NetWare server. While NetWare was once limited to microcomputers, newer versions allow VAXes and other minicomputers to act as servers. Client machines can run DOS, OS/2, or Mac OS.

Under NetWare SQL, a client database application sits atop a small stack of database client software. The application can be one developed especially to run with NetWare SQL or an existing application modified to use the server. Several client front ends to this server are available; the list includes WordTech Systems' dBXL and Quicksilver, Concentric Data Systems' R&R for SQL, Lotus 1-2-3, and others.

An application frames its database requests using XQL, NetWare SQL's programming interface. XQL actually offers two different application programming interfaces (APIs): XQLM and XQLP.

XQLM, the SQL Manager, offers a version of the SQL programming functions based on the ANSI SQL standard. XQLP offers what Novell calls its *relational primitives*—a set of proprietary, low-level database functions.

XQL uses a NetWare request interface, NSREQ, to communicate its requests to the server. NSREQ passes requests to the standard NetWare shell, which sends them across the network to the server. Under DOS, NSREQ runs as a piece of resident code; on OS/2, it's a dynamic link library.

The NetWare SQL server uses several different NetWare processes to handle requests. The first process to field a request is NW$SQL. There is one NW$SQL server process per active user. It handles some of the database processing, but it uses Novell's Btrieve for its basic record management.

An NW$SQL process interacts with the BROUTER, the Btrieve message router. The BROUTER is an interprocess-communication program that sends requests from an NW$SQL process to the Btrieve process on the server where the data is stored. On a LAN with a single server, this function is obviously unnecessary, but it can be crucial on LANs with multiple servers.

The actual Btrieve server is the BSERVER program. BSERVER handles the basic data read and write operations and uses NetWare's Transaction Tracking System to support concurrent users. Unfortunately, Btrieve automatically locks entire tables unless the application issues explicit record locks. This approach can make locking a difficult task.

to client users. Like most microcomputer users, you probably have a favorite database. In the client-server world, you keep your familiar front-end application, but now it gets its data from the server, not from your local disk. Many database developers are moving rapidly to incorporate this feature into their products. Market leaders such as Ashton-Tate (dBASE IV) and Borland (Paradox) have already announced or delivered hooks to back-end, SQL-based servers.

The server side is more complicated. First, a server must be able to handle requests in a form suitable for transmission across a network. To achieve reasonable performance, the server must minimize network traffic. That usually means a database language that lets the clients work with many records at once. Not surprisingly, nearly all of these servers are relational database systems that use the SQL language to manipulate data (see the text box "The Tie That Binds" on page 260). The client systems simply frame their requests in SQL; the server interprets those requests and chooses a reasonable strategy for executing them (see the text box "In the Real World," above).

More difficult problems arise from the need to support multiple users simultaneously. As long as you're only reading the data, there's no problem; the server can easily let many users read the same data at once. But when you start modifying data, the server must provide file- and record-locking functions to ensure that each user is treated fairly. Fair treatment in database servers is based on a logical unit of work called a *transaction*.

Atomic Transactions

A transaction is a sequence of related operations that the database system guarantees to be *atomic*; that is, it ensures that all the operations in a particular transaction either execute successfully or abort. Take, for example, a transaction that transfers money from one account to another. The atomic nature of the transaction ensures that the components—debiting one account and crediting the other—either both succeed or both fail.

Most transaction-based database systems follow three basic rules. First, they support two ways for transactions to end. A transaction can terminate normally (a commit operation) or abnormally (a rollback operation). Abnormal termination means aborting every database operation in the transaction.

Next, the server must guarantee that any database changes that a transaction T makes are not visible to any other transaction until T commits those changes. If T does a rollback instead, the database appears essentially as if T never existed. By following this approach, the server stops other transactions from seeing T's changes in case T eventually aborts.

Finally, the server must deal with the fact that different transactions may start and stop at random times, including in the middle of other transactions. Transactions that so overlap are known as *interleaved* transactions. The database server must execute interleaved transactions so that the result of their execution is *serializable*; in other words, that it is equivalent to executing those same transactions one at a time in some serial order. The server doesn't have to guarantee any particular serial order, but it must make the results of each interleaved execution equivalent to some serial order.

In addition, the server must meet these requirements in a way that provides reasonable overall performance. Locking entire files and executing the transactions one at a time, first-come, first-served, would certainly follow these transaction rules, but it would allow no simultaneous users. The database server has to automatically find the right balance of table (or file), block, and record locks to both obey these rules and maximize the number of users that can simultaneously share the available data.

Because the data is all in one place, the server must also guarantee its integrity in other ways. It must provide facilities for backing up the data and recovering it when the system crashes or the database is somehow corrupted. Problems can range from simple ones, such as when a client machine goes down in the middle of a transaction, to disk catastrophes that destroy all the server's data.

Atomic transactions often play a role

continued

in this backup-and-recovery function. You should periodically make complete backups of your server databases. The servers themselves typically maintain logs of completed transactions. When a single client transaction fails before completing, the server can effectively roll it back to remove its effects. When a catastrophe occurs, the server can use a recent complete backup of the database and its transaction log to bring the database up-to-date. The server first loads the backup and then uses the transaction log to apply the updates from all completed transactions; this operation is known as roll-forward.

What You Gain

Centralized data storage makes database backup easier. Instead of having to back up many different machines, you back up only the server. Clients needn't be concerned about backups.

Centralization can make database security a more manageable problem. Securing the data on a stand-alone microcomputer often means finding some way to limit access to the microcomputer itself, putting a password on the whole database, or removing the database when it's not in use. Most database servers offer more powerful security functions. SQL, for example, includes statements that let you specify exactly which users can perform which operations on which parts of the database.

The client-server architecture also has the potential of taking advantage of many different hardware and software architectures. You can use MS-DOS machines and Macintoshes—and all their familiar front-end software—as client machines. The server would probably be a more powerful system (e.g., a minicomputer or an 80386-based microcomputer). The server can also implement a more complex operating environment than the client machines because only data administrators need to use the server directly. Thus, the server software could run on a minicomputer under Unix.

Although similar in many respects to distributed database systems, database servers offer some advantages. Chief among these is the fact that several different database servers are commercially available today, and have been available for some time, while true distributed database systems are just beginning to appear. Database servers are also less complicated and require less communications overhead than distributed database systems—largely because a server doesn't have to manage data and data integrity across multiple sites.

What You Lose

There are, of course, some drawbacks to database servers. By their very nature they take control away from the individual microcomputer user and place it in the hands of the administrators of the server. Servers thus represent a move away from the independence of microcomputers and a step back toward the centralized control of minicomputers and mainframes. By contrast, both stand-alone and distributed database systems let you store data where it is used.

By placing all the data in one place, the client-server approach also makes the central server a crucial resource: Lose it, and you lose access to all its data. Since the database includes key data for all clients, its loss can be expensive. Even if the server is down for only a short time, its loss halts all database-dependent applications.

Database servers are complex programs that require a trained administrator. While even inexperienced microcomputer users can often manage their own local databases, a database server administrator must understand database design, data integrity and security, backup and recovery, and performance tuning. These are the same tasks you would face on a mainframe or minicomputer database system.

Finally, while the performance of a stand-alone microcomputer database system is reasonably predictable, the performance of a server can vary widely, depending on the amount of traffic on the network. Poor network or server performance can create a serious bottleneck. While most servers offer some performance tuning options, the server's limits and the network's speed establish an inherent performance ceiling.

Separation of Function

Different database servers may follow slightly different designs, but all emphasize the separation of function between client and server. This architecture will become increasingly common as LANs become more widespread and the need for a shared, consistent data store becomes more apparent. Database servers borrow the best aspects of centralized data management while still preserving most of the independence of individual users. ■

Mark L. Van Name, a BYTE consulting editor, and Bill Catchings are independent computer consultants based in Raleigh, North Carolina. You can reach them on BIX as "mvanname" and "wbc3," respectively.

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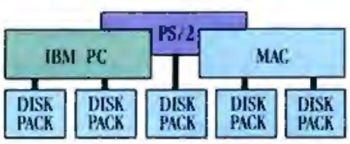

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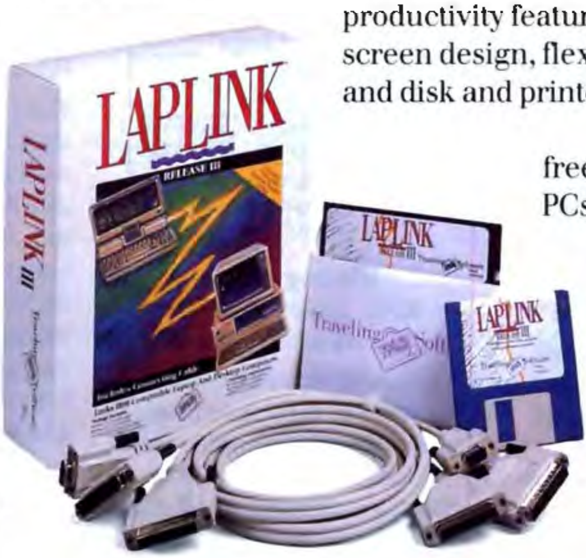

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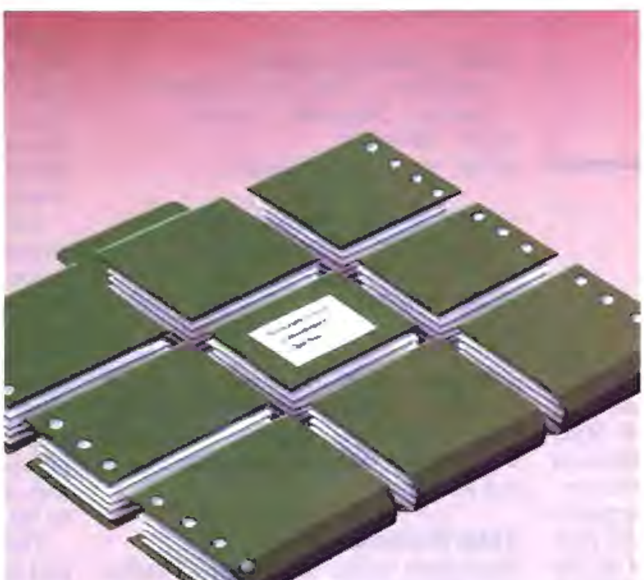

Over the past few years, rapid advances in network technology have made it easier to tie different types of computers together. In the past, the primary purpose of these connections has been sharing printers and disk drives. Now, distributed database technology lets disparate computers and database systems share another important resource: data.

The growth of distributed database technology has been closely tied to advances in relational technology. Because communications overhead is a critical factor in distributed technology, a database model capable of moving groups of records between sites was a prerequisite for a distributed database system. Moving single records incurs a much higher communications cost and is very inefficient. Thus, the maturation of relational database technology was an important step in making distributed database management systems (DDBMSes) feasible.

Describing the Distributed Database

Several factors differentiate a distributed database system from a loose confederation of autonomous sites:

• The data that makes up the logical database is stored at multiple sites connected by a network.
• At least one application takes a global view of the data.
• The global application accesses all the sites at least once.
• A global intelligence (i.e., a DDBMS) exists over and above all the local intelligences (i.e., DBMSes). Its job is to manage the distributed database as a whole. In a distributed environment, such things as query optimization, concurrency control, and transaction handling require a global intelligence.

Distributed databases give rise to some new database concepts that are important in assessing the benefits of a DDBMS and in gauging the complexity of implementing one. Three of the most important new concepts are fragmentation, replication, and allocation.

Fragmentation

Fragmentation describes how a single table is divided among network sites. You can fragment a table in several ways. A horizontal fragment of a table contains all its columns and a subset of its rows. You create such a fragment by performing a relational restrict (SELECT) operation on a table. For example, if a corporation has a table EMPLOYEE listing all its employees and wishes to store the appropriate fragments at the actual work locations (indicated by the `Emploc` column), the following SQL SELECT statement creates the fragments:

continued

Table 1: *The allocation schema of the EMPLOYEE table fragments. Note the implementation of the backup scheme.*

LA	EMPBIO (LA) EMPSAL (LA) EMPBIO (NY) EMPSAL (NY)
PX	EMPBIO (PX) EMPSAL (PX) EMPBIO (LA) EMPSAL (LA)
CH	EMPBIO (CH) EMPSAL (CH) EMPBIO (PX) EMPSAL (PX)
AL	EMPBIO (AL) EMPSAL (AL) EMPBIO (CH) EMPSAL (CH)
NY	EMPBIO (NY) EMPSAL (NY) EMPBIO (AL) EMPSAL (AL) EMPBIO (CH) EMPSAL (CH) EMPBIO (PX) EMPSAL (PX) EMPBIO (LA) EMPSAL (LA)

```
SELECT *
FROM   EMPLOYEE
WHERE Emploc = location
```

If the company has offices in New York, Atlanta, Chicago, Phoenix, and Los Angeles, this statement breaks the EMPLOYEE table into five fragments.

A vertical fragment, on the other hand, involves a subset of the columns of a table and all its rows. Suppose the company keeps a copy of the entire corporate database at its headquarters in New York. Not all the departments in the company need access to all the fields in the EMPLOYEE table. Indeed, some of the fields, such as the employee's salary, should be accessible only to departments that need to know the information in them. The following SQL statements create two vertical fragments. The first fragment contains address information, and the second contains tax records and salary data:

```
SELECT Empssn, Empname,
  Empstreet, Empcity, Empstate,
  Empzip, Empphone, Emploc
FROM   EMPLOYEE
```

```
SELECT Empssn, Empsalary,
  Empinctax, Empsstax,
  Emploc .
FROM   EMPLOYEE
```

In creating a horizontal fragmentation, you include all the columns (SELECT *) and use a WHERE clause to specify the rows. With vertical fragmentation, however, you use a field list to create a column subset and SELECT all the rows. You must include Empssn in both vertical fragments to identify each record. In fact, you must include it in all vertical fragments, both for locating the record and for reconstructing the unfragmented table.

Mixed fragmentation combines vertical and horizontal fragmentation. To illustrate, suppose that within the company's five regional offices, the same departmental jurisdictions apply as at headquarters. Thus, you still need to separate biographical information from tax and salary figures. You obtain this mixed fragmentation by combining the previous two SQL SELECTs. Therefore, for each location, you issue the following statements:

```
SELECT Empssn, Empname,
  Empstreet, Empcity, Empstate,
  Empzip, Empphone, Emploc
FROM   EMPLOYEE
WHERE Emploc = location
```

```
SELECT Empssn, Empsalary,
  Empinctax, Empsstax,
Empsttax, Emploc
FROM   EMPLOYEE
WHERE Emploc = location
```

This gives you 10 fragments. At each regional office, the accounting department has access to the tax and salary fragment, while human resources can get to names and addresses.

Table Replication

Replication is the distribution of tables around the network. You replicate tables for two reasons: to maximize local availability of data and to provide backup copies of tables in case a particular network site fails.

In the example shown above, a copy of the entire corporate database exists at headquarters for access by top management. In addition, the regional offices sometimes need to query each other's tables. While they don't need to do this often enough to warrant keeping complete copies of the tables at all sites, they do want to be able to access the data even if the computer of the office that they are querying is down. For this reason, each office backs up one other office, as follows:

- Phoenix backs up Los Angeles.
- Los Angeles backs up New York.
- New York backs up Atlanta.
- Atlanta backs up Chicago.
- Chicago backs up Phoenix.

Replication provides a great deal of security in the event of a crash at a node, but it can introduce integrity problems.

Allocation

Allocation is a combination of fragmentation and replication. The allocation process decides which sites store which fragments and is a key element in distributed database design. The guiding principle is to allocate fragments and tables to maximize local processing: You store data so that most applications need to access only locally stored data.

Table replication can increase the local availability of data. However, for frequently updated tables, replication degrades database performance, because all copies of a table must be updated to maintain the integrity of the distributed database. Table replication where the ratio of reads to writes is high, or where it's not critical that updates be cascaded immediately, can yield performance benefits by minimizing communications overhead.

The speed of the supporting network is an important consideration here. The decision of a company to replicate its full database at headquarters means that the regional offices must propagate all their updates to headquarters. To keep communications to a minimum, an overnight batch process provides updates to headquarters. Management can live with having access to yesterday's data so as not to impose too great a performance penalty on the regional offices.

The architecture of the network plays a part in this decision. By having yesterday's data replicated at headquarters, the executives can view it in a few seconds. If they had chosen instead not to replicate the data, but to work with a global view of the data (which would have to access the tables in the regional offices), then every time they made a query, the DDBMS would have to reconstruct the data in the regional offices and transmit it to headquarters. With a data transfer rate of 56 kilobits per second for its wide-area network (WAN), the time for query retrieval using a global view could be several minutes.

In a distributed database built on a

high-speed LAN, however, the difference in retrieval time between a fully replicated database and a global view of the database is much smaller. Thus, local availability is not as important in deciding whether to replicate a table. Availability of the data in case a network node fails becomes the dominant consideration.

Distributed Architecture

Fragmentation, replication, and allocation determine the data architecture of a distributed database system. This architecture is divided into several layers, or schemata.

The global schema is a description of the tables in the database as if they all resided at a single site. With the EMPLOYEE table, the global schema contains one unfragmented copy of the table.

The fragmentation schema describes the logical fragmenting of the tables, without regard to where they are stored. The fragmentation schema for EMPLOYEE contains 10 fragments: two vertical fragments (called EMPBIO and EMPSAL) for each of the five regional offices.

The allocation schema maps the fragments to their physical locations. Table 1 shows the allocation schema for the EMPLOYEE table.

A DOS machine can easily become a bottleneck in the system.

The local-mapping schema maps the allocated fragments to physical objects known to the local DBMS. Table 2 shows how the tables are actually used to store the EMPLOYEE table.

Table 2: *The location mapping schema for the EMPLOYEE table. Note the backup scheme.*

LA	EMPBIO [Emploc IN ('LA', 'NY')] EMPSAL [Emploc IN ('LA', 'NY')]
PX	EMPBIO [Emploc IN ('PX', 'LA')] EMPSAL [Emploc IN ('PX', 'LA')]
CH	EMPBIO [Emploc IN ('CH', 'PX')] EMPSAL [Emploc IN ('CH', 'PX')]
AL	EMPBIO [Emploc IN ('AL', 'CH')] EMPSAL [Emploc IN ('AL', 'CH')]
NY	EMPBIO EMPSAL

Distribution Transparency

Each layer of the architecture has an associated level of distribution transparency. The more distribution transparency a DDBMS offers, the more it shields users and applications from the actual storage structure of the data. The highest level of distribution transparency is fragmentation transparency. At this level, the entire database appears to users at all sites as if it were entirely resident at their sites. The DDBMS maps table references to the appropriate fragments. Changing the storage schema of the database (e.g., how the global tables are fragmented, and where the fragments are allocated) does not affect users or applications.

With location transparency, fragments are visible, but their locations are not. Thus, an application no longer works with the EMPLOYEE table, but with the EMPBIO and EMPSAL fragments. In addition, the application must know that one fragment contains the records for New York, another contains those for Los Angeles, and so forth. If the allocation schema changes, it does not affect the application; however, if there is a change in the fragmentation schema, the application will need to be rewritten.

Replication transparency is related to location transparency. The DDBMS handles all the details of replication, such as propagating updates or directing a query to a local copy of a table.

With local-mapping transparency, an application must know not only the fragments of a table, but also the locations of the fragments. This level of transparency only shields applications when each site may be using a different local DBMS. For instance, if the Los Angeles office is using a nonrelational DBMS, then the DDBMS enables applications to refer to relational tables. If the fragments move, your applications must be rewritten.

Clearly, the level of distribution transparency that a DDBMS offers is a major factor in evaluating it.

Distributed Data Integrity

Another essential feature in a DDBMS is the ability to protect the integrity of a distributed transaction. When a transaction consists of multiple operations, it's imperative that the DDBMS perform all of them or none of them.

Suppose the company in my example transfers an employee from Chicago to Los Angeles. If the DDBMS offers fragmentation transparency, you can accomplish the transfer with a single SQL statement:

```
UPDATE EMPLOYEE
SET  Emploc = 'LA'
WHERE Empssn = '111-11-1111'
```

In actuality, this statement breaks down into the following operations:

1. Add the employee to EMPBIO and EMPSAL in Los Angeles, and to the backup copies in Phoenix.
2. Update the `Emploc` column of EMPBIO and EMPSAL in Los Angeles and Phoenix.
3. Delete the employee from EMPBIO and EMPSAL in Chicago, and from the backup copies in Atlanta.
4. Update the employee's records in the headquarters copies of EMPBIO and EMPSAL.

(I ignore the fact that this is done as an overnight batch process. The update actually writes a record for overnight upload. I express the action here as a direct update to the tables in New York.)

The complete set of SQL statements required to relocate the employee is shown in listing 1. This entire transaction, consisting of 14 SQL statements, must execute in its entirety or not at all.

In a previous article in BYTE (see reference 1), I discussed the two-phase Commit protocol in the context of IBM's LU 6.2. This technique has gained wide acceptance as the best way to guarantee transaction integrity in a distributed database environment.

In the two-phase Commit protocol,

continued

Listing 1: *The actual SQL statements that perform an employee transfer. The @ symbol followed by the table location is a common convention to differentiate local copies.*

```
INSERT INTO EMPBIO@LA
SELECT *
FROM EMPBIO@CH
WHERE Empssn = '111-11-1111'

INSERT INTO EMPSAL@LA
SELECT *
FROM EMPSAL@CH
WHERE Empssn = '111-11-1111'

INSERT INTO EMPBIO@PX
SELECT *
FROM EMPBIO@CH
WHERE Empssn = '111-11-1111'

INSERT INTO EMPSAL@PX
SELECT *
FROM EMPSAL@CH
WHERE Empssn = '111-11-1111'

UPDATE EMPBIO@LA
SET Emploc = 'LA'
WHERE Empssn = '111-11-1111'

UPDATE EMPSAL@LA
SET Emploc = 'LA'
WHERE Empssn = '111-11-1111'

UPDATE EMPBIO@PX
SET Emploc = 'LA'
WHERE Empssn = '111-11-1111'

UPDATE EMPSAL@PX
SET Emploc = 'LA'
WHERE Empssn = '111-11-1111'

DELETE FROM EMPBIO@CH
WHERE Empssn = '111-11-1111'

DELETE FROM EMPSAL@CH
WHERE Empssn = '111-11-1111'

DELETE FROM EMPBIO@AL
WHERE Empssn = '111-11-1111'

DELETE FROM EMPSAL@AL
WHERE Empssn = '111-11-1111'

UPDATE EMPBIO@NY
SET Emploc = 'LA'
WHERE Empssn = '111-11-1111'

UPDATE EMPSAL@NY
SET Emploc = 'LA'
WHERE Empssn = '111-11-1111'
```

one site (known as the coordinator) controls the distributed transaction. The other sites (the participants) respond to its commands. The sequence of actions is as follows:

Phase 1

1. The coordinator writes a Prepare record to its local log file and then sends a Prepare to Commit record to all participants.

2. The participants, on receipt of the Prepare to Commit message, attempt to write all the information needed to process the transaction to their local logs. If this succeeds, they write a Ready record to the log and send a Ready message back to the coordinator. If it fails, they abort their transaction and return an Abort message.

Phase 2

3. The coordinator evaluates the responses. If no participant has timed out or answered Abort, it writes a Global Commit record to its log and then sends the participants a Commit message.

4. The participants, on receipt of the Commit, write a Commit record to their logs, commit the transaction, and return an acknowledgment to the coordinator.

5. The coordinator writes a Complete record to its log.

This protocol is resilient in the face of network failures and site crashes.

Thus far, no single DDBMS implements all the features of the theoretical model presented here. For a description of an actual distributed database system and a demonstration of how you would use it to implement the example database, see the text box "DDBMS Meets Reality" on page 272.

Pluses and Minuses

Distributed database technology offers several important benefits. Distributed architecture reflects the geography of the business world, with global, decentralized corporations. Allowing local processing to be done at the local site serves this corporate structure much better than concentrating all processing at a central site. It also allows a smaller volume of transactions to be handled by smaller, less expensive machines.

In addition to reflecting the geography of today's business world, distributed databases can also correct some of the problems inherent in that geography. Decentralization brought with it a proliferation of incompatible hardware, operating systems, DBMSes, and communications protocols. A DDBMS can provide significant benefits by tying all these disparate local pieces into a unified global system.

Other important advantages include the increases in the reliability and availability of the system as a result of redundant data storage and the fact that a distributed system can easily accommodate incremental growth by simply adding new machines to the network.

Finally, intelligent use of parallel processing in the distributed environment may actually yield performance that is superior to centralized processing, in spite of the increased communications costs. In his book *The Ingres Papers*, Michael

continued

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DDBMS Meets Reality

Distributed databases exist not only in theory but in fact. Two of the most talked-about systems are Ingres/Star and Oracle.

Ingres/Star is the distributed version of Ingres, one of the first relational database implementations. Its current version, release 6, represents a high level of development in distributed database technology.

Oracle also offers distributed processing, but it does not provide as high a level of support as does Ingres/Star. The distributed version of Oracle has no global intelligence overseeing the distributed database. Rather, it acts as a loose confederation of local databases linked by communications drivers.

Because of its superior support for distributed databases, I selected Ingres/Star to demonstrate how you implement a real-world distributed database.

Ingres Features

The distributed Ingres architecture consists of three components: network nodes and their associated local databases, the communications links between nodes (managed by Ingres/Net), and distributed databases that can incorporate tables from multiple local databases. These distributed databases are the purview of Ingres/Star.

You link tables from local databases into a distributed database with the REGISTER AS LINK or CREATE LINK commands. These also create tables in the distributed database. Ingres/Star stores the table in a local database and places a link to it in the distributed database.

A distributed database organizes multiple local databases into a single global entity. A user at any network node can log onto a distributed database and access tables in it as if they all resided right at the user's local site. Thus, Ingres/Star implements location transparency.

Ingres/Star designates the network node where you create a distributed database to be the coordinator node for that database. This node then tracks the location of all the tables in the distributed database and manages the global data-dictionary tables. The ADD NODE command makes other network nodes aware of the existence and location of the coordinator and lets users at those nodes log onto the distributed database without knowing where it's kept.

Strong Points

A critical piece of a distributed database management system is a first-rate distributed query optimizer. The task of the optimizer is to figure out how to process a distributed query most efficiently. It must break the query down into operations on local tables and then determine how to move the resulting tables around the network. A poor distributed optimizer can make disastrously wrong decisions. (In reference 3, Chris Date presents an example of a three-table join where processing time could range from 1 second to 2.3 days!)

Ingres/Star has a very sophisticated query optimizer that can analyze network conditions with a high degree of precision. For example, the Ingres/Net utility `netu` enables you to tell Ingres about the speed of each link in the network and the processing speed of the local CPUs. The Ingres/Star optimizer uses this data in its evaluation of processing strategy.

Ingres also provides gateways into a number of other database and file systems, including IBM's DB2, SQL/DS, IMS, and VSAM; DEC's RMS; Cullinet's IDMS/R; and Data General's DG/SQL. A distributed Ingres/Star database can include local databases using any of these systems; the distributed database still looks like a single Ingres database to its users.

Limitations

Ingres/Star does not permit multisite update transactions: It cannot guarantee that a transaction that has to update tables at more than one site will leave the database in a consistent state. This requires distributed applications to be less ambitious than they might otherwise be, and it also obliges database administrators to constantly monitor the database for any signs of inconsistency.

Ingres/Star also lacks support for fragmentation and replication transparency. As you saw, these are desirable features for a DDBMS because they give users an integrated view of the global database. With Ingres/Star, you don't need to know where table fragments reside, but you do need to know which fragment stores which data.

A Real-World Implementation

In the sample database, the EMPLOYEE table was fragmented horizontally and vertically. Because Ingres/Star doesn't support fragmentation, to implement this database you have to decide whether to reintegrate the vertical fragments (EMPBIO and EMPSAL) or to treat them as discrete tables. The purpose of the fragments is to restrict access to tax and salary information; you can get the same effect by creating views and defining authorizations on the views. This simplifies the physical structure of the data and provides the desired logical fragmentation. To implement this pseudofragmentation, you create an EMPLOYEE table, an EMPBIO view, and an EMPSAL view. You also create an index, EMPNDX, on the `Empssn` column.

Next, you need to define links between the tables and the distributed database. The tables must have unique names; to preserve location transparency, you should assign names that emphasize logical function rather than physical location. One effective method is to use suffixes on base table names. For example, you could designate the New York EMPLOYEE table as `employee_east`, the Chicago table as `employee_midwest`, and so on. The table `employee_hq` stores the data uploaded from the regional offices, including a copy of New York's local data.

You use the Ingres/Net network utility `netu` to define five network nodes: New York, Chicago, Atlanta, Phoenix, and Los Angeles. Each remote node has its own local database, and New York has two: one for its local data and one for the global corporate data. The databases are called `vi_hq`, `vi_new_york`, `vi_atlanta`, `vi_chicago`, `vi_phoenix`, and `vi_la`.

You create the distributed database and the local database at the New York node with the following commands:

```
createdb vi_hq
createdb vi_new_york
createdb vi_ddb/d
```

The `/d` parameter indicates that the database `vi_ddb` is distributed, rather than local. Once a database is created, you enter

```
sql vi_ddb/d
```

to load the SQL interpreter and connect it to the new database. To enable transparent access to the database from the nodes, you enter an ADD NODE command for every node on the network.

Creating the Local Databases

Once the distributed database is established, every node must create its local database with its tables and associated views and index and then link them into the distributed database. For example, the Chicago office would first create its local database (vi_chicago) and access it with the SQL interpreter. At this point, Chicago creates its local copies of the EMPLOYEE table, the EMPBIO and EMPSAL views, and the EMPNDX index.

To link these objects into the distributed database, Chicago goes back into the SQL interpreter. This time it connects to the distributed database and uses the following REGISTER AS LINK commands to enter the local objects into the distributed database:

```
REGISTER TABLE
employee_midwest
AS LINK FROM EMPLOYEE
WITH NODE = CH,
 DATABASE = vi_chicago

REGISTER VIEW empbio_midwest
AS LINK FROM EMPBIO
WITH NODE = CH,
 DATABASE = vi_chicago

REGISTER VIEW empsal_midwest
AS LINK FROM EMPSAL
WITH NODE = CH,
 DATABASE = vi_chicago

REGISTER INDEX empndx_midwest
ON employee_midwest
AS LINK FROM EMPNDX
```

Repeating these steps at all five regional offices completes the creation of the distributed database.

Replicating the Tables

In the theoretical design, the company implemented a circular backup scheme whereby each regional office maintained on-line backup copies of the tables for one other site. This introduces an additional level of complexity into the distributed database because every time a user updates a local table, the backup copy must also absorb the change.

Such complexity creates problems in three areas. First, transmitting the changes to the backup site increases communications costs and degrades performance at the primary site. Second, someone or some application has to know about the duplicate copy of the table and take responsibility for propagating the update. Third, this system, by definition, eliminates efficient single-site update transactions—all updates involve two sites.

The first problem involves a tradeoff. If you don't maintain backups, you increase performance and lower costs, but you also sacrifice availability and reliability. This is a management decision, not a technical issue.

The second problem is technical. If the DDBMS provides replication transparency, application programs need not worry about backups; the DDBMS handles all the complications. However, if it doesn't, applications must propagate the updates. If the replication strategy changes, so must the applications. Because Ingres/Star doesn't currently support replication transparency, the burden lies entirely with programs and users.

The third issue is critically important. If all transactions are multisite, you depend on the DDBMS to protect them. It must therefore implement some form of Commit protocol to protect their integrity. However, because Ingres/Star doesn't do this at present, you can't be sure that both the primary copy and the backup will be updated successfully. Thus, it's better to err on the side of caution and not permit an interoffice query if the target site is down. The strategy of backing up each site's tables at one other site should be abandoned.

Listing A: *Ingres/Star SQL statements that upload updates to the headquarters database.*

```
DROP TABLE employee_hq_backup

CREATE TABLE employee_hq_backup
 AS SELECT * FROM employee_hq
 WITH NODE = NY,
DATABASE = vi_hq

(If this step fails, we cancel the upload.)

DROP TABLE employee_hq

CREATE TABLE employee_hq
 AS
 SELECT * FROM employee_east
 UNION
 SELECT * FROM employee_south
 UNION
 SELECT * FROM employee_midwest
 UNION
 SELECT * FROM employee_mountain
 UNION
 SELECT * FROM employee_west
 WITH NODE = NY,
DATABASE = vi_hq
CREATE INDEX empndx_hq ON employee_hq(Empssn)
```

Collecting the Tables

Collecting the tables at headquarters presents no problems. In fact, it's quite easy, and any network node can do it simply by connecting to the distributed database. Listing A shows the SQL statements that perform the uploads. Because the update transactions use the DROP TABLE and CREATE TABLE statements, you should keep a backup copy of employee_hq (called employee_ hq_backup) for protection in case the CREATE TABLE fails. Again, I emphasize that any node in the distributed database can execute this procedure.

That wraps up the Ingres/Star implementation of the sample database. Although the hypothetical design of the database had to be scaled back to accommodate Ingres/Star, the resultant system remains quite useful. Considering that Ingres/Star could have implemented this database even though the local database systems might be a mix of DB2, IMS, and Ingres, you begin to see the value of distributed database systems in a heterogeneous network environment.

Stonebraker presents benchmark test results that show distributed Ingres outperforming single-site Ingres when parallelism is maximized (see reference 2).

On the downside, distributed databases entail considerable communications overhead, especially in WANs with relatively slow data transfer rates. The distributed query optimizer must minimize this overhead. If it makes a wrong decision, the DDBMS may perform very poorly when it tries to move large quantities of data over slow transmission lines.

Also, transaction management, concurrency control, and recovery from failure present major challenges when you develop a DDBMS because they entail considerable software complexity. Consider them carefully because they are important in protecting data integrity.

Poised for Rapid Growth

Because of their speed, LANs are ideal platforms for distributed database systems. The communications overhead is much lower than that on a WAN. Thus, LANs are well positioned to exploit the parallel processing that DDBMSes offer.

OS/2 and Unix/Xenix provide the operating-system support that a DDBMS requires. To coordinate processing on multiple sites, the DDBMS must be able to initiate software activity at those sites. This could mean loading and executing programs or waking up a server process.

Although a microcomputer running MS-DOS can provide this service through interrupts, it must run in dedicated mode. In addition, because an MS-DOS machine can service only one request at a time, it can easily become a bottleneck in the system. Only a computer running a multitasking operating system can provide high performance in a DDBMS.

With the availability of high-speed LANs and powerful multitasking operating systems, the microcomputer environment is poised for rapid growth in distributed database technology. ■

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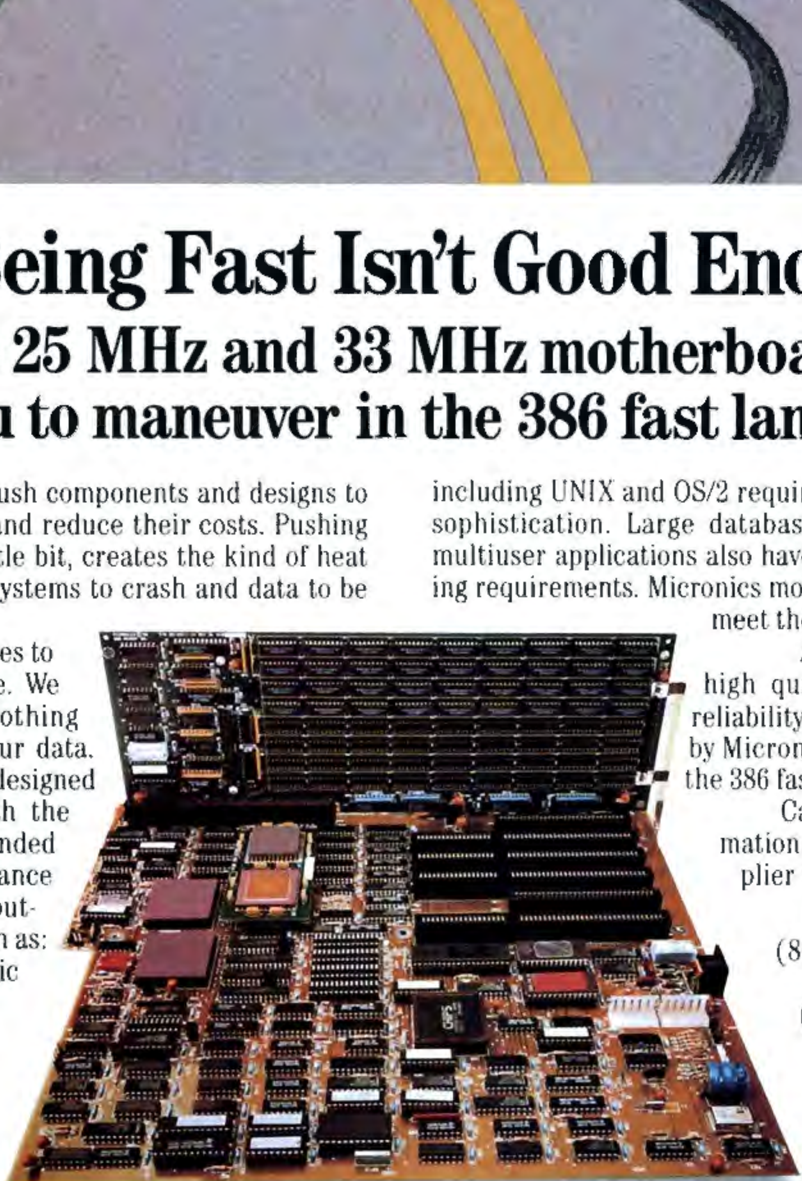

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A Family of Models

Can object-oriented databases be as successful as relational databases?

Joseph Dawson

When the dust from the great database debate settled in the early 1980s, the relational data model emerged as the sine qua non of database design technology. However, people found that the relational model is weak in handling certain types of applications: specifically, complex design applications such as CAD and computer-aided software engineering.

For instance, an electrical engineer's CAD software typically includes schema-capture editors, design-rule checkers, and circuit-layout programs: all subsystems that require massive amounts of persistent data. Such an application places demands on conventional databases that they cannot easily satisfy. These include the ability to model very complex data and evolve the database without affecting the current application base. Over the last few years, researchers have developed object-oriented database management systems to better meet the needs of complex applications.

Object Orientation

In an object-oriented programming environment, an object is an entity with a private memory and a public interface. You use messages to instruct an object to report on or alter its private memory. Messages are implemented by procedures (i.e., methods) that have special privileges in accessing the object's private memory. All objects belong to a class (i.e., a type) that defines the messages that the object can understand and respond to. A class inherits all the messages from its superclasses. In simple terms, an object consists of both private data and the methods that can act on that data.

Object-oriented databases are rooted in the same concepts as object-oriented languages, but they add characteristics such as persistence, concurrency control, resiliency, consistency, and the ability to query the database. You can program an object-oriented database with a computationally complete programming language and include more of the application execution in the database itself. By including more of the application code in the database (which is the locus of sharing), it becomes possible to share the application semantics embedded in the code. The database system can use additional knowledge about these programs to optimize query processing and to control the concurrent execution of transactions.

Unlike the relational data model, a single object-oriented data model has yet to emerge. Instead, research continues on a number of models (see references 1 through 8) that share several high-level features. Development also proceeds on

continued

a few commercial products.

Despite the lack of a single data model, research into the design of object-oriented databases shares many common goals. One goal is to provide a system with tools for building extensions. You need extensibility because new applications often involve unpredictably complex forms of data that evolve over time. A fixed set of data-structuring primitives won't adequately support arbitrary new design data. Extensions add functionality to the data model at a level indistinguishable from the built-in primitives.

One way you can provide extensions is to create new types. A type is a template that indicates how you can manipulate the type's instances. In programming languages, type checking is commonly performed to ensure that the types of expressions match the context in which they are used. For example, when making an assignment, the type of the variable to the left of the operator must be compatible with the type of the expression to the right.

An important aspect of a type system is whether type checking is done at compile time or at run time. The Trellis/OWL language (see reference 9) developed by Digital Equipment Corp. combines strong typing, abstract data types, and inheritance. The resulting language also type checks at compile time.

Creating new types is not new to databases, but the idea that a type encapsulates its representation is. Earlier database models provided you with a fixed set of built-in types and a small set of type constructors (e.g., records). You could build new types with the type constructors, but these new types didn't allow for operations that were different from those defined by the type constructor (e.g., for records, the operations are the basic get-value and set-value operations on its fields). In other words, there is no way you can hide the representation of a new type.

Encapsulation lets you build a system from modules that you access through a well-defined interface. The abstract data-type approach defines the interface by a set of strongly typed operation (or method) signatures. It also requires that each type T define a representation R (some other data type). An instance of R must be allocated whenever an instance of T is created. This representation stores the state of the object. Only the methods are allowed to access the representation, so you can change the representation without disturbing the rest of the system—all you have to do is recode the methods.

You also characterize object-oriented data models by their ability to make references through an object's *identity* (which is something about an object that remains invariant across all possible modifications of its state). You can use this identity to point to an object. Pointers have been a part of most modern programming languages for some time and were a part of some early database models (e.g., CODASYL). By contrast, the relational model is value-based because it lacks this notion of identity.

Another object-oriented model feature is a typing scheme that includes some mechanism—dubbed *inheritance*—by which type definitions can be related to each other through a type lattice. The basic notion is that you modify type definitions incrementally by adding subtype definitions that modify the original type. The combination of the supertype and the subtype produces a completely defined new type.

Database Considerations

Object-oriented databases are first and foremost databases. As such, they must provide the features and functions you'd expect from modern database systems. Among these features are persistence, concurrency control, resiliency, consistency, and associative access.

Persistence is an object's ability to outlive the process that created it. A persistent object exists in a memory space that is not dependent on any single computational entity. This persistent memory space—the database—can store a large number of objects, more than will fit into the virtual memory of a process. It typically provides some special storage structures (e.g., B-trees) that allow you to search and access this collection of objects efficiently.

Many concurrent processes (i.e., transactions) can share the persistent memory space. The medium of sharing is usually the object. Concurrent access to the shared objects requires that operations from these transactions be synchronized so you don't obtain unexpected results.

A database must also be resilient or fault-tolerant in the sense that if a system failure occurs (whether hardware or software), inconsistencies are prevented. Most database systems approach resiliency by requiring that applications divide their work into transactions. The system will guarantee that a transaction either completes successfully or has no effect on the database at all. This guarantees that transactions behave as atomic units of work.

Each program accessing a database is a potential source of inconsistency. Database systems guard against these errors by describing a set of constraints that must be maintained by all program updates. A sample constraint might be "Employees cannot make more money than their managers." The system will block any program that attempts to violate a constraint. Constraints are usually captured as a predicate calculus-based language or set of rules. There is great interest in enriching the type systems of object-oriented databases to incorporate this type of constraint knowledge.

The final characteristic that an object-oriented database must address is associative access, or *queries*. A query is constructed from a set of operations that are defined on collection types (e.g., sets). These operations return new structures based on the original database. Relational databases have been very successful at achieving these capabilities. Much current research focuses on whether or not an object-oriented database can be as successful in this area.

The question is whether object-oriented databases can handle query optimization extensibly and in such a way that storage details are encapsulated or hidden from the interface. Since queries can contain arbitrary combinations of user-defined operations, it's difficult for an optimizer to discover equivalence-preserving transformations. The optimizer must be able to figure out when a transformation is less expensive than the original when the implementation is hidden.

Relating to the Relational

The relational model is the state of the art in the commercial database field. Therefore, it is worthwhile to explore how object-oriented databases differ from their relational counterparts.

Relational databases present you with a view of the persistent data space, consisting of primitive values of integers, reals, and strings, and structured values represented as tuples or sets of tuples (i.e., relations) over these primitive values. (A tuple is a one-dimensional table. A set of tuples constitutes a two-dimensional table.) This high-level view of data is very convenient for applications that primarily produce reports. It is a hindrance, though, for programs that are at the same level of complexity as a CAD system or program development environment. These programs require tight control over how storage is used. They often need to use data structures like stacks, queues, or streams of bytes. An object-

continued

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oriented database lets you create abstractions that match the data structures that are needed for intricate tasks.

The relational data model is value-based, as opposed to earlier, identity-based data models like CODASYL. This distinction is based on the mechanisms that a data model provides for relating objects to one another—a fundamental part of any database model. A value-based system expresses the relationship between two objects by embedding the same (or a similar) value in two or more related objects. An identity-based model can relate two or more objects independently of embedded values or the context in which they are embedded.

If the clusters are set up properly, the number of disk faults declines.

Object-oriented database systems share this identity-based characteristic with network models like CODASYL. However, this one similarity is not enough to conclude that the models are essentially the same. Object-oriented models add abstract data typing based on behavioral modeling (i.e., methods or operations) and an incremental modification mechanism in the form of inheritance, resulting in a model that is quite different from its network predecessors.

Although object-oriented systems can form references based on identity, this is not the sole basis for relationships in the model. A model such as Brown University's ENCORE (see reference 8) can relate objects through properties as well. A property is a reflection of the abstract state of an object. As such, a property P relates an object X to a set of objects S with no statements about how this relationship is computed. It could be computed by a direct reference to the identity of S (or its members) or by matching values for other properties as a join. Consider the following type definition:

```
Define Type Employee
 Properties
   name: String
   dept: Department
   projects: Set of Project
```

The dept property, which expresses the department that a given employee works in, could be implemented by an embedded object identifier that refers directly to an object of type Department. On the other hand, if the representations for both the Employee and the Department types are tuples in a relation, the dept property could be implemented by a relational query of the following form:

```
dept(e) = Project((Join(Select
   (Employee,name = name(e)),
   Department),Department)
```

In this way, an object-oriented database provides a framework for unifying value-based and identity-based access.

An object-oriented database must be able to define new abstractions and to control the implementation of these abstractions. From the above example, you can see that it's possible to combine both identity-based and value-based relationships at the implementation level while retaining the same abstraction at the logical level. The particular choice between these two may have an impact on the performance of certain queries.

Implementation Considerations

Due to the nature of the applications they support, object-oriented database implementations entail some unique problems. For many design applications, it's important to be able to traverse a graph structure efficiently. Tools like a design rule checker in an electrical CAD application require that, given one component, the system must be able to quickly reference the other components connected to it. If a program is working on a circuit board, it will often require the backplane that that board is connected to. Although you can view this kind of access as a degenerate query, other implementation techniques might be more useful for this type of access than techniques that have been designed for queries over large sets.

One way you can improve performance in this situation is to minimize the probability that traversing an edge in the graph will cause a disk fault. You can do this best with intelligent prefetching. Often a scheme is used that allows applications to create arbitrary-size collections of objects (called *clusters*) that are stored contiguously on the disk. Whenever any object in a cluster is accessed, the entire cluster is read (prefetched) into the memory of the application.

If the clusters are set up properly, the number of disk faults declines. Determining how to automatically configure a set of clusters for a particular pattern of accesses will require more research.

When using an object-oriented database to serve a network of workstations, you designate one or more machines as object servers that will supply application programs with objects as needed. In such a system, you need to minimize workstation and server communications. The intelligent caching of objects in a manner related to clustering techniques is a useful way to reduce communications. The point is to keep objects as close as possible to their point of use.

Pointers to objects in programming languages are implemented by virtual memory addresses. For persistent objects, you must use pointers that are not dependent on the object's physical position, since there is no guarantee that the position will remain constant between uses by different processes. Instead, you would typically use some kind of system-generated surrogate. Dereferencing these pointers usually requires looking up the value in a hash table to locate the object on disk. Once the object is located and read into virtual memory, you'll need to eliminate the overhead inherent in this table lookup. Various schemes have been proposed for temporarily replacing the disk-based pointer with a virtual memory address and then swapping it back to the disk-based surrogate when the object is returned to the disk.

Another classic way to improve database performance is to introduce auxiliary access methods that can be used to limit the amount of searching required. Indexes have normally been used in this way to increase the system's ability to process queries efficiently. However, indexes on method results introduce problems for object-oriented databases. Unless you restrict the kinds of indexes that can be constructed, it's difficult to know when an index requires updating.

Index structures can be useful for managing large collections of objects or for handling very large objects (e.g., bit maps). The EXODUS storage system designed at the University of Wisconsin (see reference 2) constructs a tree for large objects, so you can retrieve smaller pieces more efficiently. The tree structure allows you to access a sequence of bytes from the middle of a large object without having to read the entire object.

Query Processing

A query is a high-level specification of a set of objects you want to access. You usually specify a query using a special language that allows you to describe what

continued

you want to retrieve without requiring a statement of how to go about doing it. It's the query processor's job to figure out the most efficient plan for retrieval. Query languages (i.e., fourth-generation languages) and their associated optimizers have been one of the major achievements of the relational approach.

Some proposed extensions to existing relational query languages embed object-oriented facilities in relational languages like SQL. Others propose a set of operations that you can apply to aggregate objects, thereby providing an object-oriented query algebra.

Non-first-normal-form relations (in which a cell in the relational matrix contains more than one value) address the problem of expressing complex objects with components that can be sets of objects. They extend the conventional relational model by allowing the value of an attribute (i.e., the contents of a cell) to be a record, a vector, or another relation. Object-oriented databases solve this problem, but they also introduce ideas of identity, data abstraction, and inheritance.

Queries in the object-oriented model can be cast as expressions involving special methods defined on the types that are defined for aggregating objects (e.g., `Set`, `List`, and `Tree`). As a simple example, the type `Set` would define a method as follows:

It's the query processor's job to figure out the best plan for retrieval.

```
Select(S1: Set(T), P:
  Predicate) -> S2: Set(T)
```

The predicate is a function of the form `P(t:T) -> Boolean`. The output argument `S2` is a subset of all the elements of the first input argument `S1` such that they satisfy the predicate `P`; that is,

```
Select (S, P) = { s | s in S and P(s) }
```

The `Select` operation would be part of a query language and is similar to the `Select` operation in the relational algebra.

Why is querying in an object-oriented model different from querying in the relational model? Because you can construct an algebra for expressing queries over sets of objects. One problem involves optimizing these expressions. In the relational model, queries are cast in terms of well-defined operators over very simple structures (i.e., normalized relations). In the object-oriented models, queries can involve operators for newly defined abstract data types. Each new type, by introducing new operations, creates a new algebra whose properties are unknown to the query optimizer. If you don't know the algebraic properties of these new operators, it's difficult to transform query expressions into alternative equivalent forms.

This problem has been addressed in the EXODUS project (see reference 10). Here, the optimizer is extended after being supplied with transformation rules to cover new data-model features. These

continued

rules transform query trees with operations for internal nodes and stored data for leaf nodes into equivalent query plans. A plan is also a tree with lower-level access routines as internal nodes and sequential data sets as leaf nodes.

Encapsulation of implementations by abstract types presents another problem for query optimization in object-oriented databases. Even if you could produce transformed versions of queries, you must be able to determine the relative costs of processing these query expressions. Processing costs are typically dependent on the underlying storage structures for the objects and their aggregates, which might be difficult to determine from the implementation of the methods.

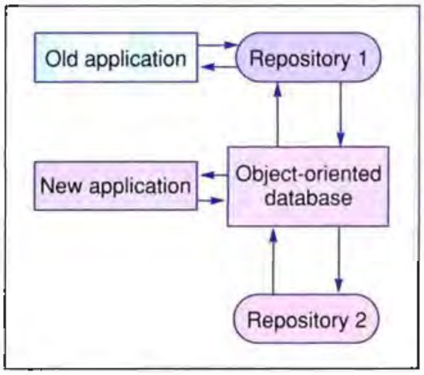
For example, if a given set S is implemented by a B-tree on some attribute A, then retrievals over S on attribute A will likely be relatively inexpensive. Knowing about the existence of such storage structures seems at first to be a violation of encapsulation.

Encapsulation is a principle of good software structuring that is important to preserve between application-level modules. The query optimizer is a trusted component of the database system; it can look inside an abstract data type and determine the implementation. There is still a question about how this can be effectively managed if the implementation can be based on other types. Graefe and Maier (see reference 11) have suggested a technique, called *revelation*, by which an abstract data type can reveal to the optimizer details about its implementation. This revealed behavior is given as expressions that are equivalent to pieces of the query in terms of the lower-level implementation types.

Transactions

To preserve the correctness of the database in the face of concurrently executing processes, database systems define an atomic transactions concept. Transactions are units of work that, when allowed to proceed concurrently, are guaranteed to produce results that are equivalent to the results produced by serial execution. Any interleaving of operations that preserves this property is considered *serializable*.

Many implementations have been proposed that guarantee serializable executions. Most are based on read/write semantics. That is, the reads and writes on a data item X are both defined to conflict with other writes on X. The data manager then decides when to schedule a read or write so that serializability is maintained.



An object-oriented database uses abstraction to ensure interoperability between older applications and newer ones. Older applications access their data repository as before. Newer applications take advantage of the abstraction mechanisms provided by the object-oriented database to access both old-style and newer repositories.

Object-oriented databases present an opportunity to improve on more traditional approaches. In the object-oriented approach, the database system knows more about the operations being performed. They are not simply reads or writes, but rather have more semantics. For example, for a queue data type, you would have operators like enque and deque. From one point of view, these can be considered a write and a read, respectively, but if you take the special semantics of these operators into account, you can achieve a higher degree of concurrency.

Suppose you have a queue object Q and two transactions, T1 and T2. If T1 has done an enque on Q, then T2 would be prevented from doing a deque on Q by common read/write semantics until T1 has committed. However, if you notice that, for nonempty queues, these two operations do not affect each other's results, you can allow them to proceed without conflict.

For cooperative applications like those seen in design environments, the notion of serializability is too strong a correctness criterion. Designers interact with many of the objects in their environment by using graphics-oriented editors. If you consider a session with an editor (or group of editors) as a transaction, serializability gets in the way. Designers do not serialize. Instead, they share information in incomplete states with each other.

Furthermore, a single transaction T might touch objects that are connected through complex integrity constraints with a large number of other objects. If T is to check and adjust the state of these objects so that they remain consistent, then T must acquire locks (read and/or write) on all of them. This reduces the amount of concurrency possible between long design transactions. Researchers are beginning to propose schemes to allow users to customize the correctness criteria that the system imposes.

Distributed Objects

When supporting a network of design workstations, you must confront the additional problems presented by a distributed database environment. To simplify programming and preserve data independence, distributed databases strive for transparent distribution. You should be able to name the data the same way you would in centralized databases. The system is responsible for locating the required data items and updating them atomically. You only have to worry about logical issues. As the data is redistributed throughout the network, the programs remain invariant—the system generates new optimizations for processing queries that require data from different sites, depending on the current locations of the data.

In an object-oriented database, programs (more correctly, methods or operations) are often viewed as objects and thus can be moved around the distributed database just like any other object. When performing a computation or processing a query, the system has the choice of moving the data to the programs, or the programs to the data. When executing a method M on a very large object X, it's often more reasonable to move the method to the machine on which X resides.

You can also use caching strategies in a distributed system. As objects move from machine to machine, retaining local copies for some period of time can often shorten subsequent retrievals.

If object placement is not done carefully, the interpretive nature of distributed object-oriented systems can create acute performance problems. Late binding of method names to method bodies requires looking at several objects to determine what code needs to run. Minimizing communications by careful object placement and by using an intelligent planner makes a huge difference in the performance of a distributed object-oriented database. The planner determines the order of operations, the machines that perform them, and the location that receives the result.

continued

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Networks made up of heterogeneous systems are a problem in a distributed environment because there is little control over the characteristics of the participating systems, yet these systems must work together. This heterogeneity can take several forms based on differences in the underlying data formats of the participating tools and systems, in the languages used for developing applications, and in how designers need to share information.

The abstraction mechanisms of object-oriented systems can be used to build bridges to existing data repositories, which become the implementation vehicle for new abstract types. The representation for this new type would be some data structure that the foreign data repository supports. Whenever a method of this new type is invoked, the method code would make a call to this repository to access the external representation. An old application would access and update persistent data the same way it always has, but a new application would access it through abstract types that are defined in the object-oriented schema (see figure). Although this might be somewhat slow, the ability to access data across different storage systems is often a requirement.

Other Features

The literature on object-oriented databases often discusses features that are not required to achieve true object orientation but are useful to a database system for CAD applications. These include version control, complex objects, and long (and cooperative) transactions. They appear in this context more for their applicability to design environments than to any inherent object-oriented nature.

A version management facility within an object-oriented database lets you look at an object as a set of snapshots over time. There are several concerns with implementing version management, however. One is the basic structure of a set of versions. A database must be able to handle situations where two or more processes propose to update the same object. One solution is to branch the versions, especially when these competing versions conflict on some basic assumptions. Additionally, you may want to provide a mechanism whereby branching versions can merge.

Another set of questions concerns how you reference the members of an object-version set. One method is to reference them statically by version number. Another is a dynamic mechanism that uses a function to return a specific version. This function might return different versions at different times.

Complex objects model objects that are built out of other objects. The crux of a complex-object facility is the semantics of the `part_of` relationship; that is, the relationship between the constituent objects and the complex object. Work in this area is concerned with allowing the database system to ascribe additional behavior to the `part_of` relationship that affects the behavior of other operations. For example, when an object is deleted, you want the objects that are *contained* (i.e., related by the `part_of` relationship) by it to be deleted also. For more detail on optimizing access to complex objects, see reference 12.

Non-first-normal-form relations address the problem of expressing complex objects with components that can be structured objects. They extend the conventional relational model by allowing the value of an attribute to be a record, a vector, or another relation.

The Sum of the Argument

Object-oriented databases are designed to meet the data-handling needs of complex design applications. While the data-modeling facilities of these systems resemble object-oriented programming languages, the database systems embed persistence, concurrency control, recovery, consistency management, and a query language.

In addition, object-oriented databases might design the data model somewhat differently from their language counterparts to effectively support database features. An example of this is the way the model incorporates aggregates (i.e., sets) into the system. Sets form the basis for efficient queries.

The history of database management is filled with proposals for competing data models. Each model has its own set of strengths and weaknesses. The object-oriented approach can unify some of these dissimilar approaches by providing a model that is based on abstraction, and that allows type designers to use whatever technique best suits their applications as an implementation of basic functionality. Although many research questions remain unanswered, the object-oriented data model holds the promise of providing advanced data handling for today's increasingly complex application environments. ■

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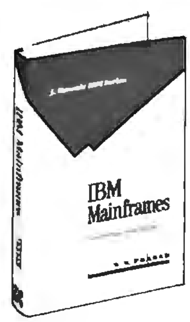

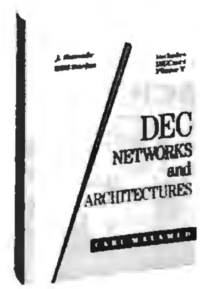

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P39826

The Data File

Desktop publishing may be the rage, and multimedia presentations the "next big thing," but no single software system is more important to a business than a reliable DBMS. Listed below is a sampling of the most powerful database systems available for personal computers. With few exceptions, the products listed adhere (to some degree) to the relational data model. They all provide you with a means to get a handle on your data. Items are arranged alphabetically by company name.

Acius, Inc.
20300 Stevens Creek Blvd.
Cupertino, CA 95014
(408) 252-4444
4th Dimension $695
Multiuser, customizable relational database for the Macintosh.
Inquiry 1181.

Advanced Data Servers
P.O. Box 4937
Boise, ID 83711
(208) 377-1906
SQL Mach 1 .... $23,950
Hardware-based SQL database server with 4 megabytes of RAM, a 320-megabyte hard disk drive, a 150-megabyte tape backup system, and many connection options. Supports multiple operating systems and LANs.
Inquiry 1182.

Aker
19782 MacArthur Blvd.,
Suite 305
Irvine, CA 92715
(800) 345-6244
(714) 250-1718 in California
PC Magic
MS-DOS version $299
Novell, 3Com, and IBM networks version $699
Fill-in-the-blanks database applications development system based on Novell's Btrieve.
Inquiry 1183.

Alpha Software Corp.
30 B St.
Burlington, MA 01803
(617) 229-2924
Alpha Four $549
Menu-driven, fully relational database management and applications-development system for MS-DOS; dBASE-file-compatible.
Inquiry 1184.

American Databankers Corp.
5295 Camerson Dr.,
Suite 107
Buena Park, CA 90621
(800) 323-7767
Databoss $399
Multiuser database development system for MS-DOS machines. Generates Turbo C and Turbo Pascal code.
Inquiry 1185.

ASAP, Inc.
1041 41st Ave., Suite E
Santa Cruz, CA 95062
(408) 476-3935
Universal Base Six $395
MS-DOS stand-alone DBMS designed for personal applications.
Inquiry 1186.

Ashton-Tate Corp.
20101 Hamilton Ave.
Torrance, CA 90502
(213) 329-8000
dBASE III Plus $695
Programmable DBMS for large MS-DOS data management tasks; can be used as a stand-alone or on a LAN.
dBASE IV $795
Enhanced dBASE for MS-DOS and OS/2 with a faster, more powerful programming language and SQL emulation.
SQL Server $2495
OS/2 LAN database server designed to act as the back end in a transaction-oriented, client/server environment. See Sybase.
dBASE Mac $495
Macintosh version of dBASE.
Inquiry 1187.

Blyth Software, Inc.
3655 Campus Dr.
San Mateo, CA 94403
(415) 571-0222
Omnis 5 .... $695
Generates database applications for multiple users and a graphical user interface. Works as a stand-alone or on a LAN. Supports SQL and HyperCard.
Inquiry 1188.

Borland International, Inc.
1800 Green Hills Rd.
Scotts Valley, CA 95066
(408) 438-8400
Paradox 3.0 .... $725
DBMS with a structured programming language, query-by-example, and fully integrated presentation graphics.
Paradox 386 .... $895
Enhanced version of Paradox written to take advantage of the speed and addressing capabilities of the 80386. Use as a stand-alone or as a network server.
Inquiry 1189.

Caltex Software, Inc.
3131 Turtle Creek Blvd., Suite 11
Dallas, TX 75219
(214) 522-9840
D The Data Language
MS-DOS version $795
80286 and Novell version $1295
80386 version $1595
Unix System V version $1995
Advanced 4GL applications generator. Includes a full complement of development and data management tools.
Inquiry 1190.

Clarion Software
150 East Sample Rd.
Pompano Beach, FL 33064
(800) 354-5444
Clarion Professional Developer $695
DBMS applications development environment for MS-DOS. Produces executable code; no run-time system required.
Inquiry 1191.

Condor Computer Corp.
1490 Eisenhower Place
Ann Arbor, MI 48108
(313) 971-8880
Condor 3 .... $495
Stand-alone MS-DOS database system designed for nonprogrammers.
Inquiry 1192.

DataEase International, Inc.
7 Cambridge Dr.
Trumbull, CT 06611
(800) 243-5123
(203) 374-8000 in Connecticut
DataEase 4.0
single-user version $700
three-user version $750
five-user version $995
Database development system for MS-DOS that uses menus and query-by-example to let nonprogrammers create applications. Supports stand-alone and LAN applications, and interfaces to graphics, cross-indexing, and imaging options. A developer package is also available.
Inquiry 1193.

Dome Software Corp.
655 West Carmel Dr.,
Suite 151
Carmel, IN 46032
(317) 573-8100
Dome $25,000
Distributed database that ties Macintosh front ends with VAX hosts. Uses object-oriented development tools.
Inquiry 1194.

Fox Software, Inc.
27493 Holiday Lane
Perrysburg, OH 43551
(419) 874-0162
FoxBASE+
MS-DOS version $395
80386 and LAN version $595
FoxBase + Mac $495
FoxBase + Mac LAN server $695
dBASE-compatible DBMS with integrated compiler. Optional FoxGraph package available.
Inquiry 1200.

continued

Gupta Technologies, Inc.
1040 Marsh Rd.,
Suite 240
Menlo Park, CA 94025
(415) 321-9500
SQLBase Server
single-user version........................$1295
multiuser version..........................$2995
Database server for MS-DOS and OS/2 that supports major LANs; includes SQLWindows. Options include SQLNetwork for connecting SQLBase Server to DB2 and Library for Clipper that lets Clipper applications run against SQLBase Server.
Inquiry 1195.

Information Builders, Inc.
1250 Broadway
New York, NY 10001
(212) 736-4433
PC/Focus..................................$1295
4GL database language and development system. Provides modules for graphics, statistics, and spreadsheets and links to large systems. Supports SQL queries. For MS-DOS, OS/2, all LANs, MVS, VM, VMS, and Unix.
Inquiry 1196.

Informix Software, Inc.
4100 Bohannon Dr.
Menlo Park, CA 94025
(415) 322-4100
Informix-4GL Rapid Development System ....from $1495
Applications development system for MS-DOS and Unix based on 4GL technology.
Informix-SQL................................$795
SQL-based DBMS features interactive queries, a report writer, and applications development tools.
Inquiry 1197.

InterSystems
1 Memorial Dr.
Cambridge, MA 02142
(617) 621-0600
M/SQL................................from $2900
Combination MUMPS/SQL applications development system. For Sun SPARCstations.
Inquiry 1198.

Microrim, Inc.
3925 159th Ave. NE
Redmond, WA 98052
(206) 885-2000
R:base for DOS $725
Menu-driven relational database system for one to three users. Supports Novell and 3Com networks. Options include a natural-language query generator, an extended report writer, programming interfaces, and utilities packages.
R:base for OS/2..............................$895
OS/2 version of R:base supports multiple sessions.
Compiler for R:base $895
Advanced development version of R:base.
Runtime R:base
MS-DOS $250
OS/2 ....$300
Run-time system for R:base applications.
Inquiry 965.

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mdbs, Inc.
P.O. Box 248
Lafayette, IN 47902
(800) 344-5832
MDBS IV..............................from $3900
DBMS designed to implement on-line transaction processing applications. For MS-DOS, OS/2, LANs, VAX/VMS, Unix, and VM.
KnowledgeMan/2.....................from $695
Relational database incorporating 4GL and decision-support tools. For MS-DOS, OS/2, VAX/VMS, and LANs.
Inquiry 966.

Nantucket, Inc.
12555 Jefferson Blvd.
Los Angeles, CA 90066
(213) 390-7923
Clipper..$695
dBASE-compatible compiler and applications development system for MS-DOS.
McMax..$295
dBASE III Plus–compatible database system for the Mac.
Inquiry 967.

Novell
122 East 1700 South
Provo, UT 84601
(800) 453-1267
Btrieve
MS-DOS version...........................$245
DOS network, OS/2, Xenix, 80286, and 80386 version $595
IBM PC network, multitasking add-on $345
Provides record and file management capabilities to BASIC, C, and Pascal programs.
XQL $795
Develops applications that access relational databases. Requires Btrieve. Versions available for MS-DOS and OS/2.
NetWare SQL.................................$595
Database server for Novell Networks. Requires Btrieve.
Inquiry 968.

Odesta Corp.
4084 Commercial Ave.
Northbrook, IL 60062
(312) 498-5615
Double Helix II..............................$595
Icon-driven database for the Mac. Options available for multiple users and for use on VAX machines under VMS.
Inquiry 969.

Oracle Corp.
20 Davis Dr.
Belmont, CA 94002
(800) 345-3267
Oracle..................................from $1299
SQL-based relational database system compatible with SQL/DS and DB2 from IBM. Supports LAN client/server and distributed processing. Supports over 80 different platforms, including MS-DOS, OS/2, Xenix, Macintosh, many Unix systems, MVS, VM, Primos, and Wang VS.
Inquiry 977.

Powerbase Systems, Inc.
32100 Telegraph Rd.
Birmingham, MI 48010
(313) 540-2398
PowerBase.......................................$349
Relational database designed for nonprogrammers. Supports stand-alone and networked MS-DOS applications.
Inquiry 970.

Precision, Inc.
8404 Sterling St.,
Suite A
Irving, TX 75063
(214) 929-4888
SuperBase 4...................................$695
Programmable DBMS with a graphical interface and the ability to manage text and graphics information. For Windows and GEM.
SuperBase 2...................................$295
Nonprogrammable version of SuperBase 4.
Inquiry 1199.

Progress Software Corp.
5 Oak Park
Bedford, MA 01730
(800) 327-8445
(617) 247-4500 in Massachusetts
Progress ....from $1000
4GL applications development system for database applications. Portable across Unix, Xenix, Ultrix, MS-DOS, VAX/VMS, and LANs.
Inquiry 979.

Raima Corp.
3245 146th Place SE
Bellevue, WA 98007
(800) 327-2462
db_Vista III...........................from $695
Network model database system that uses relational access methods. Supported systems include MS-DOS, OS/2, Macintosh, Windows, Unix, BSD 4.2, Xenix, and VAX/VMS.
Inquiry 971.

Relational Technology, Inc.
1080 Marina Village Pkwy.
Alameda, CA 94501
(415) 769-1400
Ingres for microcomputers................$695
PC version of the famous relational database system.
Ingres/Star.......................Call for pricing
Distributed version of Ingres. Ties together databases running on different machines and operating systems. Resides on a VAX or Unix machine.
Inquiry 972.

Revelation Technologies, Inc.
1180 Avenue of the Americas
New York, NY 10036
(800) 327-0216
Advanced Revelation .... from $495
Database application package for MS-DOS that uses a central data dictionary.
Inquiry 973.

Small Computer Co.
41 Saw Mill River Rd.
Hawthorne, NY 10532
(800) 847-4740
(914) 769-3160 in New York
filePro Plus .... from $995
DBMS and applications development system. Works with major network operating systems. For MS-DOS, OS/2, Unix, and Xenix.
Inquiry 974.

Sybase, Inc.
2910 Seventh St.
Berkeley, CA 94710
(415) 548-4500
Sybase................................. from $2500
SQL-based relational database server. Provides the back end to client applications that generate SQL queries. Supported systems include OS/2 (SQL Server—see Ashton-Tate), VAX/VMS, SunOS, and Unix System V 3.2.
Data Workbench...................... from $875
Sybase data-administration and decision-support software.
APT Workbench...................... from $895
Aids the development of Sybase client applications.
Inquiry 975.

Wordtech Systems, Inc.
P.O. Box 1747
Orinda, CA 94563
(415) 254-0900
dBXL.. $249
Database system for MS-DOS that is fully compatible with dBASE III Plus.
dBXL/LAN $599
Network version of dBXL.
Quicksilver...................................... $599
Compiler for dBXL and dBASE III Plus.
Inquiry 976.

XDB Systems, Inc.
7309 Baltimore Ave.,
Suite 220
College Park, MD 20740
(301) 779-6030
XDB-SQL $595
SQL-based database server software. For MS-DOS, Unix, and OS/2.
XDB Server $1995
Permits client applications to access database without modification.
XDB-DBT II $1500
Applications development system that emulates CICS, DB2, and IMS.
Inquiry 978.

Inclusion in the resource guide does not indicate that BYTE endorses or recommends either the product or the company. In addition, BYTE accepts no responsibility for any omissions, changes, or errors in the information listed.

From top to bottom:
Elegance Model 1000, 20 and 25 MHz;
Elegance Model 2000, 20 and 25 MHz;
Elegance Model 3000 25MHz

A BUS TOUR

Why the big controversy over bus architectures, and why should you care?

George White

If you own a personal computer, you are more or less familiar with the computer's bus. These days, debates rage over the relative merits and weaknesses of the IBM PC AT bus versus IBM's new Micro Channel architecture (MCA) or the yet-to-be-released Extended Industry Standard Architecture (EISA). New 32-bit buses, like the Mac II's NuBus, are touted as surpassing older, 8-bit buses in speed and memory capacity. However, if you crack open your computer, you may be hard-pressed to locate the bus, since it is simply a collection of signals and their protocols, which are used to communicate between boards.

A bus is physically embodied in the connectors that carry its signals, and the logic on each board that implements the bus protocol and connection. Essentially, the three major types of buses are the system bus, the I/O bus, and the memory bus.

System, I/O, and Memory

Minicomputers and supermicrocomputers are often designed around a central common bus to which the CPU memory and the high-performance I/O are connected. This arrangement qualifies as a system bus in that it forms the backbone of the computer.

You find I/O buses at both ends of the computer spectrum. Very large computers often have an I/O bus in addition to a system bus. They may use a proprietary and specialized system bus along with an industry-standard I/O bus that allows support of various peripherals. Personal computers often use only an I/O bus, with the CPU and memory having a close nonbus connection.

A slot that accepts manufacturer-specific memory-expansion boards is not really a bus. The signals that pass to and from this slot are merely an extension of the DRAM chip signals and provide no generality (i.e., the slots are good only for DRAM boards that are manufacturer-specific). All 80386 microcomputers have 32-bit CPU-to-memory pathways, which are important features of these machines and provide much of their performance. However, you cannot think of these pathways as buses, because they only provide a connection to a manufacturer-specific memory board.

Industrial-Strength Buses

Although it's getting harder to draw a line between personal computer buses and more "industrial" buses like Multibus and VMEbus, there are important distinctions. While multimaster capability is a novelty in personal computer buses, it's a necessity for industrial buses.

In any bus transaction, there is a master and a slave. The master initiates the transaction, and the slave responds. All industrial buses and the MCA provide general mechanisms to arbitrate the bus and turn mastership over to one of the boards in an add-in slot. The basic hardware is fairly simple; how the feature is used can vary widely. The basic use of a multimaster capability is to allow I/O cards to perform true direct memory access (DMA) and to access data from main memory independently of the central processor. In the XT and AT buses, there is generally only one master, the motherboard.

Outside the personal computer world, a bus without multimaster capability would not even be called a bus. On the other hand, the built-in DMA channels in personal computer buses are unheard of in industrial buses.

In general, the key distinction between an industrial or minicomputer system and a desktop system is the motherboard. Desktop systems have one—industrial systems do not. A VMEbus-based system starts out as an empty card cage. There is no presumption about what type of CPU the designers will use or whether they will construct a multiuser computer, RISC workstation, process-control system, or flight-simulator controller.

In the design of a personal computer, it makes sense to put as many functions as possible on the motherboard. Conversely, designers of industrial buses strive to minimize the centralized logic. Most industrial buses require only clock-generation logic. Futurebus manages to dispense with even this clock

continued

ILLUSTRATION: DAVID TILLINGHAST © 1989

generation and requires no centralized logic at all.

Cost has been another issue separating these bus categories. Personal computer users are cost-sensitive, while industrial system users are more concerned about performance and reliability. As personal computers become more powerful and are increasingly used as servers and multiuser systems, designers and users find the issues of industrial buses becoming more important.

Which Bus to Ride?

Current systems are built on a wide variety of buses (with more being created all the time), each having certain higher-level properties.

Although not a technical property, the degree of a bus's openness is one critical feature. Many buses like Multibus I and II, VMEbus, NuBus, and Futurebus are IEEE/ANSI standards. Other buses are "open," but their futures are controlled by one manufacturer (e.g., IBM's MCA). Still others are de facto industry standards that no company can continue to unilaterally influence (e.g., the PC AT bus, the so-called "industry standard architecture," or ISA).

While the subject of form factors may be mundane, designers obviously cannot put as much logic on a small board as they can on a larger board. Therefore, the size of usable board space on a bus's add-in cards may limit the number of boards that a user will have to choose from. The other real estate issue is the type of connector, or connectors, from the bus to the board (see photo). The industrial buses (including the NuBus used in the Mac II) have long since gone to two-piece connectors rather than the less-reliable edge-card connectors used in personal computers.

While performance is important, raw speed is not always the most meaningful bus criterion. How fast a bus can theoretically transfer data in a peak burst may not be indicative of real performance. Performance also depends on the speed of bus arbitration, whether or not arbitration can be overlapped with the previous data transfer, and whether existing cards run at maximum bus speeds.

Although a few systems are bottlenecked by the data transfer rate of the I/O bus, more are likely bottlenecked due to the lack of intelligence on the cards plugged into the bus. Bus features like multimastering can encourage the development of intelligent I/O controllers that can contribute more than raw transfer speed.

All the industrial buses have IEEE specifications. This means that not only is there a tight specification for designers to follow, but the evolution of the bus has been taken away from one or two manufacturers and placed in the hands of a democratic body. While committees don't have a history of successfully inventing new ideas, they have been useful at codifying technology and thus providing stability of bus definitions.

The tightness of a bus specification is directly related to how easy a bus is to design to and how likely boards of different manufacturers are to work together. For example, although there is no solid specification for the AT bus, the mass market has created an evolutionary process that weeds out computers or add-on cards that don't work well with the large installed base of AT clones.

Several industrial buses, notably NuBus and Futurebus, have had *processor independence* as important objectives. This means that they are designed not to favor one CPU interface style over another, but rather to provide a more general model of communication. In contrast, the XT and AT buses are simply decoded versions of the processor signals from an Intel microprocessor.

Standard Features and Optional Packages

The basic purpose of a bus is to get bytes moved from one board to another in an efficient and standard way. Many features can be wrapped around this basic "truth." Some features are key to creating reliable, fully functioning systems, while others are bells and whistles.

Broadly speaking, *protocol* refers to the types of transactions that a bus supports. The basics are reading and writing, and, in fact, these are quite sufficient for most systems. Others might be block reading and block writing, operations that transfer multiple data items in one burst transaction. The Futurebus defines *broadcast* as a write to multiple slave boards, and *broadcall* as a read that performs an OR on the data from multiple slave boards.

Data width is a fairly basic feature; essentially, it tells you how many wires the bus has, each one leading to a bit in an address. A bus is generally 8, 16, or 32 bits wide. Most VMEbuses are 32 bits wide, but an allowable subset is 16 bits. NuBus and Futurebus are 32 bits wide with no subset. While the MCA is billed as a 32-bit bus, most MCA slots are 16-bit only.

One AT bus limitation is the size of the address space. With 24 bits of address space, only 16 megabytes of physical memory (2^{24}) can be used. That storage capacity seemed like a lot in 1983, but it will soon be limiting. All the industrial buses have a 32-bit address space, although the actual size of the address space can vary (VMEbus can be either 24 or 32 bits).

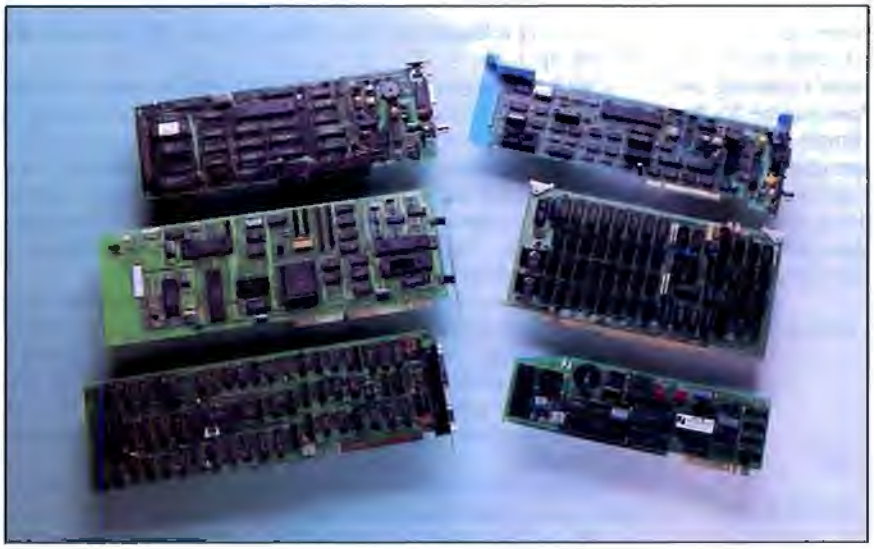
Formerly, when bus designers gathered, their most heated discussions concerned the issue of *synchronous* versus *asynchronous* buses. The first uses a single clock signal, propagated to all slots, to time all data and control information transfers. Typically, data and control lines are only valid on a certain clock edge. In an asynchronous bus, no central clock is used, and some form of handshake replaces the clock's function.

In a nutshell, asynchronous bus operations set no upper limits on the bus speed, while synchronous buses may make it easier for designers to develop more reliable, high-performance systems. NuBus and Multibus II are synchronous; VMEbus and Futurebus are asynchronous. The asynchronous school holds that synchronous buses are inherently limited by contemporary technology. The synchronous school thinks that pure, reliable asynchronous buses are difficult to invent and design to and that, in reality, the promised future performance gain is slight.

Since interrupts seem fairly basic and critical, it may come as a surprise that neither Multibus II nor Futurebus has them, and NuBus's interrupt line was only grudgingly added late in its design cycle. The standard idea of an interrupt is that a board pulls on a wire when it needs service from a single CPU. But what if you have more than one CPU? It would be nice to have a way for an I/O card to direct an interrupt to one of many CPUs in a system. The CPUs also need a way to interrupt the I/O cards and, in some cases, other CPUs on coprocessor cards.

The conventional interrupt line that the I/O board drives is quite limiting in that all devices that need to interrupt the CPU must be multiplexed onto a single line. More-advanced buses use the standard bus write transaction to convey the information that one board wants attention from another. This makes interrupts a special case of a memory write transaction, provides flexibility and directability, and eliminates special signals and hardware that would otherwise be needed. Of course, today's personal computers typically have a single CPU, but multiprocessor microcomputers are coming on strong.

Direct memory access is a feature of both personal computers and larger machines. However, the name does not mean the same thing in both realms. On the VMEbus, a controller board



Add-in boards (specifically, their connectors and the logic paths) represent the physical embodiment of computer buses. Shown here, clockwise from upper left, are boards representing six of the most popular microcomputer buses: the Mac II NuBus; the MCA; the S-100; the Apple II; the IBM PC 8-bit, and the IBM PC 16-bit. The industrial buses (including the NuBus used in the Mac II) have long since gone to two-piece connectors rather than the less-reliable edge-card connectors used in personal computers.

that is said to do DMA could arbitrate for the bus and act as bus master in transferring data from itself to memory, with no intervention by the main processor board. This simple feat would be hailed as a breakthrough example of multimastering in the personal computer world.

Personal computers have a fixed number of DMA channels on the motherboard. "Indirect" memory access would be a better name, since personal computer DMA is not really performed by the I/O board as much as by DMA chips on the motherboard.

In minicomputer systems, controllers are often developed that read control blocks from memory, perform the function indicated, put status information back into memory, and optionally interrupt the controlling CPU. Multimaster buses make this type of operation possible in microcomputers as well.

The Magic of Multiprocessing

The most sophisticated systems made possible by multimaster buses are those with true multiprocessor capabilities. Some people confuse multimaster with multiprocessor. Multimaster operation is necessary, but far from sufficient, to create a true multiprocessor. A true multiprocessor bus should also have an interrupt scheme that lets any board interrupt any other board; a particularly efficient arbitration method; and provisions for supporting multiple boards with caches.

Arbitration is an operation that keeps all the masters from trying to use the bus at once. The schemes for accomplishing this differ from bus to bus. Multibus I and VMEbus use arbitration schemes that involve daisy-chained signals. This is somewhat awkward in that any unused slots must have special jumpers inserted to continue the daisy chain.

In most modern buses, arbitration for a subsequent data transfer is carried out on a separate set of lines from those used for data transfer. This allows the overlapping of arbitration operations with data transfer. As a result, the arbitration phase adds no time to the resulting operation. When one data transfer is completed, the next one can start immediately. The MCA is the exception to this practice, performing arbitration in series with the data transfer. Thus, the arbitration phase adds to the total transaction time.

Caches are becoming more important in both the personal computer and supermicrocomputer markets. Processors are so fast that DRAM cannot keep up. A cache of static RAM is the only way to keep the CPU fed with data. Caches can be complicated, and, in a multiprocessor system, they may be especially complicated. Some buses provide hardware support for what is called the cache coherency problem. Except for a handful of proprietary buses used in high-end computers, the Futurebus is the only open bus with this feature.

These are the features most often contrasted on current buses. If industrial buses and personal computer buses continue to converge, be prepared for the marketing of bus enhancements such as geographical addressing, broadcall transactions, and cache coherency.

A Bus Inventory

The S-100 was the first microcomputer bus used in machines from different manufacturers. It was used in systems such as those from CompuPro/Viasyn. The S-100 bus provided users with the ability to add both I/O and memory options to their systems and offered a sophisticated multimaster arbitration scheme not seen in personal computer buses until the MCA. In some ways, the S-100 was the precursor to both the industrial microcomputer buses (e.g., Multibus I) and the personal computer buses (e.g., Apple II).

An 8-bit bus at first, the S-100 was extended to 16 bits. An IEEE working group ironed out several minor reliability and interoperability problems, a process that resulted in the IEEE 696 standard. Following the tradition of the S-100, most IEEE bus standards developed since then have been assigned numbers ending in 96: Multibus I is IEEE 796, Futurebus is IEEE 896, VMEbus is IEEE 996, Multibus II is IEEE 1096, and NuBus is IEEE 1196. The S-100 community is alive and well and exploring ways to extend its bus to 32 bits.

Like many buses, Multibus (now called Multibus I) started as the product of one company, became open and used by others, and then took on a life of its own. Various industrial systems and commercial computers were built around Multibus, including the original Sun boards from Stanford and later Sun Microsystems. Although not consciously processor-independent (having been developed by Intel), it was general enough that designers had no problem creating many 6800 Unix-based computer systems around Multibus.

Like the S-100, Multibus was originally an 8-bit bus, expanded to 16 bits in a cooperative effort between manufacturers and an IEEE committee. The Multibus market and user community became the model for others that followed.

continued

Although the Apple II bus was not noteworthy as a bus per se, it introduced two important features. First, each board had a ROM at a fixed address relative to the board's starting address, with both an input routine and an output routine for the particular board. This scheme provided a simple but elegant BIOS that allowed device-independent I/O operation. The second innovation was simply the shape of the board and the placement of the I/O connectors. Rather than being more or less square and sliding into card guides on both edges, it was rectangular and had its I/O connections on its outside edge. The same basic scheme was later used in the IBM PC.

In a chronology of microcomputer buses, putting Futurebus

Outside of the personal computer world, a bus without multimaster capability would not even be called a bus.

here seems odd. However, the Futurebus effort started in 1979, well before the IBM PC was announced and before the advent of the VMEbus. An IEEE Futurebus group was founded on the noble idea of developing a 32-bit bus *before* it was needed. The plan was to avoid the problems that come with an existing user base, a dilemma that faced the S-100 and Multibus I development groups. Those groups had to produce solidly engineered bus standards without unreasonably obsoleting the installed base. The Futurebus group started with a clean sheet of paper, was unencumbered by any installed-base compatibility constraints, and attracted input from bus experts worldwide.

Futurebus has not yet been designed into any commercial machines, although a very early version of the specification was used as the basis of a bus in a workstation once produced by Tektronix. Many research laboratories around the world have built prototypes of various versions of the Futurebus specification. The IEEE committee that created the Futurebus standard is now developing a standard called Futurebus+, which is gaining wider support, including support from the developers of VMEbus and Multibus II.

The best feature of the IBM PC bus is that a lot were built and sold, so it was subsequently widely cloned. It is poorly specified, is not particularly fast, and has its interrupt lines upside down (i.e., an interrupt request is indicated by a low-to-high transition on an interrupt request line rather than the other way around). But the PC bus is adequate for its target applications and has admirably achieved a critical bus feature: wide usage.

IBM upgraded its original PC XT bus for use with the PC AT. The data path was widened to 16 bits, and more address lines and interrupt lines were added. The AT bus provides crude multimastering that is little-used because it is awkward to implement and not a very high-performance method.

Several companies (not including IBM) are now upgrading the AT bus again to the EISA bus. This 32-bit bus supports multiple masters and automatic system configuration. It's not a completely open bus, since those who want access to the specification must sign a nondisclosure agreement. An estimated 200 firms, however, have paid for the spec, and with the advent of the newly released Intel four-chip chip set, the bus wars are heating up.

VMEbus was announced in 1982 and soon became a winner in the industrial bus market. It's mainly a bus for supermicrocomputers, such as those from Sun Microsystems and MIPS Computer Systems. VMEbus has been used in industrial control applications and as the I/O bus for larger machines, such as those from Sequent Computer Systems. With the other buses now available, it's unlikely that standard office-environment PC-class machines will ever be built around VMEbus.

VMEbus used a two-piece connector with the Eurocard form factor. It had support for 32 bits, and three large organizations (Motorola, Signetics, and Mostek) endorsed it simultaneously. *Eurocard* is a term for a standard card-packaging system originally used in Europe. VMEbus, Multibus II, Futurebus, and the industrial version of NuBus all use Eurocard technology.

Although the VMEbus developers didn't have the lofty technical goals of the Futurebus developers, VMEbus filled a vacuum. There was a growing realization that the Eurocard packaging was superior to the standard edge-card scheme in general use in the U.S. and that a path to 32 bits would soon be needed. (In fact, VMEbus supports both 16- and 32-bit transfers. Early VMEbus systems used only the 16-bit option.)

The original "closed" Macintoshes (the 128K, 512K, and Mac Plus), which have no bus, demonstrated the desperate need for buses. Third parties developed a wide variety of add-in products, including memory expansion, coprocessors, and internal disks. These were installed in machines against Apple's wishes and in violation of factory warranties. The ingenuity and fearlessness displayed in providing Macs with these and other capabilities illustrate the importance of open buses.

Originally designed for high-end workstations and superminicomputer applications, NuBus has found its greatest success in the Mac II (a modified NuBus is also used in the NeXT computer). NuBus was created at MIT in 1978 as a bus for a high-end reconfigurable workstation. Later, a group at Western Digital transformed NuBus into its present state (except for its form factor). Texas Instruments subsequently bought the project and used the bus in its Explorer Lisp machine. NuBus was also used in the Lambda AI computer made by the now-defunct Lisp Machine, Inc.

Its use in the Mac II and NeXT computers puts NuBus at the intersection of the industrial and desktop buses. Although used in personal computers, it has the raw speed and features of Multibus II.

While PC-clone makers are developing EISA, IBM has bet on its MCA, an architecture that has proven to be controversial. The MCA's strong and weak points are the same: its incompatibility with the AT bus. In most technologies or markets, there is a time to break with the past in order to achieve an improvement in performance and features. The given in this process, however, is that the old must really be holding you back and the new must be a significant step forward. This is still an open question regarding the MCA.

The MCA's "new" features are primarily standard elements in industrial buses: multimaster arbitration, burst transfers, and sensible interrupts. Today, the MCA is being used predominantly in the IBM PS/2 product line.

Lining Up the Buses

Although the AT bus lacks auto-configuration and high-performance multimaster capabilities, it is adequate for most desktop applications. There has been a real need for bandwidth between

continued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the CPU and memory, but ad hoc manufacturer-specific CPU-to-memory paths have solved this problem. A few more power and ground pins would be nice, as would interrupt signals that aren't upside down. A written bus specification would also be helpful. However, in spite of these limitations, board and system designers have produced a wide variety of interoperative, reliable, satisfactorily performing products.

The MCA does offer advances over the AT bus. It has reasonable interrupt lines that are not upside down, allows multiple masters (as anything called a bus should), and has a reasonable number of ground signals. Although the MCA is a technical advance over the AT bus, from the point of view of the rest of the bus world, that isn't saying much.

Auto-configuration of the MCA is possible because of the Programmable Option Select registers that are addressed on a slot basis. On Futurebus, Multibus II, and NuBus, the equivalent to POS is called *geographical addressing*—a portion of a board's physical address space is tied to the slot where that board is physically located. Optionally, the MCA is a 32-bit bus. However, a board would generally be designed to plug into either a 16-bit or 32-bit slot, and since most MCA slots are 16-bit, the majority of MCA add-in cards are 16-bit, also.

Multimastering has real advantages if add-in cards make use of it. While not strictly needed for intelligent-I/O cards (there are many for the AT bus), it does make intelligent I/O somewhat cleaner.

While NuBus is now viewed as a desktop machine bus, it was conceived as addressing the same technical needs and objectives as Multibus II and VMEbus. This concept gives it a unique position as the only bus designed for high-end applications that is also used in a mass-marketed product. Technically, it is a 32-bit, multimaster, DIN-connector, IEEE/ANSI-standard bus with auto-configuration. One missing feature is built-in support for cache coherency in multiprocessor, write-back cache systems. Of the buses mentioned, only Futurebus has such support.

The Bus Stops Here

Future high-end personal computers will have two conflicting needs: (1) advanced performance and features to support multiple processors and higher-bandwidth I/O, and (2) the availability of a wide variety of I/O options. The widest array of available options is provided by staying with the status quo, but additional performance and features require extra effort and bring up the possibility of incompatibility. The MCA takes one path through this problem, EISA another.

Some future needs, such as support for true multiprocessing, can be accommodated by specialized CPU-to-CPU-to-memory buses that can be independent of the I/O bus. A dual-bus approach can offer the benefits of both a popular I/O bus—which is not particularly fast—and an optimized intra-CPU and CPU-to-memory path.

The only example of a crossover bus is NuBus. Originally developed for supermicrocomputers or high-end workstations, it is now at home in the Macintosh and the NeXT machine. While several concepts from industrial buses, such as auto-configuration, two-piece connectors, and cache coherency, are likely to reach personal computers, the generality, form factor, and inherent additional costs of these buses will probably keep them off the desktop. ■

George White is a cofounder and president of Corollary, Inc. (Irvine, CA), a maker of multiprocessor PC systems. He was the chairperson of the IEEE 1196 NuBus committee. He can be reached on BIX c/o "editors."

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GRAPHICS FORMATS

A close look at GIF, TIFF, and other attempts at a universal image format

Gerald L. Graef

Despite telecommunications advances, many computer systems remain graphically isolated because techniques of storing and transferring graphics are not uniformly accepted. Not too long ago, most applications had their own proprietary formats. Whole companies existed (and still exist) on the sole service of translating images to run on different computers and even on different software on the same computers. But translation services cost money and time. A universal graphics format is much needed, but will it ever come about? Indeed, is it even possible?

Just about all graphics formats share some common elements. An image file must contain enough information so that the program you're using to view it can decode it. As a minimum, this consists of not only the image data itself, but also information regarding how the data is to be interpreted. Such information is often stored in a header. For many computer-specific formats, this merely entails specifying a graphics mode and an image size. A simple BASIC format such as BSAVE contains nothing more. But in other formats, this header may also contain information on the palette, aspect ratios, and even image-creation data.

Shape-Defined Formats

One of the simplest and most versatile graphics formats is the shape-defined format. This format defines an image as a series of geometric shapes and patterns. CAD programs store images in this manner because it is usually not necessary for them to define color values for every pixel. The most common shape-defined format is the X3.110-1983 North American Presentation-Level Protocol Syntax (NAPLPS) standard defined by ANSI.

NAPLPS provides an extensive body of graphics abilities, including a large palette of colors, text scaling and rotation, and mosaic graphics as well as geometric shapes. Because these shapes are relatively simple, NAPLPS can display them rapidly, and because images can be updated quickly, a limited animation capacity is inherent in the format. However, because NAPLPS relies on a set of defined shapes, it is difficult to take an existing image and store it in a NAPLPS format. This is especially true of images, such as scanned photographs, that have no readily apparent patterns. In these cases, NAPLPS could store a value for each pixel, but the format was not designed for this, and it would be extremely clumsy to do so in terms of speed and the size of the stored image.

RLE

One of the earliest graphics encoding schemes was run-length encoding. It is still

continued

ILLUSTRATION: KERRY GAVIN © 1989

LZW Compression

With the ever-increasing resolution and color density of today's computers, image compression has moved from the realm of luxury to necessity. A 256-color MCGA image (320 by 200 pixels) nominally requires 64K bytes; a 525- by 300-pixel, 18-bit color image (roughly equivalent to a National Television System Committee TV image) requires more than a third of a megabyte. Clearly, an efficient storage method is needed.

Many methods of data compression have been devised. Unfortunately, no one method is always the most efficient. A system that works well for fairly uniform images (e.g., paint program files) will more often than not achieve marginal, if any, compression on a "noisy picture" (e.g., a scanned photograph or a fractal).

One of the best compression algorithms available is LZW compression. The basic Lempel-Ziv & Welch algorithm is described in "A Technique for High-Performance Data Compression" by Terry A. Welch in *IEEE Computer*, vol. 17, no. 6, June 1984. This scheme provides rapid compression (on the order of 50K bytes per second on an 80386-based computer) while remaining relatively simple. Using LZW compression, an image can often be compressed by better than 50 percent and occasionally by as much as 90 percent. LZW relies on patterns in the data and therefore is weakest on random or chaotic data. Fortunately, however, few images are highly random; indeed, most scanners produce common patterns that LZW can exploit to perform very efficient compression. Prominent users of LZW include TIFF and GIF.

LZW uses a string table to store codes that represent strings of input data. At the start of the routine, the string table is initialized with the possible values of a single pixel. For 8-bit data, there are 256 such possibilities. As the data is compressed, the table is expanded to include longer strings. A simple pseudocode algorithm for encoding is shown below.

```
Initialize the string table
z=null string
for each character in the input {
   x=next character in input
   if z+x is in the string table
     z=z+x
   else {
     write string z to output file
     add entry z+x to string table
     z=x
}
}
```

Expansion of a compressed image is somewhat more involved but is basically the reverse of the above process. The amazing part of LZW is that the string table itself does not need to be sent. It is resynthesized as part of the decompression process.

GIF and TIFF both employ two simple extensions to the basic LZW method. A potential problem with LZW is overflow of the string table. To circumvent this problem, support is made for a *clear* code. This code resets the string table to its initial state (i.e., with one entry for each possible pixel value). The program then begins the process of building the table anew.

The second extension is variable-length codes. For example, on a stream of 8-bit data, the first character sent will be a 9-bit code. When the 512th entry is made in the string table, the program switches to 10-bit codes. Similarly, starting at the 1024th entry, 11-bit codes are sent, and at 2048, 12-bit codes. Both GIF and TIFF limit themselves to 12-bit codes. This is generally considered the optimum balance of table size and compression ratios for typical PC files. (Obviously, a 2K-byte file would never need a table larger than 11 bits, but in order to minimize complexity, a 12-bit table is set as the standard rather than using a variable-length table.)

There are other compression schemes that achieve better results than LZW. They are, however, substantially more involved, often requiring two-pass encoding, and are usually less stable. LZW compression achieves very solid results while maintaining fair worst-case performance.

common today in many applications, including CCITT Group 3 1-Dimensional fax compression. RLE stores an image as a series of run lengths of individual values. It can achieve impressive compression ratios for relatively uniform images. Generally, however, Lempel-Ziv & Welch (LZW) compression (see the text box "LZW Compression" above) produces as good, if not better, results, although at the expense of simplicity and ease of implementation.

In CompuServe's RLE format, an image is stored as a series of code-word pairs: The first word represents a run length for the background color, and the second word provides a run length for the foreground color. For example, if 1 hexadecimal represents 1 pixel, 2h represents 2 pixels, and so on, then 3h 4h 1h 9h translates to 3 black pixels followed by 4 white, 1 black, and 9 white.

Another common run-length scheme is the Macintosh Packbits. A pseudocode algorithm for unpacking is shown below:

```
Loop until you have read in one line {
   n=next byte of input file
   if n is between 0 and 127, copy next
     n + 1 bytes to the output file
   else if n is between -127 and -1,
       copy the next byte -n + 1 times.
}
```

Packbits is simple to implement yet achieves good results and maintains a good worst-case behavior.

Although a format such as RLE is only monochrome, it is possible to store color or gray-scale images in a run-length scheme. Unfortunately, because RLE techniques rely on long stretches of repeated data, the more colors or gray-scale shades added, the less effective they become.

Hardware-Specific Formats

With the vast number of paint programs and computers on the market, many commercial formats have emerged. Because these formats are typically computer-specific, they use the most efficient storage mechanisms available on their hosts. However, this causes problems when images must be moved among different computers. Somewhere, an image must be

continued

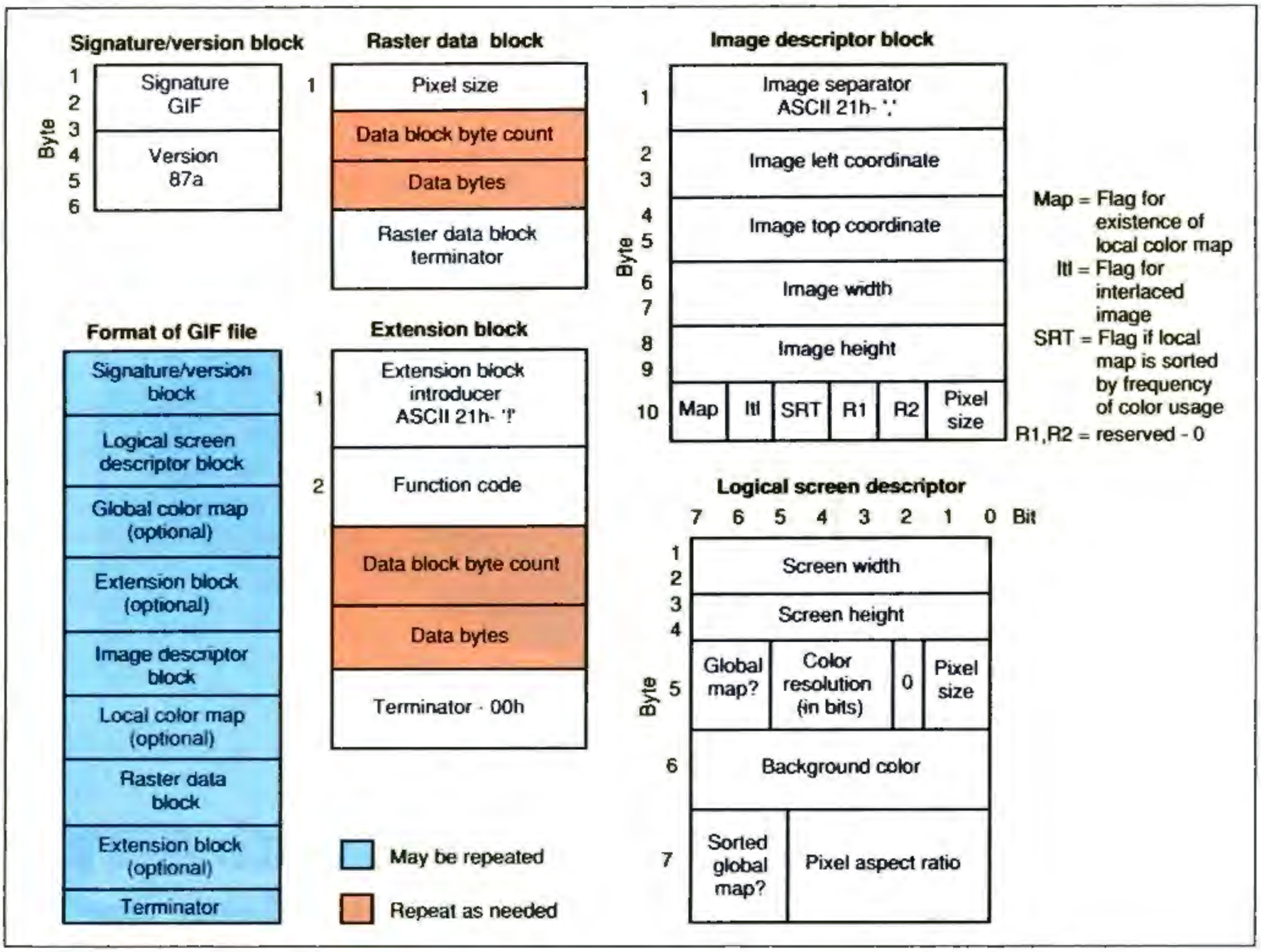

Figure 1: *The GIF image format.*

translated to fit into its new home. Many translation programs have appeared in recent years, but the introduction of an additional step in the process of moving images around is not particularly welcome. The alternative to translation is for application programs to recognize "foreign" formats and do their own translating. The number of graphics formats that currently need to be supported makes this option prohibitive, however.

Most hardware-specific formats make use of a positional structure. In such a scheme, the location of data in the file determines what the data means. For example, the header for a PC Paint file is 17 bytes long. The header starts with a 2-byte marker and is followed by the image size and offset, the number of bits per pixel, and so on. If you want to know what video mode should be used to display the image, you can immediately look at the thirteenth byte in the file. While this structure is very efficient, it is also resistant to change. And while this may not necessarily be bad, changes are inevitable in a long-lived program.

Suppose, for example, you must add a new field of data. Unless this data can be placed where it will not disturb old software versions, the best you can do is to assign a new version number to the data file, thereby prohibiting older software versions from reading it. Even if you can "hide" the new data, it may not be enough; if the new field was meant to replace an old field, problems will still arise.

One approach to alleviating this problem is to place a tag at the beginning of each data field. This tag tells the reading software what the following data is. You can then easily add new fields or even delete old ones. Old software can simply ignore fields it does not understand. While this does not eliminate all problems, it helps considerably by creating a flexible format that can readily be expanded to incorporate new features.

GIF

The Graphics Interchange Format was developed by CompuServe in 1987 to fill a need for a color-image transfer protocol. GIF was designed to support image dimensions of up to 64,000 pixels, 256 colors out of a 16-million-color palette, multiple images in a single file, rapid decoding for on-line viewing, efficient compression, and hardware independence.

The format itself makes some use of tag fields. Although most of the file information is stored in a positional header, the format switches to a tag structure thereafter. In GIF, the tag blocks (tag fields) are referred to as extension blocks. Currently, two extension blocks are supported, although the data block is also a tag field (the official documentation does not refer to it as such, however). The first extension block is a comment block for information on the image creator, software used, scanning equipment, and so on. The second extension block contains image control commands that define additional control functions related to various aspects of image display.

Figure 1 shows the structure of a GIF file. Note that extension blocks can come before or after the image data. The number of colors or gray-scale shades available is stored as a 3-bit number. Hence, from 2 to 256 colors or shades (1 to 8 bits per pixel) can be displayed. The raster data is stored as codes that reference the active color table. A color-table entry has 1 byte for each color plane (red, green, and blue), allowing for a palette of over 16 million colors. This entry must then be interpolated to the nearest color value available on the reading computer.

GIF files may have several color maps. Most use a single global map, but this is not required. In addition to, or in place of, the global map, a local color map can be defined in the raster data block. This local map is used only for the data block it appears in. If a local map exists, the global map is not used.

GIF is geared toward the exchange of images among small systems. Because it is largely an end-user format, it supports an extra interlacing feature. In an interlaced image, the horizontal lines are stored out of order in such a way that the entire image is displayed in four passes over the screen. The first pass displays every eighth line, and each succeeding pass adds a line between previously displayed lines until the image is complete. This feature allows you right away to see the entire image partially completed, rather than a part of the image wholly complete and the rest of the screen blank. GIF has as yet found little use in applications software, and the software that does support it consists largely of conversion programs.

TIFF

Whereas GIF implements some of the tag-field approach to help circumvent obsolescence, the Tag Image File Format is based wholly on the concept. TIFF was developed jointly by Aldus and Microsoft as a common format for scanner vendors and desktop publishing software. Since its introduction, TIFF has grown to far exceed the expectations of its designers. As shown in figure 2, the initial header contains only 8 bytes. All information and parameters relating to the image are stored in tag fields. The current version of TIFF (5.0) includes 45 such fields; this number is misleading, however, because there are two separate tag fields to specify the image dimensions, as well as fields to identify the creating computer, model, make, artist, description, software, and date. Several necessary fields have default values and so need not be specified (although it is a good idea to do so in any case). Many of the tag fields are not necessary to produce images, although an image may become distorted without them. For example, TIFF provides fields that enable images of unusual aspect ratios to be displayed properly. Without the proper field data, the image will appear stretched.

TIFF is an all-encompassing format. It supports several compression schemes, special image-control functions, and many other features. Because TIFF is large, it requires extensive coding to develop a complete implementation. To help programmers deal with this complexity, version 5.0 defines four TIFF classes: TIFF-B for bilevel (1-bit) images, TIFF-G for gray-scale images, TIFF-P for palette-color images, and TIFF-R for RGB images. TIFF-X refers to a program that supports all four classes. These classes enable application programs to use only the features they need to perform properly. Each class has minimum fields that must be supported to ensure compatibility, and programs need not make use of the other fields.

TIFF files have no set order in which data must appear other than the initial 8-byte header. The image-file directory (IFD) contains a list of the fields present in the file. The directory-

continued

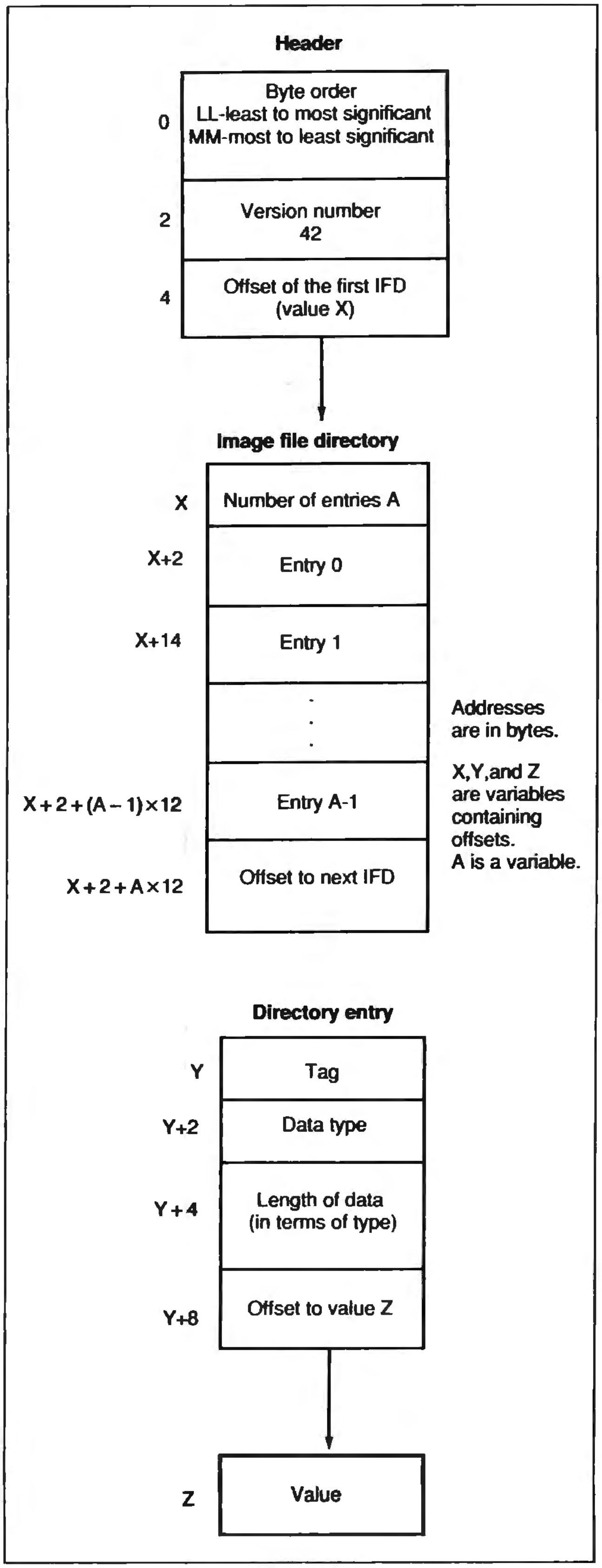

Figure 2: *The TIFF image format.*

entry offset points to the location in the file where the information is stored. This allows the data to be placed anywhere within the file. The actual image data is stored in "strips" that are found through an entry in the file directory. These strips can be of any width. The default is one strip containing the entire file, but to simplify buffering, the format specifications recommend that strips be about 8K bytes long. Because TIFF is a pointer-based format, it is necessarily more complex than GIF, but this greatly enhances the flexibility because field data can be written in any order.

TIFF, like GIF, supports multiple images in a single file (referred to as subfiles), although decoders are not required to process them. The last entry in an IFD is either 0000 for end of file or an offset to the IFD of the next subfile.

TIFF supports two methods of storing color data. TIFF-P is similar to GIF. A single field defines a color map for the image. The image data itself is then stored as codes relative to the color map. This method allows for efficient storage, although it is limited to 256 colors. The color map draws its entries from a 48-bit palette (TIFF's basic unit of structure is the 2-byte word; hence, 16 bits are present in each of the red, green, and blue planes). TIFF-R is used to define full RGB images. A pixel is represented by three 8-bit RGB values that provide over 16 million colors.

To facilitate the faithful reproduction of images on a range of equipment, TIFF supports several extra fields. These fields are typically of little use on hardware-specific formats and are generally missing from other hardware-independent formats. The ability to redefine the white point and the primary chromaticities is important when images are displayed on nonstandard equipment. For example, modern computer monitors no longer use the National Television System Committee chromaticities and white point, although television monitors often do. Another important ability is aspect ratio specification. Most computers have roughly the same aspect ratio, although there are notable exceptions—particularly the Macintosh. (GIF also supports the ability to vary aspect ratios.) In addition, you may wish to include a field that is relevant only to your applications. These fields can be registered with Aldus and Microsoft to ensure that they remain unique (the tag field number is a 16-bit value, so there is plenty of room for proprietary fields).

TIFF supports several different compression schemes. For most applications, the most useful is a variant of LZW compression. Also supported are CCITT Group 3 1-Dimensional Modified Huffman RLE and the Mac's Packbits.

Trading Images

For the foreseeable future, a great many graphics formats will remain. NAPLPS still rightfully enjoys a substantial following, although this will decrease as graphics abilities increase and processors become faster. You can expect to see TIFF continue to spread through applications across the land. Its power and flexibility make it especially attractive to commercial software developers. However, its complexity will probably keep it out of the realm of the casual programmer.

For the less-sophisticated computer enthusiast looking to trade images with friends, GIF is the likely choice, even though its limitation to 256 colors is already a hindrance to Amiga owners and others with high-color-resolution boards. From the programmers' point of view, graphics transfers will never be pretty, but end users will see spectacular results. ■

Gerald L. Graef is a programmer for a civil engineering firm in Milwaukee, Wisconsin. He can be contacted on BIX as "ggraef."

BIX CALENDAR

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IBM Exchange Opens

BIX has opened the IBM Exchange, with Barry Nance as editor. As with our other exchanges—the Macintosh, Bulletin Board, and User Group exchanges—its purpose is to better focus our activities and make the BIX system easier for you to use. The IBM Exchange conferences and their moderators are:

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THE UNIX SHELL

More than just a collection of commands, the Unix shell is often used to build applications

Greg Comeau

The Unix shell in its various forms is the user's interface to the computer's operations. One reason for Unix's popularity is its support of a rich command set. The Unix shell (or /bin/sh) is the most popular tool of this group of commands. It is defined as a "command programming language," implying that it is only a sequential command executor, much like those found under non-Unix machines. However, this doesn't do the shell justice. It is a full-fledged programming language supporting looping and logic constructs, variables, functions, parameters, and features unique to Unix (such as pipes) that allow it to be a true and consistent operating-system interface.

The Unix shell supports both terminal and file processing: You can use it either interactively or by inserting programs into files called *shell scripts*. You can execute commands or shell constructs, such as loops, directly from the keyboard or from a script. Thus, you have immediate access to a simple command spawner or to more complex capabilities. And if you're writing shell-script programs, the shell's interpretive nature lets you create and modify scripts in a quick, easy, and reliable environment. This dual quality makes the shell very popular.

Although there are many flavors of Unix shells, the Bourne shell is currently the only one that comes standard with all Unix systems. Therefore, I'll concentrate on the Bourne shell (/bin/sh), while also covering some of the important features found in other shells.

How Does It Work?

The Unix shell is an interpreter, analyzing each command line separately. Shell scripts are simple text files created with an editor, such as ed or vi. For example, if you placed the statement

```
i=100
echo i has the value of $i
```

into a file named f1, you would have a simple shell script that initializes the variable i and then displays its value in text with the echo command. (Although shell scripts are text files, the shell typically requires that they be both readable and executable. To make a text file executable, you would issue the command chmod u+x f1, where f1 is the name of the text file.)

Input to the shell can take the form of a command from the Unix command set, a built-in shell command, or a control-flow command. At the lowest level are the commands, consisting of words separated by spaces, such as

continued

ls /usr/bin. The first word is the command name or path name you want to execute; the others are the arguments to be supplied to that command as it executes. The shell waits for each command to terminate and then sets an exit status that it and other programs can act on, perhaps by printing an error message or by branching to some other section of script.

The shell also lets you compound commands with the *pipe*. You type two simple commands separated by a pipe sign, the | character, to indicate that the output of the first is to become the input of the second. For example, to count the number of files in your directory, you enter `ls /usr/bin | wc -l`, where `ls` creates a list of files and `wc -l` counts the number of lines in the

The Bourne shell will let you combine groups of simple commands and pipes into compound commands and "super" commands for more power.

ls output to obtain the number of files in the directory.

When you enter `ls` by itself, its default standard output is directed to your terminal. When a command is executed, by default it looks to the terminal for *standard input*. However, you can connect the standard output of any one command (`ls`) to the standard input of any other command (`wc`) with the pipe. Thus, the shell lets you combine groups of simple commands and pipes into compound commands and "super" commands for more power.

Shell Variables

The shell also lets you create variables much like those found in most popular programming languages. All shell variables are character strings that can be either converted or treated as other data types. Also, because you don't need to declare shell variables, they are created dynamically.

In the simple shell script above, the first line contains an assignment to a variable `i`. (Notice the lack of spaces on this line.) The statement will assign the text "100" to `i`. This adds the newly created variable to your shell's local environment. As long as it is not one of the shell's `readonly` variables, you can change the variable at will.

Besides the variables that your program creates, there's also an inherited variable environment list that your shell and programs can receive from other applications or shells, or by default from the system. Among these are

- `PATH`—a list of colon-separated directory names providing search paths for commands;
- `HOME`—usually the user's home directory;
- `PS1`—the primary command-line prompt for the shell (this is typically a $, but you can customize it as necessary);
- `MAIL`—the location of E-mail;
- `TERM`—the type of terminal display currently in use; and
- `SHELL`—the path name of the currently executing shell (this variable is typically set to `/bin/sh`).

You can export your local variables into the environment list with the `export` command. Many commercial applications require that you specify temporary file-directory names or even options by using environment variables. This is a convenient way to pass information to them. For example,

```
$ TEMP_PATH=/usr/tmp
$ OPTIONS=-dbj
$ export TEMP_PATH OPTIONS
$ app # some application using these
  variables
```

[Editor's note: *The $ is the Bourne shell prompt and implies that the following line is entered directly to the shell.*]

You may want to provide default values for environment variables and place them in the `.profile` file of your home directory. Then, each time you log in, the shell looks for the file and sets the environment variables. This feature is useful because in many situations the variables remain fixed throughout the log-in session.

The shell also provides several odd-looking variables that contain special information related to how your shell functions. They let you easily accomplish many commonly needed tasks:

- `$#` contains the number of parameters passed to the shell;
- `$-` contains flags set on shell start-up or by the `set` commands;
- `$?` holds the return code (in decimal) of the last foreground command executed;
- `$$` has the process ID number of the shell—handy for creating temporary filenames;
- `$!` contains the process ID number of the last background command executed; and
- `$0` has the name of the currently executing command.

Some shell variables are called *positional parameters*. When a shell script is invoked from the command line or by another shell script, it can provide arguments to the called program. For instance, if you create the script `args.sh`

```
echo Number of args is $#
echo 1=$1
echo 2=$2
echo 3=$3
echo 4=$4
```

and execute it by entering `args.sh` on the command line, you would get `Number of args is 0` and nothing in the arguments. If you execute the same script as `args.sh a b c d e f`, you would get this result:

```
Number of args is 6
1=a
2=b
3=c
4=d
```

Notice the variables `$1` and `$2`. These variables assume the values of each of the respective arguments when the shell calls the script. For instance, `$3` takes on the value of the third argument, the `c`. This capability comes in handy when you individually process command options or filenames.

The variable `$*` represents all the positional parameters at

continued

Unix Tools for DOS

Charles Herring

Some Unix commands have found their way onto DOS machines, where they perform functions similar to existing DOS commands. They are being used instead of their DOS counterparts for several reasons. For one, as DOS systems have grown in size and complexity, few DOS commands have been extended to reflect the growth of the systems. Unix is a more mature operating system, designed to manage more complex tasks, and Unix commands thus offer more options than their DOS counterparts. Also, Unix commands were designed to work with each other.

Many users who are familiar with Unix, who simply prefer the Unix commands to DOS, or who are using both Unix and DOS and want a consistent interface, have brought the Unix commands over.

Basic Commands

Many implementations of Unix commands in the DOS environment do not perform exactly the same or have the same options as their Unix counterparts. The commands in the following list should have the same basic function and options in any implementation:

ls

`ls` (list files) is the Unix counterpart of the DOS DIR command. It lists information about files and directories. DIR has two display options: `/w` for wide-column display and `/p` for pause. `ls` has many output format options; some implementations have over 20.

By default (BSD Unix) the files in the current directory are displayed in a sorted multicolumn format. Most versions of `ls` include the `a`, `l`, and `t` options. Most versions also support an option (`-R`), similar to the DOS TREE command, to list directories and files recursively.

mv

Moving files from a directory or disk to another location is a frequent task. Under DOS, this requires the use of both the COPY and the DELETE commands. The `mv` (move) command does this in a single action. There are two forms of the `mv` command:

```
mv file1 file2
mv files directory
```

The first form is equivalent to RENAME (i.e., file 2 will be renamed to file 1). The second form moves (copies and then deletes) the specified files to a directory. Some implementations of `mv` also permit directories to be renamed.

rm

DOS machines have been called upon to perform ever more complex tasks, and the directory structures have grown quite large. Managing these directories can be awkward using the DOS RMDIR command to remove directories. First, RMDIR requires the directory to be empty of files. This requires the use of the DELETE command before RMDIR can be used. Second, the directories must be removed one at a time. Thus, removing deeply nested directories is inconvenient.

The `rm` (remove) command was developed to remedy this problem. `rm` removes files and directories. The `-r` option causes `rm` to recursively remove all files and directories in the specified directory path. For example, `rm -r wp *.*` will remove all files under `wp`. Because of the potential devastation to forgotten files in the path, the `-i` option should be used whenever a recursive `rm` is invoked. This option interactively queries the user for affirmation on deleting each file.

Advanced Tools

Unix tools read their input from the standard input and write their data to the standard output. Tools that change the data/text fed to them in this way are called *filters*. Two commonly used filters are `pg` and `pr`, which paginate files for the screen and printer, respectively.

Other commonly used but more advanced tools are `sed` (a character stream editor), `grep` (a pattern pass filter), and `awk` (a report generator).

grep

`grep` is a filter that uses regular expressions to match input lines. Each line of input data matching the regular expression is sent to the standard output. `grep` is invoked on the command line as follows:

```
grep [-options] regular-expression files
```

`grep` has a number of options that can be included on the command line. For example, `-i` causes `grep` to ignore case in pattern matching.

One of a family of three pattern-matching filters, `grep` uses a limited form of regular expression that does not permit alteration (|), zero or one occurrence (?), one or more occurrences (+), or parentheses for grouping.

An example use of `grep` would be to find all occurrences of the `include` statement in a C application:

```
grep ^#include *.c > include.txt
```

The regular expression `^#include` matches all lines in the C source files that begin with `#include`. The metacharacter `^` in a regular expression specifies that the pattern, `#include` in this case, must be at the beginning of the line.

`grep` is used to search for a pattern of characters in text files. Programmers find it very useful in performing tasks such as locating all occurrences of a given variable name across many source code files.

awk

`awk` is a pattern-matching programming language designed for text processing and report generation. It can be used to generate simple reports or to write complex programs. `awk` was developed in 1977 by Alfred Aho, Peter Weinberger, and Brian Kernighan of AT&T Bell Laboratories (`awk` is an acronym for Aho Weinberger Kernighan). It began as an experiment to integrate and generalize the `grep` and `sed` utilities. However, because of its popularity, it was greatly expanded, and an enhanced version was released in 1985.

awk is an interpreted language like BASIC or dBASE III. Its programs are stored in text files. The basic format of an awk statement is pattern { action }. When an awk program is run, lines are read from the input data file. Each line is then separated into fields. If the current line matches the pattern, the action is executed. An awk statement can consist of only a pattern or an action. A pattern alone will print each input line that it matches. An action alone will be applied to every input line. The action part can consist of any number of statements.

The simplest form of a pattern is the expression. An example of an expression is $1 == "Name". This pattern will match any input line whose first field ($1) is the string "Name". awk also supports regular expressions.

The { action } part of the basic awk statement follows the pattern and can be a single statement or many statements separated by new lines and semicolons. The action can consist of expressions and control statements. The control statements are analogous to C control statements and include the following:

```
if (expression) statements
if (expression) statements else statements
while (expression) statements
for (expression ; expression ; expression) statements
do statements while (expression)
```

In addition to expressions and control statements, awk offers many built-in functions for arithmetic and string operations as well as arrays.

awk is a powerful and fun-to-use language. It can be used to write simple one-line filters invoked from the command line or to write an assembler. It serves as a good introduction to the C language and can be used as a prototyping language.

Unix Shells for DOS

In Unix, a shell is the user interface to the operating system just as COMMAND.COM is in DOS. The shell executes user commands and provides a job control language similar to the DOS batch facility.

At least two commercially available Unix shells are available that transform your DOS machine into a Unix look-alike. Of course, they do not implement multitasking, multiuser, and networking, but they do provide a full complement of Unix commands and tools.

MKS Toolkit by Mortice Kern Systems and PolyShell by PolyTron each provide all the basic Unix tools, including some very sophisticated ones such as awk. As Unix has evolved, many different shells have been developed. The MKS Toolkit implements the features of the Korn shell, the newest in the family of shells, developed at AT&T. PolyShell is compatible with the Bourne shell as found on Berkeley Unix (BSD).

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once. For instance, if you were to create another script called allargs.sh

```
echo Number of args is $#
echo All the arguments are: $*
```

and run it as allargs.sh a b c d e f g, you would get the following output:

```
Number of args is 7
All the arguments are: a b c d e f g
```

This can be useful when outputting values or iterating through a group of values in a for loop.

In the Loop

Table 1 shows the built-in commands for looping and control-flow logic that the shell supports. (Note that the Bourne shell doesn't support a goto command.)

Listing 1 shows a shell script that uses all these constructs. It is the beginning of a file management application. In most cases, the test command (or the [*expr*] command, for short) is used as the command target to control branching in while and if statements. Only if the commands in the target produce an exit status of zero is the body of a while loop or the then part of the if statement executed.

The test ([ ]) command is useful for evaluating various expressions. It returns a zero exit status on successful completion or a nonzero exit status when an error has occurred; therefore, it is often the target command. In the first line, the script checks to make sure that the number of arguments ($#) is not equal to zero before continuing. You can use any command you want as the command target as long as it returns a predictable exit status.

If you execute the script without any arguments, it will print an error message and terminate itself with the built-in exit command (table 2 contains a list of the shell's built-in commands). The script can also specify its exit status as hold, so its invoker can determine whether it failed.

The getfile shell function in listing 1 behaves much like a subroutine since it is called and can return a value. However, I'm only interested here in printing a string and reading a value. Notice that you can pass parameters to shell functions; within functions, they perform just like positional parameters.

The for loop iterates through each argument individually by implicitly assigning each argument to i. The variable named is assigned each word in the "in" list one at a time. In this case, the list contains all the parameters passed to the program.

Another powerful shell statement is the case statement, which allows the flow of logic to continue to one of many choices. The shell evaluates i and compares it to each of the text patterns until a match is found. It then executes the command from that pattern to the next ;; and then jumps to the next statement after the esac keyword.

The while [1] construct tells the script to loop forever. (This can be shortened to while true.) The statements and commands within this loop will continue to execute until you enter a valid response to the deletion request. When you do, a break statement is executed, and the shell transfers control to the end of the loop.

Other Features

The Unix shell's I/O capabilities are extensive. For example, you can use

continued

- < to take standard input from a specified file;
- > to send standard output to a specified file;
- << to read shell input until a specified point and treat the resulting text as the standard input;
- >> to append standard output to a specified file;
- <&*n* to duplicate the standard input from the file descriptor *n* (file descriptors are numbers; for example, 0 is standard input, 1 is standard output, and 2 is standard error);
- >&*n* to duplicate the standard output from the file descriptor *n*;
- <&- to close the standard input; and
- >&- to close the standard output.

If you use MS-DOS, you're already familiar with a subset of these, because MS-DOS borrowed its use of redirection from the Unix shell. But redirection is much more powerful in Unix.

In general, Unix shell commands execute synchronously. A command is spawned for execution, and the shell waits for its completion. Synchronous processing is also termed *foreground processing*. The shell (and Unix, of course) also allows background or asynchronous processing, which is invoked by appending an & to the command.

There are a few steps that the shell goes through to analyze the words on a line. In addition to the variable substitutions it performs on seeing a $ character, it also uses wild-card substitutions. The following are the wild-card metacharacters and their meanings:

- * matches any characters in a filename;

Table 1: *Shell commands for looping and control-flow logic.*

1. `while` *command* `do` *commands* `done`
2. `for` *variablename* `in` *word1* . . . `wordN` `do` *commands* `done`
3. `if` *command* `then` *commands* `fi` or
   `if` *command* `then` *commands* `elif` *command* `then` *commands* `fi` or
   `if` *command* `then` *commands* `else` *commands* `fi`
4. `case` *word* `in` *pattern1*`)` *commands* `;;` . . . *patternN*`)` *commands* `;;` `esac`
5. `shellfunction() {` *commands* `}`

Listing 1: *A partial file-management application showing the use of the Unix shell's built-in commands for looping and control-flow logic.*

```
if [ $# = 0 ]
then
  echo "$0: No options supplied!!"
  exit 1
fi

getfile()
{
  echo "$1\c"
  read somefile
}

for i in $*
do
  case $i in
  -p)
      getfile "Enter name of file to print:"
    echo pr $somefile
    ;;

  -d)
    getfile "Enter name of file to delete:"
    while [ 1 ]
    do
      echo "Are you sure you want to delete $somefile? \c"
      read ans
        case $ans in
        y|Y|yes|YES)
          rm $somefile
          break
          ;;

        n|N|no|NO)
          echo NOT rming $somefile
          break
          ;;
        esac
    done

    ;;

  # put other cases here

  *)
    echo "$0: Error processing arguments"
    exit 1
    ;;
  esac
done
```

Table 2: *Special built-in shell commands.*

`:`	Sets a zero exit status—the null command.
`. file`	Allows named file to be executed by the current active shell as a subroutine.
`break`	Breaks out of a `for` or `while` loop.
`continue`	Jumps to the end of a `for` or `while` loop and continues to the next iteration.
`cd`	Changes the directory of the process being executed.
`eval`	Allows you to execute input data as a command.
`exec`	Causes another program to overlay the current script.
`exit`	Terminates a shell script with an explicit exit status.
`export`	Allows you to transport named variables to the environment of commands that the current shell is executing.
`read`	Reads data from the standard input into named variables.
`readonly`	Allows you to treat named variables as constants.
`set`	Used to configure the current state of the shell. Also used to set positional parameters explicitly rather than having them as explicit arguments to the script/shell.
`shift`	Causes $1 to take on the value of $2, $2 to take on $3, and so on.
`test` (or [*expr*])	Used in testing expressions and setting an exit status for various logic-branching constructs.
`trap`	Allows the shell or script that set the trap to execute a specified compound command upon receipt of specified interrupt signals.
`ulimit`	Sets or queries the maximum file and/or pipe size.
`umask`	Provides a mechanism to communicate to Unix default file-protection bits so that you don't mistakenly create security problems.
`wait`	Waits for "child" processes that have run in the background to terminate.

- ? matches a single character in a filename;
- [char-list] matches a specified list or range of characters; and
- [!char-list] matches any characters *not* in the specified list or range.

Here's what happens when you use the echo command to demonstrate an incomplete list of permutations using these metacharacters:

- $ echo * outputs all the filenames in the current directory;
- $ echo *.c outputs all the .c files in the current directory;

Two other popular shells are the C-shell and the Korn shell. Both these alternatives to the Bourne shell offer benefits.

- $ echo ex*.c outputs all the .c files in the current directory with names beginning with ex;
- $ echo f? outputs all files beginning with the letter *f* and followed by any one character; and
- $ echo [a-m]* outputs all files beginning with a letter from *a* through *m*.

Once the files that match the desired pattern are found, the matches for the wild-card argument are sorted and become replacements for the word in the argument list.

Another type of processing that occurs as the shell generates arguments is called quotation deciphering. This occurs at five levels.

1. No quoting, which performs variable substitutions and wildcarding as necessary; for example, if you enter echo The value of PATH, the response will be The value of PATH.
2. 'expr', where the shell picks up the single-quoted string literal and won't perform any variable substitutions or wildcarding; for example, the input echo '*' will produce the output *, and echo 'The value of PATH is $PATH' will result in The value of PATH is $PATH.
3. \one-char, which quotes the character following the \ without expansion; for example, echo The value of \$PATH is $PATH produces The value of $PATH is :/bin:/usr/bin.
4. "expr", which performs variable and command substitution; for example, entering echo "The value of PATH is $PATH" results in The value of PATH is :/bin:/usr/bin.
5. 'command-expr', which executes the command and replaces the argument with the command's standard output (called *command redirection*); for example, if you enter echo "The value of PATH is $PATH" > /tmp/tst followed by echo 'cat /tmp/tst', then the output will be The value of PATH is :/bin:/usr/bin.

Shortcomings

The Unix shell is an interpreter, and as such, it has both advantages and disadvantages. On the minus side, shell scripts typically don't execute very quickly. In addition, they are text files and must be distributed in source code form.

Because scripts are simple text files, you can't use them to provide or enforce the security mechanisms available under Unix (see "Safe and Secure?" by Patrick Wood, May BYTE). Security is a capability available only by first activating an executable binary file that has the setuid bit set. Another such bit, the sticky bit, which is used to enhance system performance, is not an option with shell scripts either.

There are shell script translators that circumvent these shortcomings by rendering C source code from the shell script. You can compile this program to produce a fast and secure binary object file without rewriting your shell script prototype.

A Shell Collection

The Bourne shell is not the only shell available under Unix. Two other popular shells are the C-shell (csh) and the Korn shell (ksh). Both these alternatives offer several benefits that will appeal to users.

With csh, which was originally developed under the Berkeley Standard Distribution derivative of Unix, you have the ability to obtain a "history" of previously executed commands and review them and also the ability to re-execute and/or edit commands or their arguments from the history. The BSD prompt is %.

The Korn shell (a superset of the Bourne shell developed at AT&T) supports history and editing in a way that is similar in concept but different in implementation. The Korn shell uses the termcaps database to allow scrolling through the command history in a terminal-independent manner. Also, editing newly entered commands or commands that already exist in the ksh history can assume a vi or emacs (two popular line editors) mode. (The default Korn prompt is $.)

Besides the interactive benefits of csh and ksh, their general makeup is similar to that of the Bourne shell. They all have loops, logic constructs, variables, and so on. However, their grammars vary slightly. Both csh and ksh support arrays. They also support arithmetic capabilities; however, ksh is superior in this respect.

Job control is one of several other features that the Bourne shell doesn't support. Using job control in an interactive shell, you can control the execution of background processes, including termination, temporary halting, and background-foreground switching. This is useful if you want to create your own batch-processing environment.

Shelling the Future

Unix shells have begun their migration into the MS-DOS world. For instance, MKS (Mortice Kern Systems) of Canada has been providing a Korn shell for the past few years with reasonable AT&T Korn-shell compatibility. In addition, Comeau Computing offers CCsh for MS-DOS.

Migrations of these and other tools to OS/2 should occur in the near future. These tools provide one stepping-stone into an era of open systems and connectivity. ■

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LAPTOP TECHNOLOGY REDUX

Major innovations in small peripheral devices increase the laptop's utility

While some engineers work to make computers bigger, faster, and more powerful, others are striving to make them more portable. In June, at a trade show called Portable Computing '89, I got a look at some of the most interesting new technological developments in laptop computing. By the way, I wrote this installment of Under the Hood almost entirely on a laptop.

Display Technology: Color on the Horizon

Laptop displays used to be small and difficult to read. Nowadays, virtually every model has a high-contrast supertwist display, and most have backlighting. Resolutions range from those of the IBM CGA (many machines) to monochrome VGA (Compaq's SLT and a few others), but none, so far, have had color.

This will soon change, however. Sharp Electronics is now demonstrating the PC-8000, a portable computer with a 20-MHz 80386, a 40-megabyte hard disk drive, and a VGA-compatible 640- by 480-pixel LCD color screen. The screen, which will also be sold as a component to other manufacturers, is capable of showing 512 distinct colors. The colored areas are arranged in stripes (similar to the way the phosphors are arranged on the surface of a Sony Trinitron TV tube), and the resolution is eight lines per millimeter. (Since it takes three lines—one of each color—to make a single pixel, the effective dot pitch is on the order of 0.375 mm—not much greater than that of a good CRT.)

The PC-8000's display uses double-layer supertwist nematic (D-STN or DST) liquid-crystal technology (see figure 1). As the name implies, the display has two layers of liquid-crystal material. The rear layer, called the "driven" layer, does most of the work: It contains the active cells that control the opacity of each pixel. But if this were the only layer, a phenomenon called the *birefringence effect* would cause the color of the light passing through the cells to be distorted, particularly when the cells were only partially opaque.

The second layer, which is always transparent and doesn't have electrodes, contains more liquid-crystal material and is oriented so as to neutralize the color-distorting effects of the first. The result is an array of pixels that appear to change from nearly complete opacity to a neutral gray to clear without significant color distortion.

The image on Sharp's DST display isn't very legible without a backlight. Sharp uses a "hot cathode" fluorescent tube to provide illumination. Unfortunately, this means that machines using this technology will require significant amounts of power; they probably won't run off batteries, at least at first.

A Big Blue Rising Sun

Toshiba and IBM are also working on an impressive flat-panel color display technology. The two companies have been showing off a 9- by 11-inch color LCD screen that uses active matrix technology (see figure 2). The IBM/Toshiba color display is one of the highest-resolution LCD screens developed to date. Each pixel of the display consists of four separate cells or dots (red, green, blue, and white) instead of the usual three, allowing a total of 16 (2^4) possible colors. The white cell helps the display to achieve high contrast without markedly increasing the size of the pixels. The cells are controlled by thin-film transistors (TFTs) made of amorphous silicon, and they can switch on and off at a rate of 60 Hz, making large, flat-panel TVs possible. The dot pitch of the display is 0.40 mm—again, not much bigger than a pixel on a good CRT.

The display is backlit by a fluorescent tube; the light passes through a polarizing filter and then through the liquid-crystal cells, which can change the angle of polarization of the light, depending on whether the associated transistor is on or off. Finally, the light reaches the front polarizer, which allows it to pass only if it has not been "twisted" by the liquid-crystal material.

Amorphous semiconductors are a relatively new technology, first used in solar cells and nonvolatile memories. They aren't always as efficient as crystalline semiconductors, but they're easier to produce in bulk. This makes them an excellent choice for large displays, where yield is more important than efficiency.

Limiting the number of colors to 16 (each cell fully on or fully off) helps to mask differences in the gains of the individual TFTs. But engineers are working on ways to ensure enough uniformity among the 1.5 million transistors of the display to allow a wider range of colors.

This is the best current technology, but it's expensive and difficult to produce in quantity: There are four transistors in each of the 375,000 pixels, and every one of these transistors has to work for the display to pass muster.

People who see the IBM/Toshiba display are often tempted to reach around the back to assure themselves that it's really not a CRT. Alas, it may be a year or two before the technology demonstrated in this display is commercially available. In the meantime, Toshiba and Zenith—like Sharp—are showing laptops based on more conventional LCD technology. So is Mitsubishi, although its offerings will initially be available only in Japan. There's no telling who will be first to market, but it's clear that

continued

within a year there will be lots of color laptops to choose from.

Small Drives, Large Capacities

Laptops now have at least as many storage options as desktop models have. Compact 3½-inch hard disk drives that weigh less than floppy disk drives are available from Conner Peripherals and other companies, and 2½-inch hard disk drives are now in systems like the new Agilis (see "The Ever-Shrinking, Ever-Expanding Laptops," August BYTE).

Many manufacturers, however, are opting to make their machines smaller and lighter by providing nonvolatile RAM disks instead. The 4⅖-pound NEC UltraLite has a 1-megabyte or 2-megabyte RAM disk with a separate battery that keeps it alive even when the main battery runs out. (It also uses ROM cartridges to hold some programs.) The Toshiba T1000 weighs in at 6½ pounds and has an optional 760K-byte nonvolatile

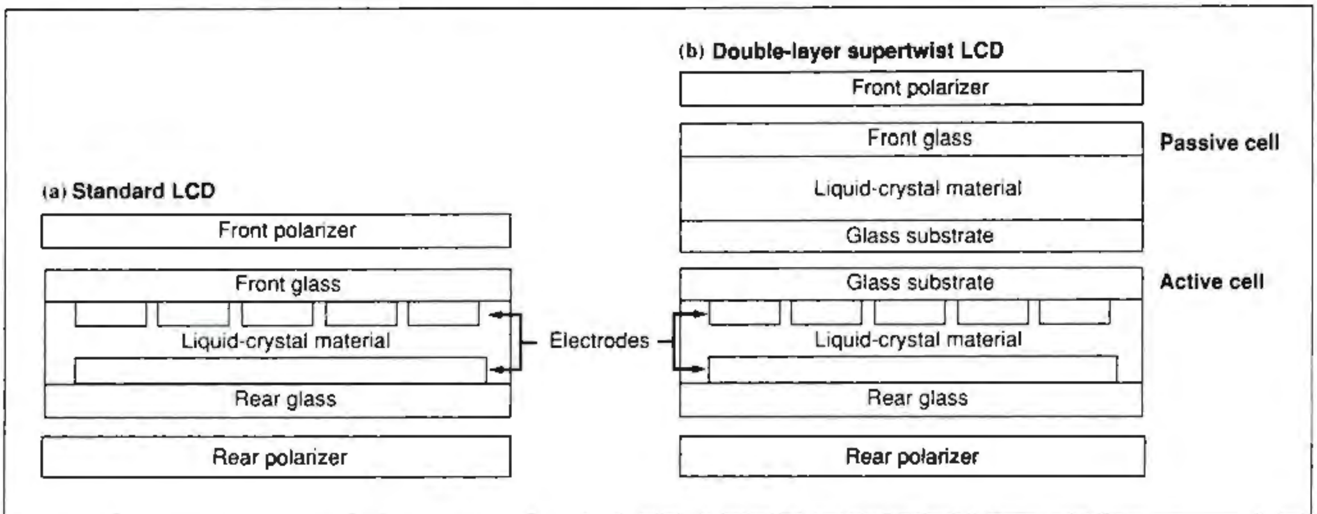

Figure 1: *The major difference between the standard LCD* **(a)** *and the double-layer supertwist (DST) display* **(b)** *is the addition of a passive liquid-crystal layer in front of the active LCD layer. The additional layer reduces color distortion.*

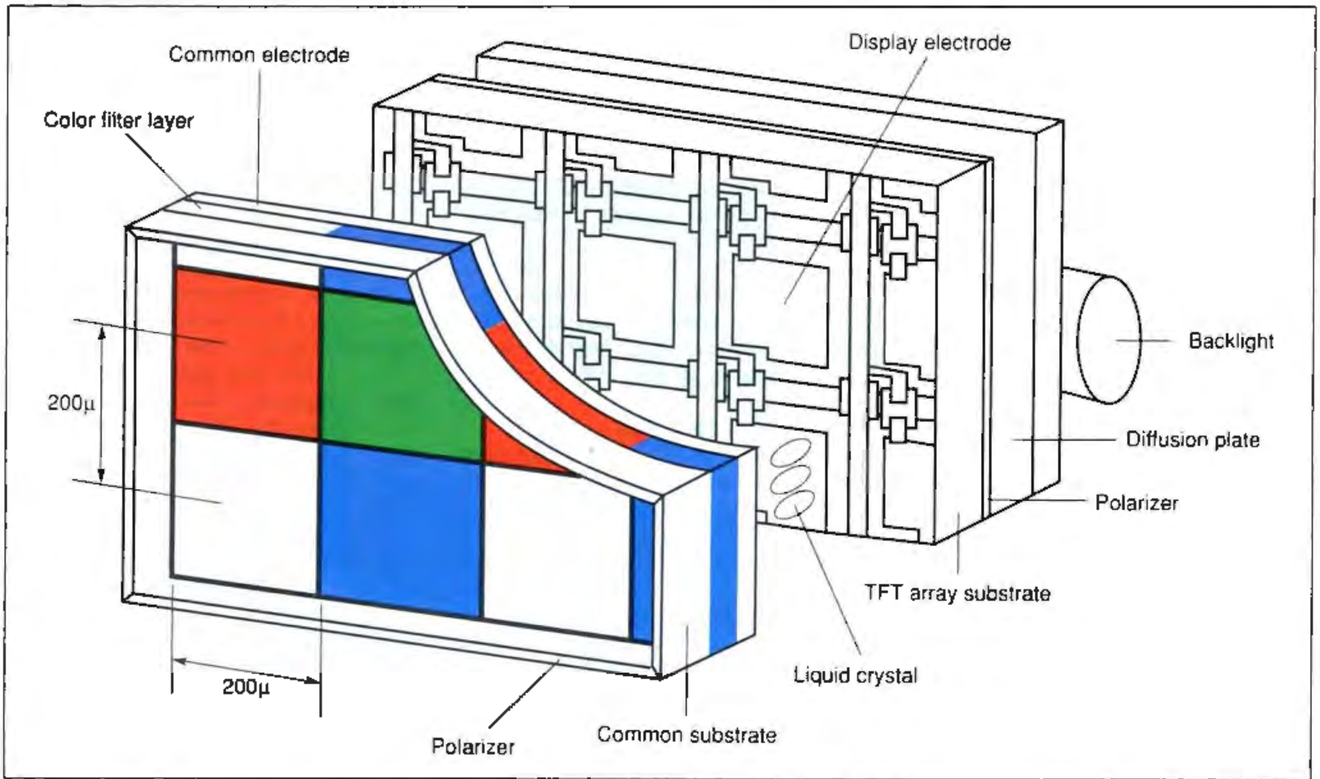

Figure 2: *IBM and Toshiba are jointly developing a high-resolution color LCD screen. The 14-inch display contains 1.5 million color dots. Four dots (red, green, blue, and white) combine to form a single pixel. Since a dot is either completely on or completely off, there are 16 possible colors.*

RAM disk.

Even more interesting and capacious are the new high-capacity floppy disk drives on the way from Insite Peripherals and Brier Technology. To understand how these drives manage to store 20 megabytes or more on an ordinary floppy disk, you must first know that the storage capacity of flexible media is normally limited by two factors: the maximum density of the bits on each track and the accuracy with which you can position the head. Insite Peripherals and Brier Technology have taken different approaches to the same problem: replacing the "open-loop" stepper motors of conventional floppy disk drives with more accurate positioning systems that can accommodate irregularities and eccentricities in the disk. They also use run-length-limited (RLL) encoding (see the February Under the Hood) to increase the bit density.

Insite's Floptical drives use standard 3½-inch floppy disks with special laser markings etched into their surfaces (see figure 3). Light from an infrared LED is focused on the disk; an optical servo system dubbed *diamond tracking*, very much like the one used in compact disks, follows the markings. The very precise

continued

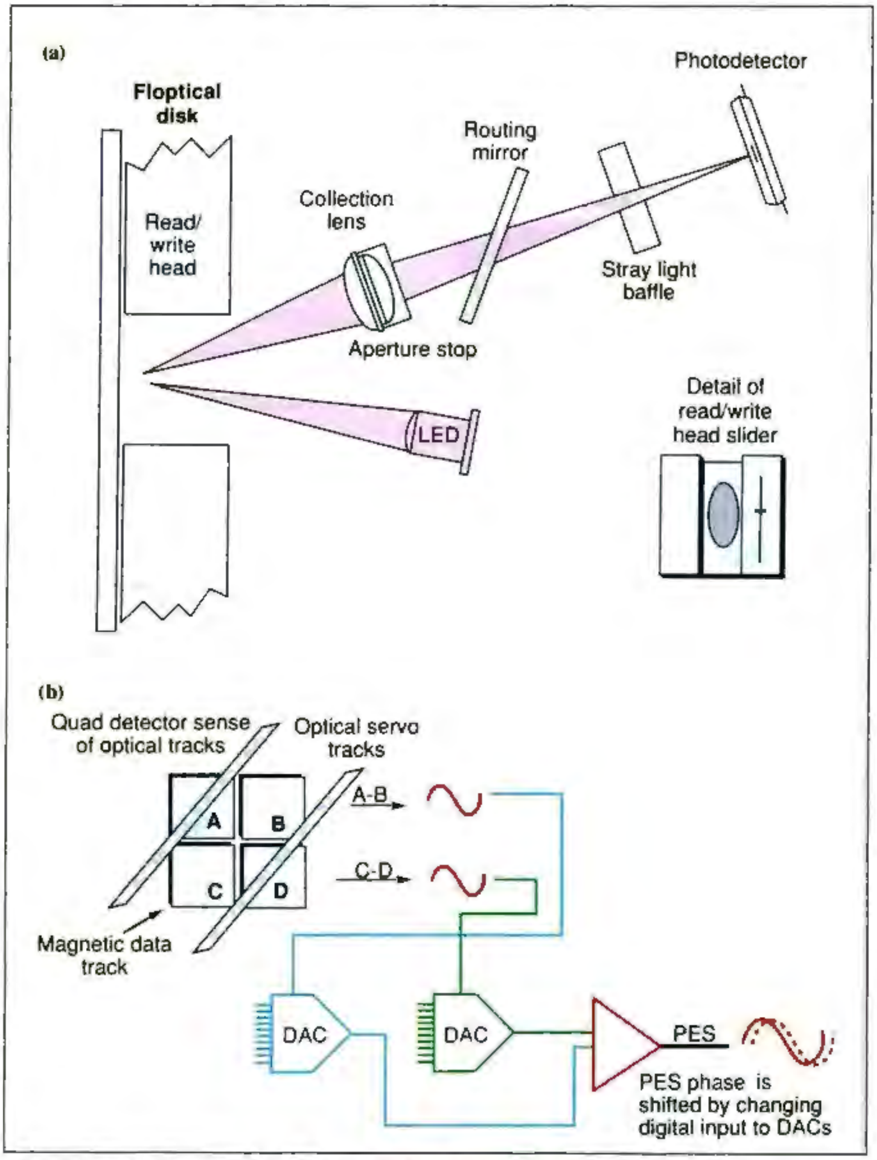

Figure 3: (a) *The Floptical disk technology increases data density by using an optical track to generate precise tracking of the read/write head.*
(b) *Alignment of the head to optical servo tracks is accomplished with a Phase Error Signal shift technique using multiple digital analog converters.*

positioning obtained in this way allows the tracks to be packed much closer together than they can be on a standard floppy disk drive. The track density of the Floptical media is 1250 tracks per inch; a standard floppy disk, by comparison, has 45 to 135 tpi. The Floptical's bit density is 24,145 bits per inch (bpi).

Brier's Flextra drives use special two-layer magnetic media and a servo technique called T^3, for Twin Tier Traeking (see figure 4). An embedded, unerasable magnetic layer deep below the surface contains servo information, while the upper layer carries the data.

In addition to the special servo technique, Brier also uses *multizone recording* to fit more data on the disk. The disk is divided into three ring-shaped zones; tracks in the outer zone contain 48 sectors, those in the middle 40, and those on the inside only 32. Most conventional disk drives store the same amount of data on each track; this means that the total capacity of the disk is limited by the capacity of the innermost (and shortest) track. Changing the number of sectors per track lets Brier exploit the additional circumference of the outer tracks. The rated bit density of the Brier drives is 26,000 bpi. The track density is 777 tpi for the two lower-priced models, and 1555 tpi for the more expensive one. (Insite's literature makes a conflicting claim that the maximum track density for a magnetic system is less than 1000 tpi.) Brier's intermediate model can also read—but not write to—IBM-compatible 3½-inch disks.

Insite's drive has a formatted capacity rating of 20.8 megabytes and an average seek time of 65 milliseconds. Brier's specs are better: The high-end model boasts a formatted capacity of 43.2 megabytes, with an average track-to-track seek time of 29 ms. (The higher capacity is probably due to the multizone recording technique, while the higher speed is most likely due to smaller head size and weight.)

Insite's media can be made from standard 3½-inch floppy disks by a special machine that Insite plans to sell to third parties. Brier's disks, on the other hand, must be specially manufactured. Therefore, Floptical disks (which are expected to sell for $10) will probably be about half the price of Brier's media.

Both drives use SCSI interfaces, so they should be compatible with a wide variety of machines. Both also weigh around 2 pounds, so either one should be able to fit into a laptop without imposing an excessive weight penalty.

Peripheral Issues

Finding peripherals that will work with a particular brand of laptop can be a problem. Some of the larger laptops and luggables have IBM ISA-compatible slots, but few small, battery-powered units do. Some machines can be fitted with an expansion chassis, but since these are low-volume items, they're generally quite expensive—and they're hard to take on the road. And when a manufacturer does provide an expansion bus, chances are it's a unique design. (So far, only Yamaha has designed its laptops to use a connector that's compatible with another machine's—in this case, the Toshiba T1100+'s). Slot configurations even differ among different units from the same manufacturer; my T1000, for instance, won't take expansion cards that fit the rest of the Toshiba line.

All this incompatibility hurts laptop users by keeping peripheral prices high.

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Research Division
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Insite Peripherals
(Floptical disk drive)
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Santa Clara, CA 95054
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Inquiry 1083.

Sharp Electronics Corp.
(PC-8000, JX-100 Handheld Color Scanner)
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Toshiba America, Inc.
(Forthcoming IBM/Toshiba high-resolution color LCD screen, T1000, T1000+)
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(Pocket Ethernet adapter)
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Inquiry 1087.

What's really called for is a standard laptop bus—something like Hewlett-Packard's HP Interface Loop, which was developed for HP's calculators. Until the industry agrees on such an interface, however, peripheral makers will be forced to find clever ways to connect peripherals using existing ports.

One such peripheral is Xircom's Pocket Ethernet adapter. This device, which attaches to a laptop's parallel port, lets you hook into an Ethernet-based LAN. You can do everything you can do on any other network station, including uploading and downloading data and executing programs. While some software (e.g., LapLink) lets you do the same thing, nothing can quite compare with the convenience of having the resources

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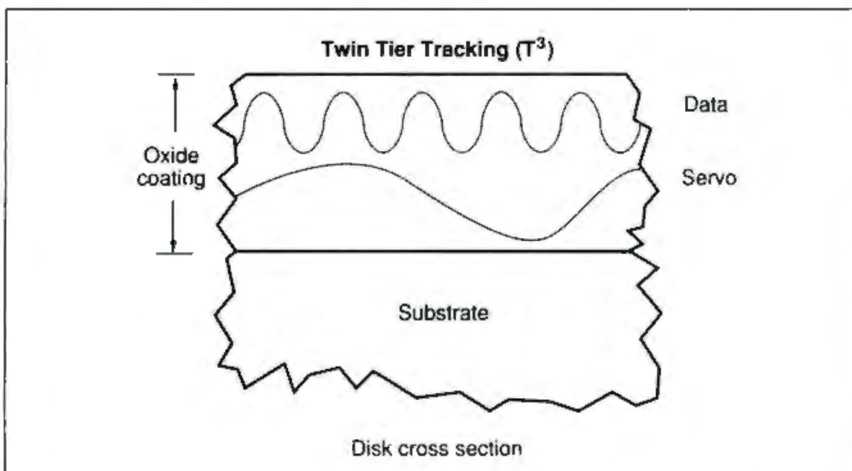

Figure 4: *Brier's T^3 (Twin Tier Tracking) Servo System uses two layers of magnetic information. The deeper layer is permanent and provides the tracking information.*

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Norton SI Rating v 4.0	2.1	11.2	17.6	22.0
Standard Memory	640K	512K	1MB	1MB
Shadow BIOS	—	—	Yes	384K
Memory Upgrades	—	1MB	2/3/5/6/8MB	2/4/8/10/16MB
Coprocessor Support	8087	80287	80387SX	80287 or 80387
Expansion Slots: 32-bit	—	—	—	1
Expansion Slots: 16-bit	—	6	6	4
Expansion Slots: 8-bit	8	2	2	3
Dual HD/FD Controller	w/HD systems	Yes	Yes	Yes
Device Bays (Exposed/Internal)	2 Exp./2 Int.	3 Exp./2 Int.	3 Exp./1 Int.	3 Exp./2 Int.
Serial Ports	1	1	1	2
Additional I/O Ports	1 Par./1 Game	1 Parallel	1 Parallel	1 Parallel
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w/80MB (28ms) & 1:1 Interleave	$1849	$1898	$2248	$2348
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386SX	VIDEO OPTIONS Include Monitor & Video Adapter			
Drive Options	Mono	14" Flat Mono	VGA Mono	VGA Color
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w/48MB (28ms) & 1:1 Interleave	$1999	$2048	$2198	$2498
w/80MB (28ms) & 1:1 Interleave	$2349	$2398	$2548	$2848
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The Pocket Ethernet adapter comes in two varieties—one for thin Ethernet (cheapernet) and one with a standard communications connector. The unit is packaged with an IPX driver for Novell's NetWare. There are no NetBIOS or TCP/IP packages available at this writing, though with luck there may be by the time you read this.

A peek inside the Pocket Ethernet adapter reveals a standard National Semiconductor Ethernet chip and a custom application-specific IC that handles the interface to the serial port. Presumably, this same ASIC can be used to drive other chips for other types of networks; according to president Dirk Gates, Xircom is now working on a Pocket Token Ring adapter that will interface to a microcomputer in the same way.

Another very clever peripheral that should be available by press time is the PFIDO (Printer/Fax Input Device with Output) from Holmes Microsystems. This gadget weighs less than 4 pounds and measures only about 10 by 2¼ by 3 inches, yet it's a complete monochrome scanner and thermal printer in a single unit. It attaches to the serial port of your laptop and is meant to work with an internal fax card on an NEC, Zenith, or high-end Toshiba portable. (Alas, there doesn't seem to be any provision for an external fax modem, so other portables—and my T1000—may not be able to use this device.)

Most of us have seen those little handheld scanners that scan a monochrome image into just about any machine through a serial port, but Sharp has come up with something even more useful: A miniature 4- by 6-inch *color* flatbed scanner. Dubbed the JX-100 Handheld Color Scanner, it does color separations using three filters and a single charge-coupled device sensor.

The output can be specified at 1, 2, 4, or 6 bits per pixel, and it runs off 12 volts, either from batteries or from an AC adapter. Combined with one of the new flat-panel color displays, this device should let you do serious color desktop publishing on the road.

Finally, the laptop industry has been abuzz lately with rumors about a patent dispute concerning—of all things—laptop computer hinges. GRiD Systems, now owned by Tandy, patented certain key aspects of the hinges it used to make its original clamshell-style laptops. Tandy, now in control of the patent, is said to be approaching other laptop vendors and demanding that they pay license fees. It's not clear whether laptop prices will rise as a result, but the dispute, like many patent issues, bears watching.

As you can see from the variety of technological developments under way, there's no single direction in the laptop world. Still, there is a common thread: Makers of laptops and laptop peripherals are pushing their resources and ingenuity to the limit to make their products smaller, lighter, and more convenient to use. Even if you don't own a laptop, you can expect to reap the benefits of these efforts in future computer products. ■

L. Brett Glass is a freelance programmer, author, and hardware designer residing in Palo Alto, California. He can be reached on BIX as "glass."

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STALKING THE 8-BIT SPECTRUM

Here's how to get around a prickly problem when using color palettes

During the day-to-day grind of computer processing, the fruits of the Information Age can occasionally toss you some bad apples. For example, that report you downloaded is in a format that your word processor refuses to recognize. Or the first thing your hot new graphics application does is bomb and blow a 10-megabyte black hole in your hard disk's volume directory. At times like these, those special-purpose utilities you bought earn their money. Unfortunately, there comes a time (guaranteed by Murphy) when you become blessed with a problem whose characteristics are so unique that there's no ready-made solution.

Such problems, by their very nature, tend to occur with crucial information. Your only hope in this type of jam is to be intimately familiar with your computer and how it works. That's because you have to take control of the situation by cobbling together a unique repair tool to work around the problem. Whether or not you save the work depends solely on what you know. This month I want to relate a problem I encountered on the Mac II, and how I fixed it.

While doing some graphics work, I discovered that, at times, the set of colors that belonged to a scanned image file weren't the same colors that showed up when the file was imported into a graphics application. Worse, the Mac, in its efforts to display the best possible colors for the front window, hampered conventional rescue efforts.

The solution was to craft an unconventional tool: a Mac function key that lets me capture the original image colors and save them to a file, allowing me to restore the image later by applying the stored colors to the file. Since I only dabble in art, this problem was not a crippling one for me, but it was probably devastating for professional artists. Solving it provided me with plenty of experience working with the Mac's internals. Before discussing the fix, I should explain how the Mac handles color.

The Mac and Color

Everything appearing on a Mac SE/30's or Mac II's screen is rendered by graphics software called Color QuickDraw. It represents colors in an internal format that uses a byte for each primary color: red, green, and blue (RGB). These 3 bytes of color information provide the Mac with the capability of displaying up to 2^{24}, or 16,777,216, possible colors.

You may have noticed the word *possible* in that last sentence. Doesn't Apple's newly introduced 32-Bit QuickDraw work with 32-bit pixels that contain 24 bits of color information, allowing the Mac to display this many colors? That's true, but remember that a computer's display is a combination of software and hardware. So even though 32-Bit QuickDraw might be willing, the hardware might not be.

Quite often you'll be using a video board that manages only 8 bits of color information, which limits you to 256 colors. Why is this? After all, most D/A converter (DAC) hardware can generate the wide range of colors if necessary. However, it's a different matter for a display board to have enough video RAM to hold an image composed of 24-bit pixels, and here the major obstacle quickly becomes cost. Boards with the several megabytes of video memory required to accomplish this cost thousands of dollars. Compare this to the price of a typical 8-bit-deep video board, which is about $700. Unless you've won the state lottery, I'm willing to bet you're seeing a

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lot fewer colors on your Mac monitor.

If 256 colors seems limiting, remember that they can be any of the possible 16.8 million. Realistic images are possible if the proper colors are selected: Warm colors for flesh tones, say, or lots of green hues for a forest scene. This sleight of hand, where an 8-bit value can represent a 24-bit pixel, is handled by a set of Color Manager routines and the display hardware.

The Color Manager uses a color lookup table (CLUT) that maps QuickDraw's internal 24-bit RGB value to an 8-bit index value. It's this value that QuickDraw writes to the video board's RAM. When the pixel is displayed, the video hardware uses its own copy of the CLUT to map the pixel's index back into a 24-bit value that's sent to the DACs. Like much of the information on the Mac, these color tables can be saved in a resource on disk called `clut`.

So far, so good. But what happens if there's more than one window on the screen, as is often the case under MultiFinder, and each window's image has its own unique set of 256 colors? A set of Palette Manager routines determines how to share the limited number of colors. The Palette Manager does the best it can for all the windows, but it gives preference to the frontmost window, since that's the active one and typically the one you're most interested in. It makes these judgment calls based on information contained in data structures called color palettes. Of course, color palettes can be stored in a `pltt` resource. Stay acquainted with color tables and color palettes; I'll be getting back to them.

To facilitate the sharing of images among applications, Apple has defined a version 2 picture format (termed PICT) that describes color images as a sequence of Color QuickDraw commands. (An earlier pre-Mac II version 1 picture format dealt only with black-and-white images.) As an image is drawn, the Color QuickDraw commands can be recorded into the data fork of a file whose type is set to PICT so other Mac applications can recognize it.

The image can also be written into a (you guessed it) PICT resource, but in this case, it can't be stored on the fly. The entire image must be built in memory before the Resource Manager can write it to a file. Wherever it's saved, an image's data can be read and "played back" from within different applications by using the appropriate Color QuickDraw calls. The PICT format and Color QuickDraw thus allow images to be treated as objects that can be displayed, selected, and copied to other documents without regard to how the image was made.

The Problem: Colors That Run

With all this software working in concert to properly render color graphics on the Mac II's screen, you might be wondering where things could go wrong. Remember that the image pixels, whether living in video RAM or on a disk file, are composed of 8-bit indexes. The PICT format also contains a copy of the color table so that these indexes can be translated back to 24-bit RGB values as required.

When an image is loaded into memory, the Color Manager updates both Color QuickDraw's and the video hardware's CLUTs from this color table, and the image reproduces accurately. But

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if this information is lost, the Mac II doesn't know what RGB values to use to reconstruct the image. In such a case, the Mac uses what it has: a set of 256 default system colors. While this default color table carries a wide range of colors, there may not be nearly enough warm shades or green hues available for the images mentioned earlier. When this happens, some of the scene's colors get rendered in other hues, frequently producing horrific results.

How could this occur? As long as an application uses Color QuickDraw to display the image, there's no trouble. However, some graphics applications use their own routines to read in the image data so that they can manipulate it in their own internal format. Then the application extracts the color table from the PICT file so that it can make sense of the colors. Now you can see where there might be a problem.

I used PixelPaint 1.0 to tinker with color images that I scanned on a Howtek scanner. Although the images looked great in the scanning application, they often looked ghastly when imported into PixelPaint. It turns out that PixelPaint 1.0 expects to find the color table information in a custom COLR resource attached to the file. You're all set if the PICT file contains the COLR resource that PixelPaint expects. But if you get a PICT file from an application that doesn't attach this extra resource to it, you're in trouble. Certain scanning software just doesn't supply the extra—or correct—color resources. (Some scanning software covers all bets, saving not only the image, but also COLR, `clut`, and `pltt` resources in a file.)

My first attempt at a workaround for this problem of colors getting away was to use Bill Steinberg's Klutz desk accessory (*klutz* being a pun on *clut*). This spiffy DA lets you examine the current color table, modify certain colors in it if you wish, and then save the table to a file. Even better, when the time is right, you can have Klutz reload the file and then adjust the Mac II's colors to those stored in the file.

My plan of attack was to scan in an image, activate Klutz, and save the image's color table. Then I'd save the image in a PICT file. Next, I'd launch PixelPaint and load the PICT file. Then I'd start Klutz, load the color table file (forcing the default colors to those I had captured in the scanning application), and finally save the image. PixelPaint would, of course, add the modified colors to a COLR resource as it saved the file. It might be a clunky way to nail the colors down, but at least it should solve the problem.

What looked good in concept was flawed in execution. When I was ready to capture the image's colors using Klutz, something odd happened. Some of the colors changed to new, bright hues, mangling the scanned image. Now what? I didn't have a clue until I realized that about six of the new colors matched the colors of the Apple logo in the menu bar. Remember the Palette Manager? It adjusts the display's colors, giving priority to the frontmost window. The frontmost window was no longer the image window, but now the Klutz DA, including the Apple logo in the menu bar.

Every time I captured the color table with Klutz, the Palette Manager methodically contaminated the color table with the Apple logo colors. Tinkering with the offending colors within Klutz didn't do any good, because the Palette

continued

Listing 1: *The complete source listing for the Capture CLUT FKEY. It's compiled into a resource of type FKEY and then pasted into the System file.*

```
#include "EventMgr.h"
#include "FileMgr.h"
#include "MacTypes.h"
#include "MemoryMgr.h"
#include "pascal.h"
#include "StdFilePkg.h"
#include "QuickDraw.h"
#include "WindowMgr.h"
#include "Color.h"
#include "SetUpA4.h"

#define NIL      0L

/* Coords for output file dialog box */
#define PUT_FILE_X  100
#define PUT_FILE_Y  100

/* number indicates the window uses color */
#define HAS_COLOR   0xC000

/* Indicates the graphics port is a direct device */
#define DIRECT_DEVICE 16

/* bytes per RGBColor entry */
#define BYTES_IN_RGB 6

/************** main **************/
main()
{
int             i;
OSType          file_Creator, file_Type;
OSErr           file_error;
short           refNum;
int             oldVol;
unsigned char   *out_Name;
SFReply         out_Reply; /* Reply from SFPutFile */
int             out_vRefNum;
FInfo           tempfileInfo;
Point           where; /* Top left corner of file dialog */
int             err;
int             numberofColors;
CTabHandle      thiscolorTab;
CGrafPtr        the_Window;

/* Custom resource for PixelPaint */
typedef struct our_Colors {
   int            colorCount;
   RGBColor       colorData[];
   } our_Colors, **our_ColorHandle;

/* Handle for custom resource */
our_ColorHandle dummyTable;

RememberA0();

SetUpA4();

/* Start our REAL code */
/* Get CGrafPtr to active window */
the_Window = (CGrafPtr)FrontWindow();
/* Save current volume */
GetVol(NIL, &oldVol);

/* Window present? */
if ((the_Window != NIL) &&
  /* Uses color? */
  ((*the_Window).portVersion >= HAS_COLOR) &&
  /* Uses a CLUT? */
  ((**(*the_Window).portPixMap).pixelType != DIRECT_DEVICE) &&
  /* Uses a CLUT? */
  (((WindowPeek)the_Window)->windowKind != dialogKind))
   {
   /* Lock the color table handle down */
   HLock((**(*the_Window).portPixMap).pmTable);

    /* Stash # of colors */
   numberofColors =
     (**(**(*the_Window).portPixMap).pmTable).ctSize;

    /* Get handle to the color table */
   thiscolorTab = (**(*the_Window).portPixMap).pmTable;

    /* Make a copy of it */
   err = HandToHand(&thiscolorTab);

    /* Copy successful, continue */
   if (!err)
     {
     dummyTable = (our_ColorHandle) NewHandle((BYTES_IN_RGB *
      (numberofColors + 1)) + 2);

      /* Did we get the memory? */
      if (!MemError()) /* Yes */
       {
       /* Stuff count into header */
       (**dummyTable).colorCount = numberofColors;
       /* Copy the RGB values */
       for (i = 0;i <= numberofColors;i++)
         {
         (**dummyTable).colorData[i].red =
          (**thiscolorTab).ctTable[i].rgb.red;
         (**dummyTable).colorData[i].green =
          (**thiscolorTab).ctTable[i].rgb.green;
         (**dummyTable).colorData[i].blue =
          (**thiscolorTab).ctTable[i].rgb.blue;
         }
       where.v = PUT_FILE_X;
       where.h = PUT_FILE_Y;

       /* Ask for filename */
       SFPutFile(where, "PSave color info as:", "", NIL,
        &out_Reply);
       /* Get a valid response? */
       if (out_Reply.good) /* Yes */
         {
         /* Make the destination volume current */
         SetVol(NIL, out_Reply.vRefNum);
         /* and create the file with its creator
            and type specified */
         file_error = Create(out_Reply.fName,
            out_Reply.vRefNum,'PIXR','PX05');
         /* Now write resource map to it */
         CreateResFile(out_Reply.fName);

         /* Process result from Resource Manager */
         switch(ResError())
          {

           case dupFNErr:
            /* File already exists, wipe it out */
            file_error = FSDelete( out_Reply.fName,
             out_Reply.vRefNum);
            file_error = Create(out_Reply.fName,
             out_Reply.vRefNum, 'PIXR', 'PX05');
            CreateResFile(out_Reply.fName);

           case noErr:
            /* No problem! Open the resource fork */
            refNum = OpenRFPerm( out_Reply.fName,
             out_Reply.vRefNum, fsWrPerm);
            /* Add custom resource */
            AddResource(dummyTable, 'COLR',
             999, "\PCustom Colors");
            /* Add the color table */
            AddResource(thiscolorTab, 'clut',
             999, "\PColor Table");
            /* Close the file */
            CloseResFile(refNum);
            break;

           default:
            /* Unknown error, try to abort cleanly */
            CloseResFile(refNum);
            /* Announce that there was a problem */
            SysBeep(50);
            break;
          } /* end switch */
         } /* end if out_Reply.good */

       /* Release memory for the custom resource */
       DisposHandle(dummyTable);
       } /* end if !MemError */
     else
       SysBeep(50);

     DisposHandle(thiscolorTab);
     } /* end if !err */
    else
     SysBeep(50);

    /* Release the color table handle */
    HUnlock((**(*the_Window).portPixMap).pmTable);
    } /* end if the_Window */
  else /* No window, or bogus type */
    SysBeep(50);

/* Clean up */
/* Back to the volume we started on */
SetVol(NIL,oldVol);
RestoreA4();
} /* end main */
```

S O F T W A R E   S E C U R I T Y

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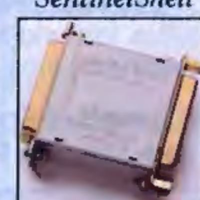

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Manager simply reassigned them elsewhere in the color table. It didn't take too long to realize that I couldn't use Klutz to fix the problem.

A Keyboard Fix

An unconventional problem requires an unconventional solution. Ideally, I wanted to keep the window with the image frontmost, or else the Palette Manager would get into the act. Yet I had to have some way to save its colors. The answer was, in a sense, obvious: Since pointing and clicking with the mouse changes the window order, and thus wreaks havoc with the color tables, don't use it. Use the keyboard instead to trigger the color capture process. A function key was what I needed.

The occasional Mac user might wonder where the function keys are on a Mac. It's not that they're hidden, it's just that there are no physical function keys on a Standard Mac keyboard. (The function keys on an Extended keyboard are there primarily for those who run a DOS emulation; they normally serve no other purpose.) A Mac function key is actually a combination of keystrokes: the Command key, the Shift key, and a number key pressed simultaneously. The Mac OS intercepts these key combinations and executes snippets of code that perform specific actions. Mac function keys are called FKEYs, based on the name of the resource (FKEY) that the code is stored in.

Apple has defined the actions for FKEYs 1 through 4. Most Mac users know that Command-Shift-1 ejects the floppy disk from the internal drive, Command-Shift-2 ejects a floppy disk from an external or second drive, Command-Shift-3 dumps the Mac screen to a MacPaint file, and Command-Shift-4 dumps the screen to an Imagewriter. FKEYs 5 through 9 and 0 are unassigned. However, these empty "slots" can be put to use if you plug in an FKEY resource whose resource ID number matches one of the unassigned values. Thanks to the flexibility of the Mac OS, I can install my own FKEY and use it to capture the color information.

A Close Look at the Solution

Needless to say, I wandered down a lot of blind alleys—and got mugged in quite a few of them—before I got it right. I called the FKEY "Capture CLUT" and wrote it in Symantec's Think C version 3.0. Listing 1 tells the whole story, but allow me to cover some of the important details by following the sequence of operations that Capture CLUT uses to grab a color table.

When the FKEY starts, it uses the Window Manager's `FrontWindow()` trap to select the frontmost window on the screen. Now, to start some safety checks, first check for the presence of a window. `FrontWindow()` does the work by returning a NIL if there isn't a window.

Check that it's a color window. Why would this be a problem on a Mac II, since it uses color? Well, when the Mac II was first introduced, it was able to run existing Mac software because it supported conventional QuickDraw (black-and-white) windows as well as the Color QuickDraw windows. It's possible for both types of windows to be sharing the screen. The ability to support two different drawing environments at the same time is a hazard. Technically, both windows are the same depth in the video

board's memory, but down in the window management data structures, things are quite different for monochrome and color.

Conventional windows use a drawing mechanism called a *graphics port*, or `grafPort`; for Color QuickDraw it's a *color graphics port*, or `cGrafPort`. The data structures of these graphics ports are the same size, and much of the information is identical, but certain entries in `cGrafPort` are handles pointing to color information associated with the port. To locate and extract the color table from the front window, Capture CLUT relies on these entries to hold valid information.

If you were to accidentally trigger Capture CLUT with a `grafPort` window (rather than a `cGrafPort` window) in the front position, Capture CLUT would be working with gibberish. This often pitches the Mac into the abyss of the Odd Address and Illegal Instruction, and it reacquaints you with either your debugger or the infamous bomb box. You can safely determine the type of window that you're using by examining the graphics port's `portVersion` value. The high 2 bits are set (C000 hexadecimal) when you're using a color window.

Oddly enough, the recently introduced 32-Bit QuickDraw poses a hazard as well. Since 32-bit pixels by themselves are large enough to hold actual color information, they are used by the video board's DAC hardware directly. Video boards using 32-bit pixels in this way are called *direct devices*. They obviously don't require color lookup, so there's no valid information in the window's color table—another opportunity for information to trip Capture CLUT into hyperspace. To avoid this possibility, you examine the window's `pixelType`. If `pixelType` has a value of 16, the window is associated with a direct device, and you should abort the attempt to use the color table.

Finally, check to see if the window is a dialog box. Dialog boxes typically carry text-only information or alert you to a problem requiring a response. I've designed Capture CLUT to ignore this window type. For whatever reason, if the frontmost window doesn't pass muster, you beep the Mac to signal a problem and return the thread of execution to the host application.

The Real Work

Capture CLUT locks the window's color table in memory using the Memory Manager's `HLock()` trap. This lets you extract the number of colors in the table and make a copy of it, while preventing the Mac's Memory Manager from hustling it off to a different part of RAM if an operation triggers memory relocation. Use the general-purpose copy routine `HandtoHand` trap to make a duplicate of the table in memory, letting it deal with allocating the memory it needs. Check the error code returned by `HandtoHand` to see if it was successful. Again, if there was trouble, beep and bail out of the operation.

Now, to tackle that custom resource, start by using `NewHandle()` to allocate memory for a data table structure that's designed to resemble the COLR resource. I determined the format of COLR by conversing on BIX and spelunking in ResEdit. The amount of memory to request depends on the depth of the screen. Again, check to see if you got the memory you need. If you did, Capture CLUT copies the number-of-colors value to

continued

the dummy table, followed by the color table's RGB values.

You've got the goods, and Capture CLUT asks where you want to store them. It uses `SFPutFile()` to put up a dialog box prompting you for the volume and filename in which to stash the color table. When this dialog box becomes the frontmost window on the screen, the Palette Manager might monkey with the screen colors. But that's no problem, since you've already captured the color table before the `SFPutFile()` window is up front.

After typing a filename, tapping on Return or clicking on OK proceeds to create the file. Use the File Manager's `Create()` function to make a file whose attributes are type PX05, with a creator of PIXR. These attributes match those that PixelPaint uses when it searches for a color table to load. Then use the Resource Manager trap `CreateResFile()` to build a resource map in memory that will be used for writing to the file's resource fork.

Again, check for errors. If a file with that name already exists, use the File Manager's `FSDelete()` function to ask if you want to replace the file. Use `AddResource` to assign the color table to the file while setting its resource type (clut) and resource ID (999). And you're done except for cleaning up.

Call `CloseResFile()`, which has the resources written to the file and then closes it. Dispose of any memory you allocated and unlock the color table. Be careful where and how you free the memory for the dummy table and color tables. Nothing causes the Mac to crash and burn faster than deallocating a block of memory that you never had to begin with.

Two Caveats

You should note two important things about Capture CLUT right away. First, there's no initialization code. Some specialized FKEYs execute minimal setup code to perform a specific task, but for the problem I'm trying to fix, Capture CLUT relies heavily on information within the application's environment. That means the last thing you want to do is mess with it.

It also means that this FKEY relies on the host application to have initialized certain Managers if it's to operate properly. Since Capture CLUT examines the data structures of a window, the Window Manager should have been initialized. The `SFPutFile()` dialog box requires that the Dialog Manager and TextEdit be set up. It's a rare application that doesn't have a window or menu bar, or doesn't use the `SFGetFile()` or `SFPutFile()` functions to deal with files, so you're pretty safe assuming that this initialization has been done. Nevertheless, be aware of the remote possibility that Capture CLUT could crash an application if this initialization hasn't been done.

Second, notice that Capture CLUT does error checking. Since the FKEY kicks in right in the middle of a working application, it's a good idea to verify that your operations worked properly. If you don't, you stand a good chance of damaging the application's environment, causing it to crash. As an added bonus, if the application has files open when it crashes, there's the risk of trashing the Mac II's hard disk. Needless to say, I have little use for something that destroys my computer system with just a few keystrokes. The file I/O checking could be beefed up, but it's been more than adequate for my work.

This is not to say that an FKEY is an unreliable way to deal with a problem. For starters, you don't need to write a lot of initialization code or try to implement an elaborate event loop that typical Mac and OS/2 applications require. As the listing shows, all that's required is a short, linear piece of code. As for handling errors, you can avoid a lot of trouble simply by coding defensively. But that's a truth that applies equally to applications as well as FKEYs. Finally, you can invoke the FKEY from within any application at any time, and that's usually when trouble pounces on you: while you're trying to do some work, not at the Desktop.

It's true that you need to know a lot about the Mac before you can begin programming it. I've used no less than the Window Manager, Color Manager, Resource Manager, File Manager, and Memory Manager just to write a simple FKEY. But also notice the rich set of functions that the Mac provides: for this FKEY, 18 that make heavy use of data structures maintained by the Mac OS. It's both the Mac's weakness and its strength. This complex but versatile environment lets you write short pieces of code that accomplish a lot.

I had Think C compile the code and then generate a code resource of type FKEY, with a resource ID of 6. This ID number tells the Mac OS to execute the Capture CLUT code when Command-Shift-6 is pressed. I also had Think C set the output file's type to FKEY and creator to CWFK, so that most FKEY installation utilities would recognize it.

continued

However, I used ResEdit 1.2 to paste the resource into the System file. For those using ALSoft's Master Juggler or Fifth Generation Systems' Suitcase II to manage FKEYs, I've tried Capture CLUT with both, and it works without a hitch.

Using It

My rescue operations had deviated from my original plan. Once the scanning application is done, I save the image as a PICT file. If the order of windows has changed, I select the window whose colors I want to capture by clicking on it, bringing it to the front. Then I fire the FKEY. The dialog box comes up. I type a descriptive filename into it, press Return, and Capture CLUT is done.

I quit the scanning application, and, using ResEdit 1.2, I copy the COLR resource from the file made by Capture CLUT. Then I paste it into the PICT file's resource fork. When I launch PixelPaint 1.0 and open the file, the image is rendered in the colors it deserves. The type and creator of the file made by Capture CLUT are recognized by PixelPaint, so I can also load a ready-made palette of colors to work with. If a graphics application uses a clut resource, I can use ResEdit in the same way to copy it into a PICT file and modify the ID numbers of the resource. The paint application does the rest when I open the file.

Today, Things Are Better

I made heavy use of Capture CLUT when color applications were evolving rapidly on the Mac II. I rarely use it now, because the software has matured to the point where many applications use the color table in the version 2 picture format. For example, PixelPaint 2.0 now imports PICT files and renders the colors properly, even if the COLR resource is absent. Not only that, but 32-Bit QuickDraw corrects a number of Palette Manager bugs. The color mashing interaction I had observed with Klutz and PixelPaint 1.0 no longer occurs. Nevertheless, Capture CLUT was highly useful during that interval when matters of color were being sorted out.

The greatest value of Capture CLUT is that I learned a lot about how the Mac works, and this knowledge can be applied to other Mac problems. ■

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UPD70108-5	(5MHz) V20 Chip ~~$5.49~~	$5.95
UPD70108-8	(8MHz) V20 Chip ~~$9.49~~	$7.95
UPD70108-10	(10MHz) V20 Chip ~~$12.25~~	$10.95
UPD70116-8	(8MHz) V30 Chip ~~$9.95~~	$7.95
UPD70116-10	(10MHz) V30 Chip ~~$16.95~~	$15.49

7400

Part No.	1-9	10+	Part No.	1-9	10+
7400	SALE	.15	7474	SALE	.25
7402	29	.19	7475	49	39
7404	SALE	.15	7476	45	35
7405	35	25	7483	69	59
7406	39	29	7485	SALE	.45
7407	SALE	.25	7486	SALE	.29
7408	35	25	7489	1.95	1.85
7410	SALE	.15	7490	49	39
7411	SALE	.19	7493	45	35
7414	SALE	.25	7495	SALE	.29
7416	SALE	.19	74107	SALE	.13
7417	SALE	.19	74121	SALE	.25
7420	29	19	74123	SALE	.35
7427	SALE	.13	74125	SALE	.35
7430	SALE	.15	74147	SALE	1.49
7432	39	29	74150	SALE	1.10
7438	SALE	.25	74151	SALE	.13
7442	SALE	.29	74154	1.35	1.25
7445	SALE	.59	74161	69	59
7446	89	79	74173	SALE	.59
7447	89	79	74174	SALE	.35
7448	1.95	1.85	74175	SALE	.35
7473	39	29	74193	79	69

74LS

74LS00	SALE	.15	74LS139	SALE	.29
74LS02	SALE	.15	74LS151	SALE	.29
74LS03	SALE	.15	74LS153	SALE	.25
74LS04	SALE	.19	74LS154	1.19	1.09
74LS05	SALE	.19	74LS157	45	35
74LS06	59	49	74LS161	SALE	.29
74LS07	59	49	74LS163	SALE	.35
74LS08	28	18	74LS164	SALE	.35
74LS09	SALE	.15	74LS165	75	65
74LS10	SALE	.15	74LS166	SALE	.69
74LS11	29	19	74LS173	SALE	.35
74LS14	SALE	.29	74LS174	SALE	.29
74LS20	SALE	.15	74LS175	SALE	.29
74LS21	SALE	.19	74LS191	SALE	.39
74LS27	SALE	.19	74LS192	69	59
74LS30	SALE	.15	74LS193	69	59
74LS32	SALE	.19	74LS194	SALE	.45
74LS38	SALE	.25	74LS221	SALE	.49
74LS42	49	39	74LS240	SALE	.45
74LS47	89	79	74LS241	SALE	.49
74LS73	SALE	.25	74LS244	SALE	.49
74LS74	SALE	.19	74LS245	SALE	.59
74LS75	SALE	.25	74LS257	SALE	.29
74LS76	39	29	74LS259	99	89
74LS83	59	49	74LS273	89	79
74LS85	59	49	74LS279	49	39
74LS86	29	19	74LS367	SALE	.29
74LS90	SALE	.29	74LS373	SALE	.59
74LS93	SALE	.29	74LS374	SALE	.49
74LS123	SALE	.35	74LS393	SALE	.69
74LS125	49	39	74LS541	SALE	.99
74LS132	SALE	.29	74LS590	5.95	5.85
74LS138	49	39	74LS688	2.39	2.29

74S/PROMS*

74S00	SALE	.19	74S188*		1.49
74S04	SALE	.19	74S189		1.49
74S32	SALE	.19	74S240		1.39
74S74	SALE	.19	74S244	SALE	.75
74S112	SALE	.25	74S287*		1.49
74S124	SALE	1.25	74S288*		1.49
74S138	SALE	.49	74S373	SALE	.99
74S153	SALE	.25	74S374	SALE	.99
74S163	SALE	.75	74S387*		1.29
74S174	SALE	.25	74S472*	SALE	2.49
74S175	SALE	.25	74S571*		2.49

CD-CMOS

CD4001	.19	CD4051	.59
CD4002	.19	CD4052	.59
CD4007	.25	CD4053	.59
CD4011	.19	CD4060	.65
CD4012	.25	CD4066	.29
CD4013	.29	CD4069	.19
CD4015	.49	CD4070	.29
CD4016	.29	CD4071	.22
CD4017	.49	CD4072	.22
CD4018	.59	CD4073	.22
CD4020	.59	CD4081	.22
CD4021	.59	CD4093	.35
CD4024	.45	CD4094	.89
CD4027	.35	CD4503	.39
CD4028	.49	CD4511	.69
CD4029	.69	CD4516	.75
CD4030	.35	CD4518	.75
CD4040	.65	CD4520	.75
CD4042	.59	CD4522	.79
CD4043	.59	CD4528	.69
CD4046	.65	CD4538	.79
CD4047	.65	CD4543	.79
CD4049	.29	CD4584	.49
CD4050	.29	CD4585	.69

EEPROMS

2816A	2048x8	350ns (9V 15V) 5V Read/Write	5.25
2816A-25	2048x8	250ns (9V 15V) 5V Read/Write	5.49
2817A	2048x8	350ns 5V Read/Write	7.95
2864A	8192x8	250ns 5V Read/Write (Pin 1 No R/B)	13.95
2864A-30	8192x8	300ns 5V Read/Write (Pin 1 No R/B)	12.95
2865A	8192x8	250ns 5V Read/Write	12.95
52B13	2048x8	350ns (21V) 5V Read Only	1.49

MICROPROCESSOR COMPONENTS

Z80, Z80A, Z80B, SERIES

Part No.		Price
Z80		1.19
Z80A		1.29
Z80A CTC		1.65
Z80A DART	~~4.95~~	3.95
Z80A PIO	~~1.89~~	1.49
Z80A SIO/O	~~3.95~~	2.95
Z80B		2.75
Z80B CTC	~~3.95~~	3.25
Z80B PIO		3.95
Z8681B1	~~8.95~~	6.95

8000 SERIES

Part No.		Price
8031	~~3.95~~	3.49
80C31	~~9.95~~	8.95
8035	~~1.95~~	1.25
8039	~~1.95~~	1.59
8052AHBASIC		24.95
8080A	~~2.25~~	1.49
8085A	~~2.49~~	1.95
8085A-2		3.59
8087 (5MHz)	~~99.95~~	94.95
8087-1 (10MHz)		184.95
8087-2 (8MHz)		134.95
8088 (5MHz)	~~4.95~~	3.49
8088-2 (8MHz)	~~6.95~~	5.95
8116	~~4.95~~	3.95
8155		2.49

8000 SERIES Continued

Part No.		Price
8155-2		3.49
81C55		3.95
8156		2.95
8205	~~9.49~~	8.99
82C11		6.95
8212	~~2.29~~	1.99
8216		1.39
8224	~~1.75~~	1.49
8228	~~1.95~~	1.49
8237-5	~~4.25~~	3.95
8243		1.75
8250A	~~4.95~~	3.95
8250B (For IBM)	~~5.95~~	4.95
8251A		1.69
8253		1.89
8253-5		1.95
82C53-5		3.95
8254		3.95
8255A-5		2.95
82C55A-5		3.49
8259-5		2.25
8272	~~3.95~~	2.95
8274	~~5.95~~	4.95
8279-5	~~2.95~~	2.75
8282		3.49
8284		1.75

8000 SERIES Continued

Part No.		Price
8286		2.29
8741	~~9.95~~	9.49
8742	~~17.95~~	14.95
8748 (25V)		7.95
8748H (HMOS)(21V)		9.95
8749		9.95
8751H (3.5-12MHz)		36.95
8755		13.95
80286-10 (10MHz) LCC		49.95
80287-3 (5MHz)		109.95
80287-8 (8MHz)		209.95
80287-10 (10MHz)		259.95
80386-16 PGA		279.95
80387-16 (16MHz)		395.95
80387-20 (20MHz)		459.95
80387-25 (25MHz)		569.95
82284 (8MHz)	~~9.49~~	7.95
82288 (8MHz)	~~9.95~~	7.95

DATA ACQUISITION

ADC0804LCN		3.25
ADC0808CCN	~~5.95~~	5.49
ADC0809CCN		3.69
ADC1205CCJ-1		18.49
DAC0808LCN	~~1.75~~	1.49
AY-3-1015D		4.95
AY-5-1013A		1.95

STATIC RAMS

Part No.	Function			Price
2016-12	2048x8	120ns	~~3.75~~	2.95
2102	1024x1	350ns		.89
2112	256x4	450ns MOS	~~2.49~~	1.95
2114N	1024x4	450ns	~~.99~~	.79
2114N-2L	1024x4	200ns Low Power		1.49
21C14	1024x4	200ns (CMOS)		.49
5101	256x4	450ns (CMOS)	~~2.47~~	1.95
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
43256-10L	32,768x8	100ns (256K) Low Power	~~26.95~~	23.95
43256-15L	32,768x8	150ns (256K) Low Power	~~25.25~~	22.95
62256LP-10	32,768x8	100ns (256K) LP CMOS	~~27.95~~	24.95
62256LP-12	32,768x8	120ns (256K) LP CMOS	~~27.25~~	24.25
62256LP-15	32,768x8	150ns (256K) LP CMOS	~~26.25~~	23.95

DYNAMIC RAMS

421000A9A-10	1,048,576x9	100ns 1MEGx9 SIP	~~300.95~~	229.95
421000A9B-10	1,048,576x9	100ns 1MEGx9 SIM	~~299.95~~	195.95
421000A9A-80	1,048,576x9	80ns 1MEGx9 SIP	~~419.95~~	229.95
421000A9B-80	1,048,576x9	80ns 1MEGx9 SIM	~~239.95~~	225.95
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)		4.49
4164-100	65,536x1	100ns	~~3.49~~	3.29
4164-120	65,536x1	120ns	~~2.95~~	2.65
4164-150	65,536x1	150ns	~~2.59~~	2.49
41256-60	262,144x1	60ns	~~9.25~~	9.49
41256-80	262,144x1	80ns	~~7.95~~	6.95
41256-100	262,144x1	100ns	~~7.25~~	6.49
41256-120	262,144x1	120ns	~~6.95~~	6.19
41256-150	262,144x1	150ns	~~6.49~~	5.89
41264-12	64Kx4	120ns Video RAM		12.95
41464-10	65,536x4	100ns	~~14.49~~	8.95
41464-12	65,536x4	120ns	~~11.95~~	8.25
41464-15	65,536x4	150ns	~~10.95~~	7.95
51256-10	262,144x1	100ns Static Column	~~13.95~~	8.95
41256A9A-10	262,144x9	100ns 256x9 SIP	~~149.95~~	69.95
41256A9B-10	262,144x9	100ns 256x9 SIM	~~74.95~~	64.95
511000P-10	1,048,576x1	100ns (1 Meg)	~~19.95~~	19.49
511000P-80	1,048,576x1	80ns (1 Meg)	~~22.95~~	21.75
514256P-10	262,144x4	100ns (1 Meg)	~~24.95~~	22.95
514258-10	262,144x4	100ns Static Column		31.95

EPROMS

TMS2516	2048x8	450ns (25V)	~~5.95~~	4.95
TMS2532	4096x8	450ns (25V)		5.95
TMS2532A	4096x8	450ns (12.5V)	~~4.49~~	3.25
TMS2564	8192x8	450ns (25V)		6.95
TMS2716	2048x8	450ns (-5V, +5V, +12V)	~~6.95~~	6.49
1702A	256x8	2K (1μs)	~~4.95~~	4.25
2708	1024x8	450ns	~~6.95~~	5.95
2716	2048x8	450ns (25V)	~~3.75~~	3.25
2716-1	2048x8	350ns (25V)	~~3.95~~	3.49
27C16	2048x8	450ns (25V) CMOS	~~4.24~~	3.75
2732	4096x8	450ns (25V)		3.95
2732A-20	4096x8	200ns (21V)	~~4.25~~	3.95
2732A-25	4096x8	250ns (21V)	~~3.95~~	3.75
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~~	3.39
27C64-15	8192x8	150ns (12.5V) CMOS		5.95
27128-20	16,384x8	200ns (21V)	~~6.49~~	5.95
27128-25	16,384x8	250ns (21V)	~~5.54~~	4.95
27128A-15	16,384x8	150ns (12.5V)		7.75
27128A-20	16,384x8	200ns (12.5V)	~~5.25~~	4.75
27C128-25	16,384x8	250ns (21V) CMOS	~~5.95~~	5.49
27256-15	32,768x8	150ns (12.5V)		8.95
27256-20	32,768x8	200ns (12.5V)	~~6.25~~	5.49
27256-25	32,768x8	250ns (12.5V)	~~5.49~~	4.95
27C256-15	32,768x8	150ns (12.5V) CMOS	~~7.95~~	7.25
27C256-25	32,768x8	250ns (12.5V) CMOS	~~5.49~~	4.95
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	~~9.49~~	8.49
27C1024	131,072x8	200ns (12.5V) CMOS (1 Meg)	~~24.95~~	19.95
68764	8192x8	64K 450ns (25V) (Chip Enable)		19.95
68766-35	8192x8	64K 350ns (25V) (Output Enable)		16.95

6500/6800 68000 Series

Part No.		Price
6402	~~3.95~~	3.49
6502	~~2.65~~	2.25
6502A	~~2.75~~	2.59
65C02 (CMOS)		7.75
6520		1.95
6522		2.95
65C22		4.25
6532	~~5.49~~	4.95
6551	~~2.95~~	2.69
65C802 (CMOS)	~~16.95~~	14.75
6800	~~1.95~~	1.49
6802		2.95
6808		1.95
6810	~~1.25~~	.99
6820		2.75
6821	~~1.75~~	1.49
68B21	~~1.95~~	1.75
6840	~~3.49~~	2.95
6845	~~2.75~~	2.49
6850	~~1.95~~	1.49
6852	~~.75~~	.59
MC68000L8	~~9.95~~	8.49
MC68000L10	~~11.95~~	8.95
MC68010L10	~~39.95~~	29.95
MC68020RC12B		89.95
MC68701		17.95
MC68705P3S		9.95
MC68705U3L	~~10.95~~	9.49
MC68705U3S	~~10.95~~	9.49
MC68450L10	~~40.95~~	29.95
MC68881RC16A		129.95
MC68881RC20A		169.95

Commodore

WD1770	~~8.95~~	7.49
SI3052P	~~1.25~~	.99
6504A		1.19
6510		14.95
6526		14.95
6526A		15.95
6545-1	~~3.95~~	2.95
6560	~~10.95~~	8.95
6567		24.95
6572	~~10.95~~	7.95
6581 (12V)		12.95
6582 (9V)	~~12.95~~	9.95
8502		7.95
8564	~~4.95~~	2.95
8566	~~9.95~~	7.95
8701		9.95
8722	~~10.95~~	6.95
*82S100PLA**		15.95
325572-01		17.95
901225-01		15.95
901226-01		15.95
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		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	Sale	2.95	74C912		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		.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	2.25
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
LM338K	4.49	MC3487P	.99
LM339N	.39	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
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LM747CN	.49	75452	.39
LM1458N	.35	75492	.79
LM1488N	.45	MC145406P	2.95
DS14C88N (CMOS)	1.19		

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Circle 146 on Reader Service Card

See the next SIX pages for NEW Products and SALE Pricing!

15th ANNIVERSARY YEAR 1974 - 1989

SPECIAL! Monochrome Text Card

Sperry Monochrome Display Adapter

- IBM PC/XT Compatible
- Use for Text only
- Great for Network Servers and Dedicated Work Stations

TEXT.........$12.95

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	$179.95
DMS200	200DPI 3-Button Ser. Mouse	$39.95
DMS200S	200DPI 3-Button Ser. Mouse with Dr. Halo Software	$59.95

IBM Compatible Cases and Power Supplies

JE2010 Pictured

JE1030 Pictured

JE1010	Flip-Top Standard PC/XT Case	$39.95
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
JE2019	Flip-Top Baby AT Case	$69.95

Datatronics 2400/1200/300 Baud Pocket Size Modems

2400 Baud Pocket-Size Modem...Only $149.95!

2400P Pictured

1200P	1200/300 Baud Pocket Size Modem With ProComm Software	$89.95
2400P	2400/1200/300 Baud Pocket Size Modem With ProComm Software	$149.95

TEST EQUIPMENT

Metex Digital Multimeters

Metex General Specs:
- Handheld, high accuracy
- AC/DC Voltage, AC/DC Current, Resistance, Diodes, Continuity, Transistor hFE
- Manual ranging w/overload protection

M3650B & M4650 only:
- Also measures frequency and capacitance

M4650 only:
- Data Hold Switch
- 4.5 Digit

M4650 Pictured

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

Jameco 16MHz 80286 NEAT Computer Kit With 2 Megabyte RAM

- Fully IBM AT Compatible
- Free! QAPLUS Diagnostic Software Included!
- Free! PC Write Word Processing Software Included!
- 2Mb RAM Included, Expandable to 8Mb
- 8 or 16MHz Operation
- AMI BIOS ROMs Included
- Flip-Top Case w/200 Watt Power Supply
- 1.2Mb Disk Drive
- 18.0 Norton SI Rating
- 101-Key (Enhanced) Keyboard

SALE

SAVE $190.55

Shown with VGA Option (not included)
JE2055 Monitor and Adapter Card....$599.95
(See Below)

JE3013	16MHz IBM AT Comp. Kit... ~~$1199.95~~	$949.95
EZDOS	EZ-DOS: MS/PC-DOS Comp. Operating System	$49.95
EZDOSP	Same as above with TrueBASIC	$69.95

IBM COMPATIBLE DISPLAY MONITORS

SALE!

QC1478 Pictured

AMBER	12" Amber Monochrome		$99.95
HD55H	14" RGB 640x240	~~$249.95~~	$239.95
TM5154	EGA 14" 720x350	~~$399.95~~	$369.95
JE1059	EGA Monitor & Card	~~$610.95~~	$479.95
TM5155	14" Multiscan 800x560	~~$649.95~~	$479.95
QC1478	14" VGA 720x480	~~$449.95~~	$399.95
JE2055	VGA Monitor & Card	~~$649.95~~	$599.95

JAMECO IBM PC/XT/AT COMPATIBLE CARDS

JE1043	360K/720K/1.2Mb/1.44Mb Floppy Disk Controller Card (PC/XT/AT)	$49.95
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~~	$149.95
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
JE1077	Multi I/O Card w/ 360K/720K/1.2Mb/1.44Mb Floppy Controller (AT)	$79.95
JE1081	2Mb Expanded or Extended Memory Card (zero-K on-board) (AT)	$99.95

SEAGATE HALF-HEIGHT HARD DISK DRIVES

Your One-Stop Center for Hard Disk Drive Needs!

ST225XT Pictured

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

Seagate 60Mb, 80Mb & 120Mb Hard Disk Drives Also Available!

HARD & HARD/FLOPPY DISK CONTROLLERS

	MFM Hard	RLL Hard	MFM Hard/Floppy	RLL Hard/Floppy
Computer Type	Part No./Price	Part No./Price	Part No./Price	Part No./Price
8088 (PC/XT) 3:1 Interleave	XTGEN $79.95	ACB2072 $89.95	JE1044 $129.95	-------
80286 (AT)/386 2:1 Interleave	1003VMM1 $129.95	1003VSR1 $189.95	1003VMM2 $149.95	1003VSR2 $199.95
80286 (AT)/386 1:1 Interleave	1006VMM1 $149.95	1006VSR1 $199.95	1006VMM2 $179.95	1006VSR2 $219.95

IBM PC/XT/AT COMPATIBLE 3.5"/5.25" DISK DRIVES

JE1022 Pictured

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

MOTHERBOARDS

20MHz 386 Only $749.95!

- *All w/ ØK RAM (except JE3027)*

JE3520 Pictured

JE1001	Jameco 4.77/8MHz 8088 (PC/XT)	$89.95
JE1002	Jameco 4.77/10MHz 8088 (PC/XT)	$99.95
JE3005	Jameco Baby 8/12MHz 80286 (AT)	$279.95
JE3010	Jameco Baby 8/16MHz 80286 (AT)	$379.95
JE3020	AMI Baby 16MHz 80386 (AT)	$999.95
JE3025	AMI Baby 20MHz 80386 (AT)	$1199.95
JE3026	AMI Full-Size 25MHz 80386 (AT)	$1999.95
JE3027	AMI Full-Size 33MHz 386 w/4Mb (AT)	$4299.95
JE3520	Jameco Baby 20MHz 80386 (AT)	$749.95
JE3525	Jameco Baby 25MHz 80386 (AT)	$1499.95

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	720Kb Drive	$59.95
SMK	5.25" Mounting Kit	$14.95

PROTOTYPING PRODUCTS

Jameco Solderless Breadboards

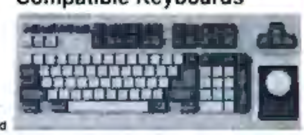
JE23 JE24 JE27

Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price
JE21	3.25 x 2.125	400	0	$4.95
JE23	6.5 x 2.125	830	0	$7.95
JE24	6.5 x 3.125	1,360	2	$12.95
JE25	6.5 x 4.25	1,660	3	$19.95
JE26	6.875 x 5.75	2,390	4	$24.95
JE27	7.25 x 7.5	3,220	4	$34.95

COMPUTER ACCESSORIES

Jameco IBM PC/XT/AT Compatible Keyboards

JE2017 Pictured



JE1015	84-Key Standard AT Layout	$59.95
JE1016	101-Key Enhanced Layout	$69.95
JE2016	111-Key Enhanced w/Solar Calculator	$79.95
JE2017	104-Key Enhanced w/Trackball	$99.95

Colorado Memory 40Mb Tape Back-Up for IBM PC/XT/AT

DJ10	40Mb Tape Back-Up and Tape	$299.95
TB40	40Mb Tape Cartridge	$24.95

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21035	Sams TTL Cookbook (88)	$14.95
21398	Sams CMOS Cookbook (88)	$19.95
22453	Sams Op-Amp Cookbook (88)	$21.95
270645	Intel 8-bit Controller Hndbk. (89)	$19.95
270646	Intel 16-bit Controller Hndbk. (89)	$19.95
270647	Intel 32-bit Controller Hndbk(89)	$19.95
400041	NSC Linear Data Book Vol 1 (88)	$14.95
400042	NSC Linear Data Book Vol 2 (88)	$9.95
400043	NSC Linear Data Book Vol 3 (88)	$9.95
ICM89	1989 IC Master (3 Volume Set)	$119.95

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MMC

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80386 COMPUTER KITS

Jameco Electronics — **New Kits!**

Build your own computer, it's fun and easy...

Jameco is pleased to announce the introduction of two new 80386-based computer kits. We offer the JE3550 starter kit for those just entering the world of 386 computing and the JE3555 power user kit for the serious enthusiast. These kits feature superior Jameco 386 motherboards with the Chips and Technology Chip Set for incredible speed, design reliability and full IBM compatibility. For more detailed specifications on the Jameco 386 motherboards see page 350 inside this advertisement. Each kit comes with complete step-by-step assembly instructions to help you set up your new system.

Using only a screwdriver, you can have your 386 computer system assembled and ready to run in only an evening! Included free with every Jameco computer kit is Diagsoft's QAPlus diagnostic software and Quicksoft PC Write Word Processing Software. If you are ready to upgrade from your present computer system or simply want to enter the world of 386 computing, a Jameco 386 computer kit will help you learn more about how your computer works and save you money at the same time!

Jameco 20MHz 80386 Kit

- *Fully IBM Compatible*
- *60Mb Hard Disk Drive*
- *80386-20 CPU, optional 80387-20 Math Coprocessor Capability*
- *1 Megabyte RAM Included, Expandable to 8 Mb On-board, 16Mb w/optional expansion board (see next page)*
- *Parallel, Serial, Game Ports*
- *8/16/20MHz Keyboard Switchable Operation*
- *AMI BIOS ROMs Included*
- *Free! QAPLUS Diagnostic and PC Write Software Included!*
- *Save $259.45 (60 lbs.)*

Shown with Multiscan Option (not included)
JE2056 Monitor and Adapter Card **$779.95**
(See page 352)

Part No.	Description	Price
JE3520	Jameco Baby 20MHz 386 Motherboard (Zero-K RAM - includes AMI BIOS ROMs)	$749.95
JE2019	Baby AT Flip-Top Case	69.95
JE1016	Enhanced 101-Key XT/AT Compatible Keyboard	69.95
JE1077	Multi I/O with Floppy Controller	79.95
JE1032	200 Watt Power Supply	89.95
JE1022	5.25" 1.2Mb DSHD Disk Drive (Gray Faceplate)	99.95
1006VSR1	RLL Hard Disk Controller Card with 1:1 Interleave	199.95
ST277	Seagate 60Mb Hard Disk Drive	409.95
41256A9A-10	1 Megabyte RAM (4 ea. 100ns 256K x 9 SIP modules)	279.80

Save $259.45 — *Regular List* **$2049.40**

JE3550 20MHz 386 Kit w/60Mb Hard Drive **$1789.95**

Jameco 25MHz 80386 Power User Kit

- *Fully IBM Compatible*
- *120Mb Hard Disk Drive*
- *80386-25 CPU, optional 80387-25 or Weitek 3167 Math Coprocessor Capability*
- *4 Megabyte RAM Included, Expandable to 16Mb on the expansion card (included)*
- *High Density 3.5" and 5.25" Floppy Disk Drives*
- *Parallel, Serial and Game Ports*
- *8/16/25MHz Keyboard Switchable Operation*
- *AMI BIOS ROMs Included*
- *Free! QAPLUS Diagnostic and PC Write Software Included!*
- *Save $279.45 (65 lbs.)*

Part No.	Description	Price
JE3525	Jameco Baby 25MHz 386 Motherboard (Zero-K RAM - includes AMI BIOS ROMs and 16Mb Expansion Card)	$1499.95
JE1016	Enhanced 101-Key XT/AT Compatible Keyboard	69.95
JE1077	Multi I/O with Floppy Controller	79.95
JE1022	5.25" 1.2Mb DSHD Disk Drive (Gray Faceplate)	99.95
356KU	3.5" 1.44Mb Floppy Disk Drive	129.95
1006VSR1	RLL Hard Disk Controller Card with 1:1 Interleave	199.95
JE2010	Tower Case with 250 Watt Power Supply	279.95
ST4144	Seagate 120Mb Hard Disk Drive	699.95
421000A9A-80	4 Megabyte RAM (4 ea. 80ns 1Meg x 9 SIP modules)	919.80

Save $279.45 — *Regular List* **$3979.40**

JE3555 25MHz 386 Kit w/120Mb Hard Drive..... **$3699.95**

With 120Mb Hard Drive!

Shown with M9070S Multiscan Monitor @ 1199.95 and GC1501 VGA Card @ $329.95 (not included) both items sold separately (See page 352)

• REFER TO CODE 4039 WHEN ORDERING • CALL (415) 592-8097

Jameco ELECTRONICS

8088 AND 80286 MOTHERBOARDS

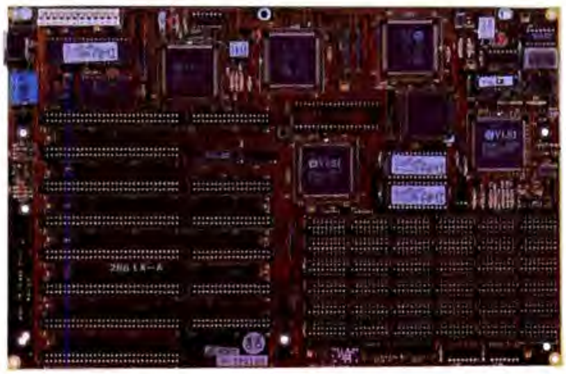
1-YEAR WARRANTY!

12MHz 80286 Motherboard

IBM AT Compatible

SALE!

- Expandable to 1Mb RAM using 256K DRAM chips
- Expandable to 4Mb RAM using 1Mb DRAM chips
- Uses 100ns DRAMs
- Battery-backed clock/calendar
- 8 or 12MHz hardware or keyboard selectable operation
- Front panel LED indicators supported
- Six 16-bit and two 8-bit expansion bus slots
- AMI BIOS ROMs included
- 12 MHz Intel CPU
- Selectable wait states (0 or 1)
- 80287-8 Math Coprocessor capability
- Norton SI rating of 13.7
- Size: 13" x 8.75"
- Weight: 2.25 lbs.



JE3005 8/12MHz 80286 Motherboard... ~~$299.95~~ **$279.95**

16MHz 80286 *NEAT* Motherboard

IBM AT Compatible

SALE!

- Expandable to 1Mb RAM using 256K DRAM chips or 4Mb using 1Mb DRAM chips
- Additional 1Mb with 256K DRAM SIPs or 4Mb with 1Mb DRAM SIPs for a total of 8Mb
- Uses 100ns DRAMs
- Battery-backed clock/calendar
- 8/16MHz selectable
- Front panel LED indicators supported
- AMI BIOS ROMs included
- Five 16-bit and three 8-bit expansion bus slots
- 16MHz CMOS Harris CPU
- Supports all *NEAT* functions including shadow RAM, EMS 4.0, RAM re-mapping, selectable wait states, memory interleaving, etc.
- 80287-10 Coprocessor capability
- Norton SI rating of 18.0
- Size: 13" x 8.5"; Weight: 2.25 lbs.

JE3010 8/16MHz 80286 *NEAT* Motherboard . ~~$399.95~~ **$379.95**

Jameco ELECTRONICS

COMPUTER KEYBOARDS

1-Year Warranty!

111-Key Enhanced Keyboard with Calculator

for IBM PC/XT/AT and Compatible Computers

Benefit from increased productivity with Jameco's new JE2016 keyboard with built-in solar powered calculator!

• XT/AT Switchable • 111-Key Enhanced Layout • 12 Function Keys • LED Indicators for Num Lock, Caps Lock, and Scroll Lock • Large Return Key • Separate cursor/keypad • Tactile touch keyswitches • Color: Beige • Manual Included • Size: 19.5"W x 7.6"D x 1.5"H • Weight: 3.6 lbs.

JE2016 .... **$79.95**

104-Key Enhanced Keyboard with Trackball

for IBM PC/XT/AT and Compatible Computers

• Fully Microsoft Mouse and Mouse Systems Compatible • 200 DPI Resolution

The JE2017 combination keyboard and trackball will enable you to use your mouse-based computer applications with greater ease and efficiency!

• XT/AT Switchable • 104-Key Enhanced Layout • 12 Function Keys • LED Indicators for Power, Num Lock, Caps Lock, and Scroll Lock • Large Return Key • Separate cursor/keypad • Tactile touch keyswitches • Color: Beige • Manual and software drivers Included • One open serial port required for operation • Size: 18.6"W x 7.5"D x 1.75"H • Wt: 4 lbs.

JE2017 .... ~~$109.95~~ **$99.95**

84-Key Keyboard

for IBM PC/XT/AT and Compatible Computers

IBM's original AT Style layout!

- XT/AT Switchable
- 84-Key AT Style Layout
- LED Indicators for Num Lock, Caps Lock, and Scroll Lock
- Large Shift and Return Keys
- Tactile touch keyswitches
- Color: Beige
- Manual Included
- Size: 19.5"W x 7.5"D x 1.33"H
- Weight: 4.6 lbs.

JE1015 .... **$59.95**

101-Key Enhanced Keyboard

for IBM PC/XT/AT and Compatible Computers

Our most popular keyboard!

- Automatically switches between XT or AT
- 101-Key Enhanced Layout
- 12 Function Keys
- LED Indicators for Num Lock, Caps Lock, and Scroll Lock
- Separate cursor/keypad
- Tactile touch keyswitches
- Spec. Included
- Color: Beige
- Size: 19"W x 8"D x 1.33"H
- Weight: 4.6 lbs.

JE1016 .... **$69.95**

• REFER TO CODE 4039 WHEN ORDERING • CALL (415) 592-8097

Circle 146 on Reader Service Card

8088 AND 80286 COMPUTER KITS

Jameco ELECTRONICS — DOS Available!

Jameco's 8088 and 80286 IBM PC/XT/AT compatible kits allow you to build your own computer and come with complete step-by-step assembly instructions. *FREE* **Word Processing and Diagnostic Software included!** *NOW AVAILABLE . . .* **Jameco's new System Tech Manual and DOS.** Computer tool and maintenance kits also available. Please note: JE3008 and JE3013 shipped in 1 box (43 lbs. total) - JE3002 and JE3003 shipped in 2 boxes (55 lbs. total)

12MHz 80286 Computer Kit

- *Fully IBM AT Compatible*
- *Free! QAPLUS Diagnostic Software Included!*
- *Free! PC Write Word Processing Software Included!*
- *DOS Available*
- *80286 CPU, optional 80287-8 Math Coprocessor Capability*
- *512K RAM Included,*
- *8 or 12MHz Keyboard Switchable Operation*
- *Clock/Calendar*
- *AMI BIOS ROMs Included*
- *Save $156.55*

Shown with EGA Option (not included)
JE1059 *Monitor and Adapter Card* **$479.95**
(See page 352)

Part No.	Description	Price
JE3005	8/12MHz Baby 80286 Motherboard (Zero-K RAM - includes AMI BIOS ROMs)	$279.95
JE1016	Enhanced AT Style Keyboard	69.95
JE2019	Baby AT Flip-Top Case	69.95
JE1077	Multi I/O Card with Universal Floppy Controller	79.95
JE1022	5.25" DSHD Disk Drive (Gray Faceplate)	99.95
JE1032	200 Watt Power Supply	89.95
41256-100	512K RAM (18 chips)	116.80

SAVE $156.55 *SALE!* *Regular List* **$806.50**

JE3008 12MHz 80286 Computer Kit .... ~~$799.95~~ **$649.95**

16MHz 80286 *NEAT* Computer Kit

- *Fully IBM AT Compatible*
- *Free! QAPLUS Diagnostic Software Included!*
- *Free! PC Write Word Processing Software Included!*
- *DOS Available*
- *80286 CPU, optional 80287-10 Math Coprocessor Capability*
- *2 Megabyte RAM Included, Expandable to 8 Megabyte*
- *8 or 16MHz Keyboard Switchable Operation*
- *Clock/Calendar*
- *AMI BIOS ROMs Included*
- *Save $190.55*

Shown with VGA Option (not included)
JE2055 *Monitor and Adapter Card* **$599.95**
(See page 352)

Part No.	Description	Price
JE3010	8/16MHz 80286 *NEAT* Motherboard (Zero-K RAM - includes AMI BIOS ROMs)	$379.95
JE1016	Enhanced AT Style Keyboard	69.95
JE2019	Baby AT Flip-Top Case	69.95
JE1077	Multi I/O Card with Universal Floppy Controller	79.95
JE1032	200 Watt Power Supply	89.95
JE1022	5.25" DSHD Disk Drive (Gray Faceplate)	99.95
511000P-10	2Mb RAM (18 chips)	350.80

SAVE $190.55 *SALE!* *Regular List* **$1140.50**

JE3013 16MHz 80286 *NEAT* Kit ...... ~~$1199.95~~ **$949.95**

8MHz 8088 Computer Kit

- *Fully IBM PC/XT Compatible*
- *Free! QAPLUS Diagnostic Software!*
- *Free! *PC Write Word Processing Software Included!*
- *DOS Available*
- *256K RAM Included, Expandable to 640K*
- *4.77 or 8MHz Switchable Operation*
- *Parallel Printer Port*
- *AMI BIOS ROM Included*
- *Save $102.66*

**Please note, PC Write will require 512K RAM for operation.*

Part No.	Description	Price
JE1001	4.77/8MHz 8088 Turbo Motherboard (Zero-K RAM - includes AMI BIOS ROM)	$89.95
JE1040	360K Floppy Controller	29.95
JE1010	Flip-Top Case	39.95
JE1015	XT/AT Compatible Keyboard	59.95
JE1030	150 Watt Power Supply	59.95
JE1050	Mono/Graphics Card w/Printer Port	59.95
JE1020	5.25" DSDD Disk Drive (Black Faceplate)	89.95
AMBER	12" Monochrome Amber Monitor	99.95
41256-150	256K RAM (9 chips)	53.01

SAVE $102.66 *SALE!* *Regular List* **$582.61**

JE3002 8MHz 8088 Turbo Kit .... ~~$499.95~~ **$479.95**

10MHz 8088 Computer Kit

- *Fully IBM PC/XT Compatible*
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Part No.	Description	Price
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QC1418P

Part No.	Description	Price
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*ST157R	40Mb	3.5" HH	40ms	RLL	$379.95	----------	----------
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ST225XT	20Mb	5.25" HH	65ms	MFM	----------	$269.95	----------
ST225AT	20Mb	5.25" HH	65ms	MFM	----------	----------	$339.95
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ST238XT	30Mb	5.25" HH	65ms	RLL	----------	$299.95	----------
ST238AT	30Mb	5.25" HH	65ms	RLL	----------	----------	$389.95
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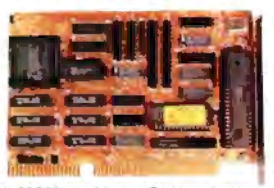

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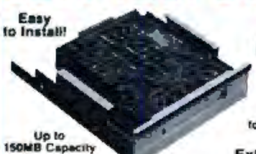

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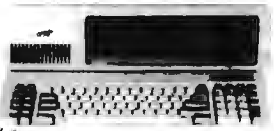

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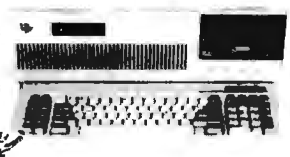

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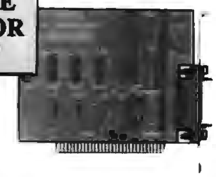

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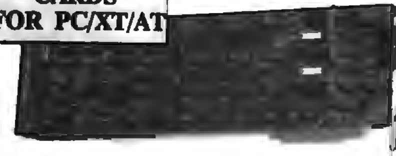

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- Digital I/O: 16 Input / 16 Output channels; All I/Os TTL compatible.
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- Digital I/O: 16 Input / 16 Output channels; All I/Os TTL compatible.
- Counter: 1 channel programmable interval counter/timer; Uses Intel 8253.
- Software: LabDAS ($195/495), ASYST, LABTECH, UnkelScope

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- Digital I/O: 16 Out, 16 In; TTL compatible; All I/Os TTL compatible.
- Counter: 1channel 16 bit programmable interval counter/timer; Uses Intel 8254. Provides pacer clock.
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- Input: 32 TTL compatible channels; Input load is 0.2 mA at 0.4V.
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OPTICAL WORM

$895

~~$2795~~

Write Once Read Many... California Digital has just purchased hundreds of Information Storage's ISI/525WC optical WORM drive. Chosen "Editors Choice" by PC Magazine, (March 29, 1988) the 525 provides 230 megabytes of random accessible data on each doubled sided flippy cartridge. (manually flipped).

Optical storage is the perfect medium for maintaining "on line" programs or other static data. Also ideal for sending to field offices, catalogs, part lists or any data where random accessibility is required.

The ISI/525 is available in external or internal configuration. Supplied with one cartridge, ESDI/PC controller, cable and transparent optical software. For additional information, contact Steven in our technical support department (213) 217-1947. The ISI/525 is a current production drive.

~~$3995~~

Dest Scanner $559

Image scanning for OCR text, photographs, and line art. High resolution 300 DPI the DEST PC Scan Plus/651 is capable of rendering photographs to 32 halftone shades. Also inputs text directly from printed pages to ASCII files or directly into most word processing programs. Electronic status display. Available for both the Macintosh (SCSI) or the IBM/PC. Please specify 115 or 230 volt.

Original price was over $3000, now is your chance to purchase a DEST scanner for only $559.

NEC/890 Laser $3095

PC Magazine has chosen the NEC-890 best laser printer of the year (Jan 12 1988). And its obvious why: the printer is Postscript, Hewlett Packard, and Apple compatible, and comes standard with three megabytes of memory. The 890 accepts data from parallel, serial and Apple-Talk devices.

Roland 980 $695

~~$1795~~

The DXY 980 is an eight pen, size "B" flat bed plotter. This unit is fully HP 7470/7475 compatible and accepts both parallel and serial inputs.

Digital LED coordinate display, .05mm step resolution and electrostatic paper holder are only some of the outstanding features on this quality plotter.

~~$1299~~

Saba Scanner $359

The Saba Scanner inputs a printed page of evenly spaced text in less than three seconds. Included OCR software allows your computer to transfer printed pages into ASCII files or directly to spreadsheets and most word processing programs.

Archival data, legal briefs... No problem. Simply insert 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.

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Laser Printer II/D double sided	3995	2995
QMS PS/810 2 Meg. 35 fonts, Post/S	5495	3879
APPLE Laser Writter NT	4550	3659
NEC890 Postscript, 3 meg	4975	3095

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HDG 1515 15x15	969	659
Tiger 1111C, 12x12 stylus extra	727	487
HDG 3648, 36x48	5357	3995
SUMMAGRAPHICS		
Summa 1201 plus 12x12"	599	379
TB 3648, 36x48"	4748	3729
KYE Genius Tablet w/4 but. mouse	599	279
CALCOMP		
25180, 12x18"	1275	999
91480, 36x48"	4118	3389

PLOTTERS

HOUSTON INSTRUMENTS		
DMP 41 single pen, 3 ips, C&D	2995	2295
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		
1023 Artisan A-D, 8 pen, 30 ips	4895	3795
1043GT size A-E, 8 pen, 24 ips	7995	5495
HEWLETT PACKARD		
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LP3700MP 8 pen size "E" 10 ips	4695	3495
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SP600 size "B" 6 pen	995	659
SP1000 single pen size A-D	3995	2795
SP1800 8 pen, A-D, 32 ips	4695	3369
JDL 850, size "C" one meg. memory	3845	2799
VERSATEC 8524 Electrostatic	16,900	13799
NUMONICS		
5460 size "A-D"	2495	1859
5860 size "A-D" 8 pen	7495	5759

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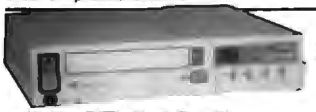
AutoSketch Std & Enhanced 2.0	99	79
VERSACAD Designer	2995	1995
GENERIC CAD level 1	49	35
AMERICAN SM. BUS'N. Design Cad	299	179



$539

CD/ROM Complete Kit

Doctor, lawyer, indian chief . . . Virtually every industry and profession is disseminating information on CD/ROM. One compact disk, the same size as an audio disk, can store over 500 megabytes of data in High Sierra format.

Below is a listing of some of the CD/ROM drives currently available from California Digital. The best value is the Eclipse 430 external drive. The CDS/430 includes PC/XT interface, cables, sampler software and MS/DOS extension. It also offers an audio output feature for mulitmedia presentations. The system is Manufactured in Japan by one of the Worlds largest producers of magnetic storage equipment. A super value at only $539.

Eclipse 430 external system	$539	NEC interface kit for above	159
Hitachi 1503S External system	695	Sony CD/510 internal drive only	559
Hitachi 3500 Internal system	595	Sony 6101 external drive only	795
Hitachi internal drive only	519	Sony 230B interface kit	159
NEC CDR/77 External drive only	695	Panasonic LF5000 "write once"	1895
NEC CDR/80 Internal drive only	639	Panasonic interface kit for above	359

SCANNERS

SABA SCANNERS		
page scanner with OCR software	1299	359
hand held scanner with OCR soft	799	159
DEST SCANNERS		
PC/651 scan + 32 shades	3995	559
2000 edge feed scanner	935	719
MICROTECH300G 256 gray scales	2195	1759
DFI HandiScan 300 with Halo	359	199
PRINCETON GRAPHICS LS-300	1095	789
PANASONIC		
RS505 Image page scanner	1499	999
RS506 Page scanner	1899	1259

MicroSoft Mouse

Your choice, MicroSoft "Inport Buss Mouse" or "Serial Mouse". The industry standard, list price $150, now available for only $59. Includes software and manual. Packaged in OEM boxes.

$59

40 Meg. Tape Back-up

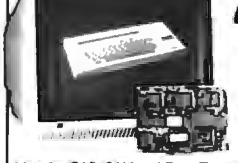
$239

~~$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.



EGA Color Monitor $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.

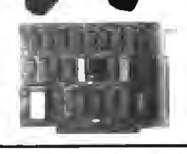
Full featured, 132 column, multi-resolution video color adapter card available for only $139 additional. Comparable card package would retail for $1095.

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.



DISK DRIVES

5" DISK DRIVES

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TEC504 ½ ht. double sided	59
TANDON 101/4 full ht. 96 TPI	99
TEAC FD55BR half height	89
TEAC FD55FR 96 TPI, half ht.	119
TEAC FD55GFR for IBM AT	109
PANASONIC 455 Half Height	89
PANASONIC 475 1.2 Meg./AT	99
Fujitsu 5¼" double sided	69
Dual enclosure for 5¼" drives	69

3½" DISK DRIVES

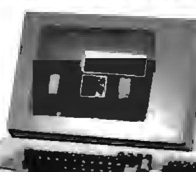
SONY MP-73W, 1.44 Meg	139
TEAC 235HF 1.44 Meg	99
5¼" Form Factor Kit	20

8" DISK DRIVES

QUME 842 double sided	189
QUME 841 single sided	99
SHUGART 851R dbl.sided	319
SHUGART 801R sgl.sided	259
SIEMENS 100/8 sgl. sided	119
REMEX RFD4000 dbl. sided	189

Color Graphics Terminal

Lear Siegler 7107



$659

~~$3995~~

Thirteen inch color graphic terminal is both VT-100/51 and Tektronix 4010/4014 compatible. The 7107 offers a pallette of 4,096 colors on a 640 pixel by 480 line non-glare black screen.

Horizontal pan and image zoom, to 16 times original size make the 7107 the ideal terminal for CAD/CAM applications.

Five Inch Winchester Disk Drives

Price does not include controller.	each	two+
SEAGATE 225 20 Meg. ½ Ht.	239	229
SEAGATE 238 30 Meg. RLL	259	249
SEAGATE 251/1 51 M. 28mS.	459	445
SEAGATE 4096 96 M. 35mS.	559	539
MINISCRIBE 8425 25 M 65ms.	239	227
MINISCRIBE 3650 50M 61 ms.	319	309
MINISCRIBE 6085 90 meg.	459	435
MINISCRIBE 3053 25 ms. ½ ht.	359	339
FUJITSU 2242 55 M. 35mS.	1299	1229
FUJITSU 2243 86 M. 35mS.	1695	1619
RODIME RO-204E 53 Meg.	895	859
MAXTOR XT1140 140 Meg.	1495	1450
MAXTOR XT2190 192 Meg.	1919	1875
TOSHIBA MK56 70 M. 30mS.	1289	1229
CONTROL DATA WREN "V"	call	

• Winchester Controllers for IBM/PC •

XEBEC 1220 with floppy controller	159
DTC 5150CX	119
OMTI 5527 RLL controller	99
ADAPTEC 2070 RLL controller	99
ADAPTEC 2372A 1/1 interleaf	159
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Last month I reviewed improved hard disk performance from proper interleaving. This month's topic is memory interleaving.

Although as important to memory design as access time, CYCLE time is seldom discussed beyond the board designers lab. ACCESS time is the time it takes a memory chip to either make its contents available to the processor (read), or store the data that the processor wants saved (write). CYCLE time is equal to access time plus precharge time. PRECHARGE time is the time it takes the memory chip to restore its internal charge after a read or write cycle. In many processor designs, the critical timing factor that prevents back to back memory accesses is the precharge delay, because without it, the processor could run full speed ahead with no WAIT states.

Interleaved memory is used to nullify that delay. First the memory is divided into left and right banks. The processor then accesses the memory by alternating from one bank to another. While the left bank is recovering from an access (precharging), the right bank is ready to go; on the next access from the left bank the right bank recovers.

While not all accesses are sequential, and sometimes the memory request will be to the same bank that was last accessed, the vast majority will be interleaved and the machine will run at NEAR ZERO wait states because of interleaving.

Derick Moore, Director of Engineering

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Index of companies covered in articles, columns, or news stories in this issue
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COMING UP IN BYTE

The following articles are in the works for upcoming BYTE issues. Most will appear in October, but, computers being what they are and magazines being what they are, nothing is carved in stone.

PRODUCTS IN PERSPECTIVE:

More and more users are turning to optical storage devices—write-once and erasable—for archiving gigabytes of data. We look at both types of drives, for both the Mac and the PC, in the October **Product Focus**.

System reviews in October will cover two new Micro Channel architecture–bus 80386SX machines from IBM and American Mitac.

Now that 32-Bit QuickDraw is available for your Mac, a printer capable of reproducing its output sounds like a good idea. We look at such a printer, Tektronix's ColorQuick, in a **peripheral review**.

Software reviews: At long last, BYTE gets the opportunity to evaluate release 3.0 of Lotus 1-2-3. Is it enough to hold off improving competition? For the Mac, we look at Silicon Beach Software's SuperCard, which improves and expands on HyperCard.

IN DEPTH:

We'll be covering **optical technologies**. While we tend to think of these as something from the future, we have in fact had optical technologies for some time. Lasers and their many implementations (e.g., printers, LCDs, and LEDs) are an optical technology. So are CD-ROMs and other forms of optical storage. And we are constantly seeing announcements of some of the elements of optical computing: signals, interconnections, and forms of packaging. Even optical computing itself is being accomplished with varying amounts of success in academic laboratories. Indeed, rather than being something from the future, optical technologies appear to be one of the roads to it.

FEATURES:

This year marks the twenty-fifth anniversary of BASIC and the fifteenth anniversary of Bill Gates and Paul Allen's seminal implementation of BASIC for microcomputers. In our October issue, we'll present an **anniversary retrospective on BASIC** by Bill Gates.

We'll also take a look at **helical scan technology**, a method of storing data on magnetic tape that owes a great deal to the consumer VCR.

With the advent of desktop publishing, the **design of digital typefaces** has become increasingly important. We'll show how digital fonts are designed and implemented in a variety of systems.

Also, look for the regularly scheduled features of our columnists in both the **Expert Advice** and **Hands On** departments, industry news in **Microbytes**, new hardware and software of note in **What's New**, and the latest in noteworthy items tested by BYTE staffers in **Short Takes**. Readers outside North America, take note that the international Short Takes, Features, and What's New sections of your copies are bonuses, not substitutes for items appearing in the domestic version of the magazine.

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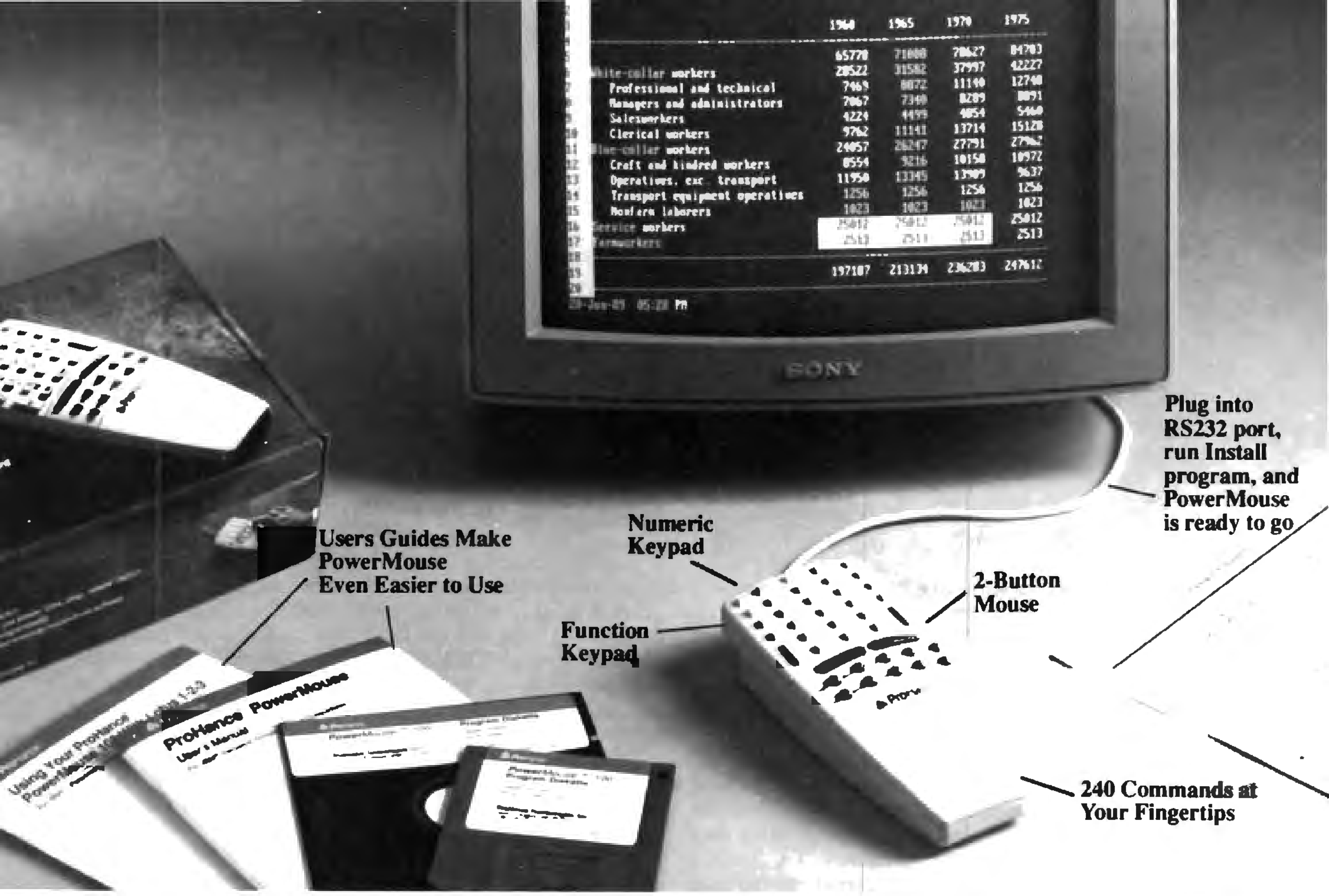

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Hugh Kenner

Putting Mike in a Box

THE RISE OF THE EXPERT COMPANY: How Visionary Companies Are Using Artificial Intelligence to Achieve Higher Productivity and Profits

by Edward Feigenbaum, Pamela McCorduck, and H. Penny Nii

In 1972, Hubert Dreyfus wrote the book *What Computers Can't Do*, which he says is pretty well anything that draws on diffuse experience. One story tells how a computer struck back by beating Dreyfus at chess. Still, chess experience, as he might have retorted, is anything but diffuse; it's fiercely concentrated, and experts have a monopoly. What they know can be arranged for a system to consult by way of decision trees.

The same, we're now learning, is true of other sorts of experience. How does your doctor decide you need a triple bypass? In the years I've been asking doctors a like question over the dinner table, I've not heard one coherent answer. What they know, they don't seem to know how they know. Yet, yes, it's formulable knowledge, so reducible to hard questions and hard answers that an expert system called MYCIN could simulate a huge range of diagnostic expertise. MYCIN, which dates from 1976, drew on more pooled experience about bacterial infections and optimal treatments than any one internist likely had, and it never suffered from distraction or sagging attention. It's become the stock instance of AI doing something useful at last.

You can buy an expert-system skeleton called 1st-Class for your microcomputer—no toy, it's one of several AI shells in use at DuPont—and use it to set up a savvy question-and-answer tree for a subject that concerns you. The manual's example: "I've a 7-oz package that must be in Omaha tomorrow (which isn't a Saturday), so what's my best gamble?" (Answer: Express Mail; but if the deadline is prior to 10:30 a.m., try Federal Express.) That draws on the know-how of a shipping-room expert. Call him Jack: 1st-Class has provided Jack-in-a-Box.

What Jack-in-a-Box advises you could figure out for yourself, if not as fast, from a master list of rates and schedules. The Mike-in-a-Box kept at DuPont is more interesting. Round the clock a massive distillation system runs, and the output *must* be 99.99 percent pure. A turnkey operation, you'd think? No. "The distillation column had to be watched constantly, and complex purges decided on the spot." The only man who had really mastered the art was an engineer named Mike. For 10 years, the routine for humbling smart-aleck upstarts was to place them where they had to do Mike's job.

Then, in a month of interviews, Mike's subtle web of understanding got transferred to an expert system. In effect, Mike is now available 24 hours a day and will stay on call long after he's retired. The savings are $100,000 a year.

Paging through the case histories found in *The Rise of the Expert Company*, I was struck by the commonness of Mike dependency, how often there's one crucial person who gets phoned at midnight about a crisis. And the very fact that help can be delivered over the phone makes it likely that an expert system can simulate the crucial person. On the screen, just as on the phone, questions are prompted by your answers to previous questions. Once the data is deemed sufficient, there's a recommendation. One expert said the chief benefit he'd received from AI was being able to count on unbroken sleep.

Another aspect of Mike dependency is this: The years that were steeping Mike in savvy also swept him toward retirement, so let's pray we can soon count on someone else showing comparable learning skills. Expert systems never retire, and they are readily modified as parameters are altered.

"The same corporate streamlining that affected most American firms in the early 1980s has reduced staff at DuPont by 30 percent since 1981, but that represents a loss of perhaps 70 percent in experience, since much of that reduction was through early retirement. A few hundred of those early retirees

continued

ILLUSTRATION: TIM TEEBKEN © 1989

are being brought back to have their expertise captured in expert systems that will help do the jobs they used to do themselves." And they love it. The AI people point to "the immortality syndrome."

The capture technique can vary. At Nippon-Kokan Steel, where it may take 20 years to train a blast-furnace operator (someone whose readings of several thousand sensors can keep the beast from dumping or else choking up), the very best operator came to be known as "God," and setting up an expert system so all the furnaces could be as well run as God's meant

The prime narrative theme of the book is how a mere hint that we might, ah, "automate Mike" impinges on corporate sociology. Knuckles whiten.

winkling out of him knowledge "even he didn't know he had." He's like those physicians I've talked to. At the other extreme, there exist Mikes who are so articulate you just turn on the tape recorder and stand back.

American Express, DEC, DuPont, Texas Instruments, Schlumberger, IBM, Toyota, Fujitsu, Westinghouse . . . they all have AI systems stowed away here and there (and decentralized DuPont has several hundred). Given the evident benefits of an automated Mike at strategic junctures, it all sounds open-and-shut. It wasn't and isn't. The prime narrative theme of the book is how a mere hint that we might, ah, "automate Mike" impinges on corporate sociology. Earflaps are buttoned, eyes averted. Knuckles whiten. Why?

Managers tend not to realize how dependent they are on a tiny platoon of Mikes, or how fragile that dependence is. (We've a system working here, haven't we?) Then there's the NIH (not invented here) syndrome: We know our business, let eggheads tend to theirs. Or the mention of Lisp and Prolog turns eyes glassy. Or you're talking about spending money, and we're comfortable where we are, amid a smooth payroll flow. Worst, if word gets to Mike himself prematurely, he'll panic. *Me?* replaced by a *robot*?

No, he won't be replaced, he'll be assisted; it's important to have the word reach him in that form, so put that he'll crave the assistance. Generally, in scenario after scenario, what has paid off in happy Mikes and million-dollar savings has been the zeal of some middle-level person who understood just the right way to keep persisting.

At American Express, a man named Robert Flast worked month in, month out, against all manner of corporate obstruction, until a system was in place that automates the vetting of an unexpected credit request phoned in by, say, a book dealer in Paris. In effect, it automates a 5-inch-thick manual of which humans were supposed to recall any relevant detail in a 70-second time frame. (Say "no" wrongly, and you've lost a transaction. Say "yes" wrongly, and you've pointed yet another file to the bad-debt basket.) The annual yield of the AI system, which simply lets a human decide from improved information, is estimated at $27 million. (And a human who doubts the system's recommendation can ask it to outline its reasons.)

And at Northrop Aircraft, Ken Lindsay and Bob Joy took the "Ken and Bob Show" (an Apple on a dolly, with a demonstration program hacked in BASIC) to office after office in building after building till they'd gotten agreement that a system called ESP could automate the immensely intricate and often wasteful process of scheduling the flow of 20,000 parts into a jet fighter (speedup factor: 12 to 18).

And at Texas Instruments, a man named Harry Tennant landed the firm a $50 million Air Force contract when the firm wasn't yet convinced that its newly formed AI division had been a good idea. Stories about MYCIN ("but when you've heard those stories once you don't want to hear them again"), demonstrations of Lisp prototyping ("but Lisp can seem to be all about matching parentheses")—such had been about the state of the action when Uncle Sam came fishing for a system whereby decision makers who were too far along in their careers to bother with computer language could query a big database in plain English. TI asked for a data sample, the Air Force obliged, and Tennant had a demonstration program running in five days. He even makes it sound easy: "I worked late one night."

The Rise of the Expert Company is chatty and ill-structured and laden with redundancy and badly needs an index—but is still worth your time. Whether *Natural Computation: Selected Readings*, which is edited by Whitman A. Richards, merits your time depends on you. It's a fat paperback compilation of college-course readings, replete with sentences like—hold your breath—

"Human walking is a very complicated activity in which the cyclic movements of the lower extremities translate the body in the forward direction. These movements are due to the action of muscles, which in turn are coordinated by the nervous system."

True, and human writing results from twitching of the fingers. These are learned papers, with coauthors and academic addresses and kudos to granting bodies. What they're about, though, isn't risible: efforts to get a computational handle on all manner of human activity, starting with vision. That was AI's old plenary dream, before expert systems (in the purist view) reduced it to compacted instruction manuals. Have a look at #4 on the Cartoon Algorithm, which addresses from another angle the art historian Ernst Gombrich's classic question: How do we recognize a caricature when most "information" is missing and what's left is demonstrably wrong? Or at #12, where a Connection Table shuttles the reader between visual and verbal presentations, not omitting freaks like Milne's heffalump and Penrose's triangle. Or at . . . well, *you* go and look. ■

The Rise of the Expert Company, *Times Books, New York: 1988, 322 pages, $19.95*

Natural Computation, *MIT Press, Cambridge, MA: 1988, 561 pages, $25*

Hugh Kenner is a professor of English at Johns Hopkins University. His reviews have appeared in publications like the New York Times *and* Harper's. *His recent books include* A Sinking Island *and* Mazes. *He can be contacted on BIX as "hkenner."*

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

PACHYDERMIC PERSONNEL PREDICTION

A bold new proposal for matching high-technology people and professions

Over the years, the problem of finding the right person for the right job has consumed thousands of worker-years of research and millions of dollars in funding. This is particularly true for high-technology organizations where talent is scarce and expensive. Recently, however, years of detailed study by the finest minds in the field of psychoindustrial interpersonal optimization have resulted in the development of a simple and foolproof test to determine the best match between personality and profession. Now, at last, people can be infallibly assigned to the jobs for which they are truly best suited.

The procedure is simple: Each subject is sent to Africa to hunt elephants. The subsequent elephant-hunting behavior is then categorized by comparison to the classification rules outlined below. The subject should be assigned to the general job classification that best matches the observed behavior.

Classification Guidelines

Mathematicians hunt elephants by going to Africa, throwing out everything that is not an elephant, and catching one of whatever is left. Experienced mathematicians will attempt to prove the existence of at least one unique elephant before proceeding to step 1 as a subordinate exercise. Professors of mathematics will prove the existence of at least one unique elephant and then leave the detection and capture of an actual elephant as an exercise for their graduate students.

Computer scientists hunt elephants by exercising Algorithm A:

1. Go to Africa.
2. Start at the Cape of Good Hope.
3. Work northward in an orderly manner, traversing the continent alternately east and west.
4. During each traverse pass,
   a. Catch each animal seen.
   b. Compare each animal caught to a known elephant.
   c. Stop when a match is detected.

Experienced computer programmers modify Algorithm A by placing a known elephant in Cairo to ensure that the algorithm will terminate. Assembly language programmers prefer to execute Algorithm A on their hands and knees.

Engineers hunt elephants by going to Africa, catching gray animals at random, and stopping when any one of them weighs within plus or minus 15 percent of any previously observed elephant.

Economists don't hunt elephants, but they believe that if elephants are paid enough, they will hunt themselves.

Statisticians hunt the first animal they see n times and call it an elephant.

Consultants don't hunt elephants, and many have never hunted anything at all, but they can be hired by the hour to advise those people who do. Operations research consultants can also measure the correlation of hat size and bullet color to the efficiency of elephant-hunting strategies, if someone else will only identify the elephants.

Politicians don't hunt elephants, but they will share the elephants you catch with the people who voted for them.

Lawyers don't hunt elephants, but they do follow the herds around arguing about who owns the droppings. Software lawyers will claim that they own an entire herd based on the look and feel of one dropping.

Vice presidents of engineering, research, and development try hard to hunt elephants, but their staffs are designed to prevent it. When the vice president does get to hunt elephants, the staff will try to ensure that all possible elephants are completely prehunted before the vice president sees them. If the vice president does see a nonprehunted elephant, the staff will (1) compliment the vice president's keen eyesight and (2) enlarge itself to prevent any recurrence.

Senior managers set broad elephant-hunting policy based on the assumption that elephants are just like big field mice, but with deeper voices.

Quality assurance inspectors ignore the elephants and look for mistakes the other hunters made when they were packing the jeep.

Salespeople don't hunt elephants but spend their time selling the elephants they haven't caught, for delivery two days before the season opens. Software salespeople ship the first thing they catch and write up an invoice for an elephant. Hardware salespeople catch rabbits, paint them gray, and sell them as desktop elephants.

Validation

A validation survey was conducted about these rules. Almost all the people surveyed about these rules were valid. A few were invalid, but they are expected to recover soon. Based on the survey, a statistical confidence level was determined. Ninety-five percent of the people surveyed have at least 67 percent confidence in statistics. ■

ACKNOWLEDGMENT
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Peter C. Olsen is a registered professional engineer and a lieutenant commander in the Coast Guard Reserve. He can be reached on BIX as "pcolsen."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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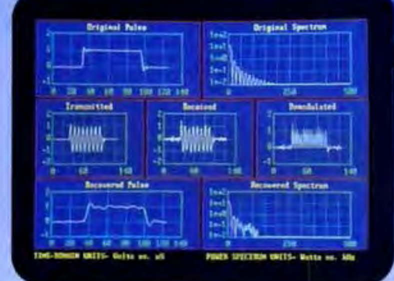

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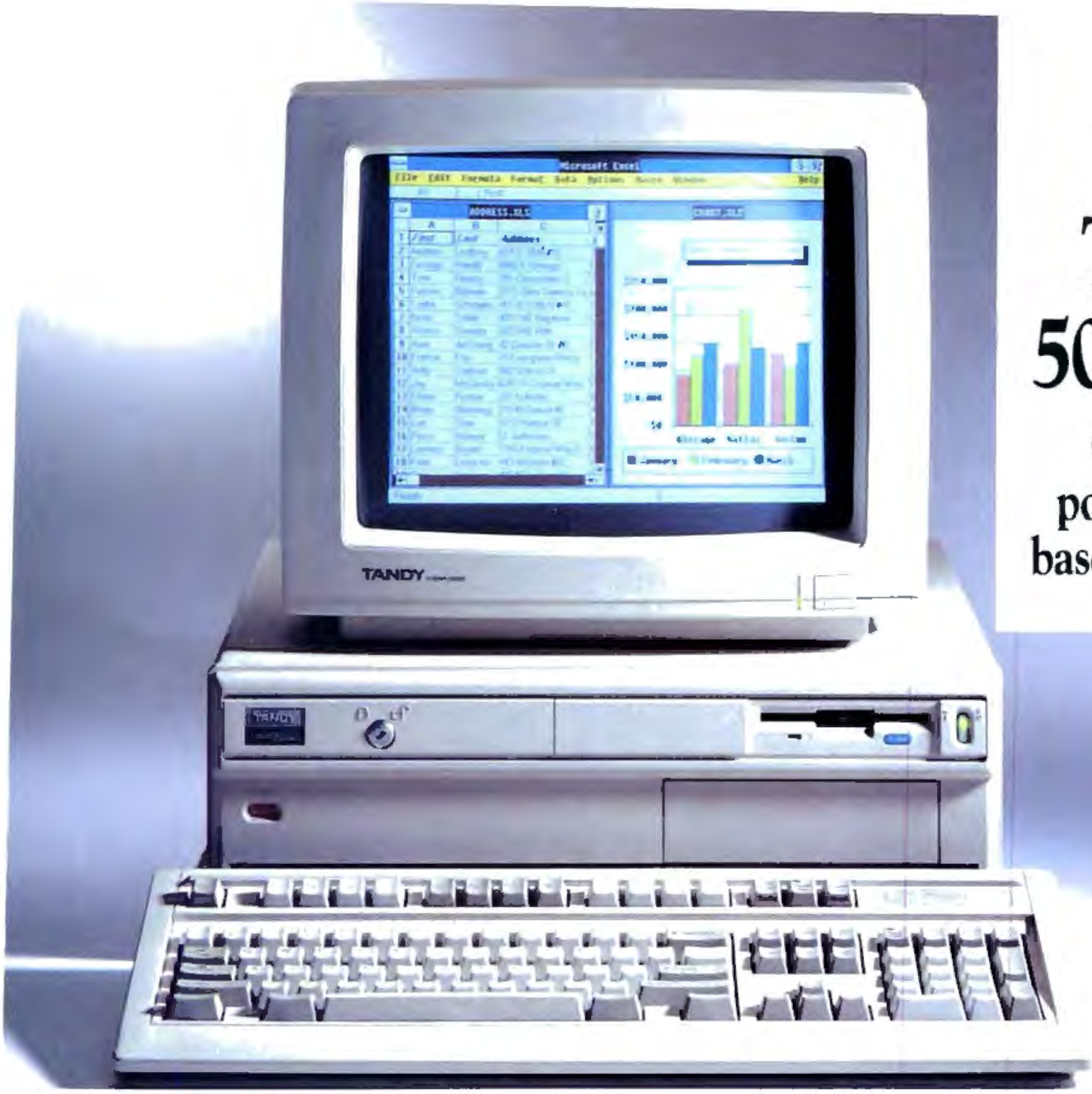

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